Impact of an education intervention addressing risk factors for iron deficiency among mothers and their young children in Northern Ghana

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DECLARATION

I certify that the thesis hereby submitted by me for the PhD (Nutrition) at the University of the Free State, is my independent effort and has not previously been submitted for a degree at another university/faculty. I furthermore waive copyright of the thesis in favour of the University of the Free State.

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DEDICATION

Dedicated to my family; James Wanlu Abu (late), Alimata Abu, Thelma Zulfawu Abu, Rahinatu Suleman and Benjamin Kaleonaa Abu.

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LIST OF ABBREVIATIONS

Acronym	**Full Meaning**
ACD	Anemia of Chronic Diseases
AF-ALB	Aflatoxin B (1)-Lysine Adducts
AHA	Assuring Health for All
AI	Adequate Intake
AIDS	Acquired Immune-Deficiency Syndrome
BMI	Body Mass Index
CBS	Community Based Surveillance
CHPS	Community-Based Health Planning and Services
CIAT	International Center for Tropical Agriculture
CIOMS	Council For International Organisations of Medical Sciences
CRC	Child Record Card
CRP	C-Reactive Protein
CV	Coefficient of Variation
DALYs	Daily-Adjusted Live Years
Dcytb	Duodenal Cytochromes B
DMT1	Divalent Metal Transporter 1
EAR	Estimated Average Requirement
EER	Estimated Energy Requirement
EDTA	EthyleneDiaminetetraacetic Acid
EBF	Exclusively Breastfed
ECUFS	Ethics Committee University of The Free State
ESA	Development Economics Division
ESPGHAN	European Society for Pediatric Gastroenterology, Hepatology and Nutrition
Fe	Iron

FFQ	Food Frequency Questionnaire
FIVIMS	Food Insecurity and Vulnerability Information For Mapping Systems
GAIN	Global Alliance for Improved Nutrition
GDHS	Ghana Demographic and Health Survey
GHS	Ghana Health Service
GLSS	Ghana Living Standard Survey
GSS	Ghana Statistical Service
HAPA	Health Action Process Approach
HAZ	Height-for-Age Z-Score
HBM	Health Believe Model
HCP1	Heme Carrier Protein1
HCP1	Heme Carrier Protein1
HFE	Hemochromatosis
HIV	Human Immune-deficiency Virus
HJV	Hemojuvelin
Hp	Haptoglobin
Hpx	Haemopexin
HRG	Heme-Regulated Gene
ICN	International Conference On Nutrition
ID	Iron Deficiency
IDA	Iron Deficiency Anemia
IDD	Iodine Deficiency Disorders
IDEA	Project Iron Deficiency Elimination Action
IFPRI	International Food Policy Research Institute
ILSI	International Life Sciences Institute
INACG	International Nutritional Anemia Consultative Community
IQ	Intelligence Quotient

IRB	Institutional Review Board
IRP	Iron Regulatory Proteins
ISC	Iron-Sulfur Cluster
IUD	Intra-Uterine Device
KAB	Knowledge, Attitude and Behaviour
KAP	Knowledge, Attitude and Practices
KVIP	Kumasi Improved-Ventilated Pit
LBW	Low Birth Weight
MFP	Meat, Fish and Poultry
MICS	Multiple Indicator Cluster Survey
MoH	Ministry of Health
MOST	USAID Mirconutrient Program
NaFeEDTA	Sodium Iron EthyleneDiaminetetraacetic Acid
NGO	Non-Governmental Organizations
NMIMR	Noguchi Memorial Institute of Medical Research
NRAMP	Natural Resistance –Associated Macrophage Protein
NRAMP1	Natural Resistance –Associated Macrophage Protein 1
RA	Research Assistant
RBC	Red Blood Cells
RBV	Relative Bioavailability Value
RCH	Reproductive and Child Health
RDA	Recommended Daily Allowance
SCT	Social Cognitive Theories
SI	Serum Iron
SLC	Solute Carrier
SLC11A1	Solute Carrier Family 11 (Divalent Metal Ion Transporters), Member 1
SLC11A2	Solute Carrier Family 11 (Divalent Metal Ion Transporters) Member 2

SLC11A3	Solute Carrier Family 11 (Divalent Metal Ion Transporters) Member 3
SLCA2537	Slc Transporter Mitoferrin
STEAP	Six Transmembrane Epithelial Antigens of The Prostate
TBAs	Traditional Birth Attendants
TF	Transferrin
TFR	Transferrin Reductase
TIBC	Total Iron-Binding Capacity
TMPRSS6	Transmembrane Protease, Serine 6
TRF	Transferrin Reductase
TZ	Tuo-Zaafi
UL	Upper Levels
UNDP	United Nation Development Programme
UNICEF	United Nations Children Fund
UNU	United Nations University
USAID	United States of America International Develeopment
USDA	United States Department of Agriculture
WAZ	Weight-for-Age Z-Score
WHO	World Health Organisation
WHZ	Weight-for-Age Z-Score
WRA	Women of Reproductive Age

GLOSSARY

Bambara bean is a highly nutritious legume or groundnut.

Banku is prepared from fermented maize meal dough, and cassava dough, and salted.

Baobab leaves are leaves from the baobab, usually used for soup by pounding the wet leaves or dried leaves. Soup from the leaves is usually eaten with TZ.

Bitor/Bra leaves are the leaves of *Hibiscus sabdariffa* used for soup preparation or mostly mixed with peanut or okra as a sauce for TZ.

Dawada is a condiment prepared from the fermented seed of the locust tree. The yellowish pulp of the fruit is also fruit and is a good source of beta carotene.

Koko is porridge made from maize or millet or a combination of the two flours, typically used as a complementary foods introduced to breastfed children.

Koose is a cake made from a paste from cowpea powder (ground dry) which is fried.

Kola nuts are bitter caffeine-containing chestnut-sized seeds of the kola tree used as a masticatory, and as a flavouring ingredient in beverages.

Nkontomire leaves of cocoyam, which is similar to spinach.

Shea butter is the oil extracted from the shea kernel (‘nut’). Shea trees grow in the wild and the shea fruit is also edible.

Teff is a grain from an annual grass, called “Williams lovegrass” in Ethiopia.

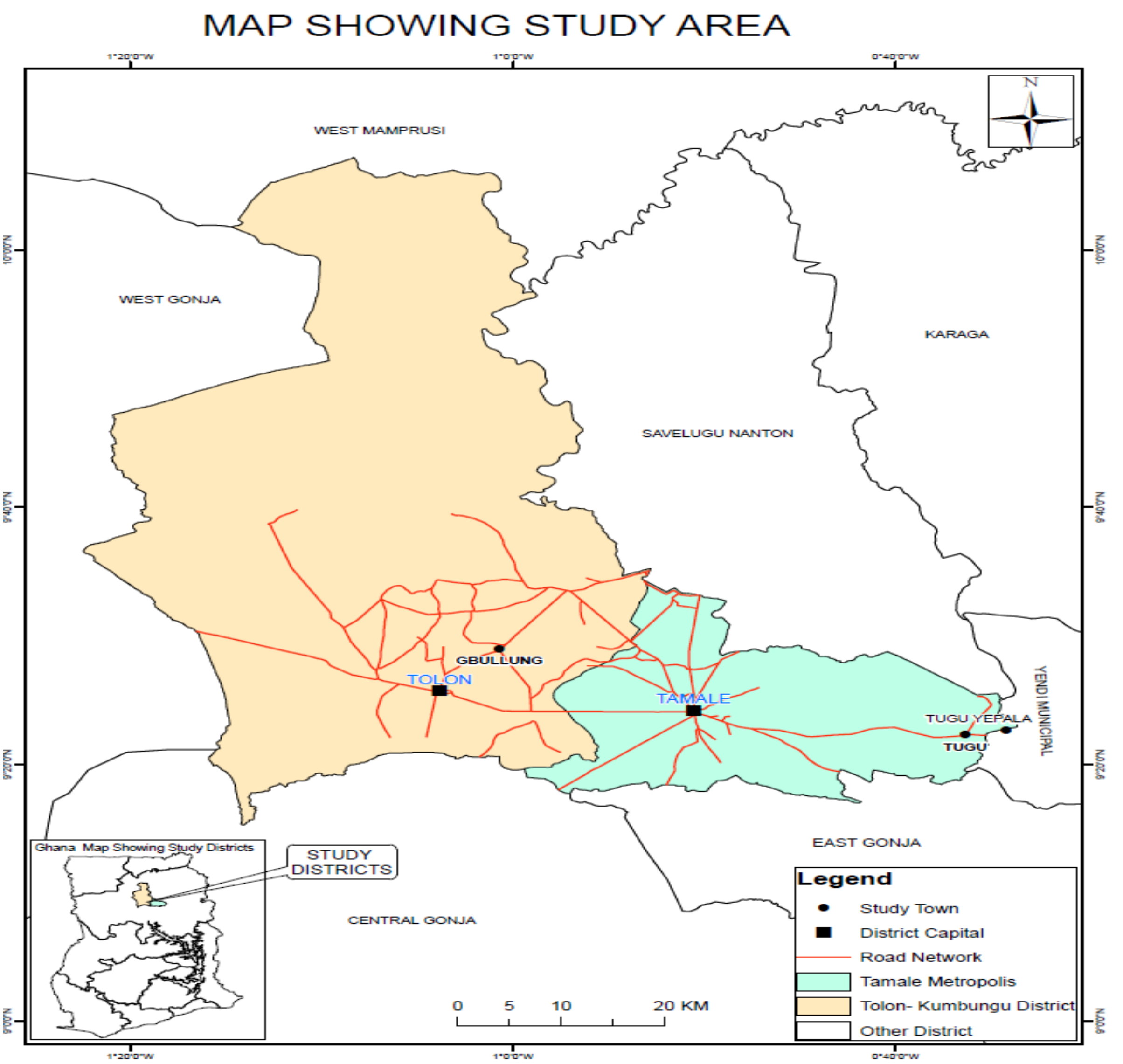
Tubani is made from a paste of cowpea powder (ground dry), which is steamed, and eaten with sauces or with shea butter oil.

Tuo-zaafi is a thick porridge prepared from fermented maize meal and cassava flour.

Yama, also called *Apapransah*, is a thick porridge prepared from maize which is soaked overnight, ground wet, dried in the sun, and further ground into a very fine flour, which is added to a light soup prepared from tomatoes, onion and fish powder.

Wean mix is a porridge made from roasted corn, beans, and peanuts, mostly used as complementary foods to breastfed children.

MAP SHOWING STUDY AREA



LIST OF PUBLICATIONS AND CONFERENCE PRESENTATIONS

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1. Abu BAZ, Louw VJ, Raubenheimer JE & van den Berg VL. 2014. Effectiveness of a nutrition education intervention to improve knowledge, attitudes and practices regarding; *South African Journal of Clinical Nutrition*, 27(3):145. Available at: http://reference.sabinet.co.za/webx/access/electronic_journals/m_sajcn/m_sajcn_v27_n3_a12.pdf

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3. Abu BAZ, Louw VJ, Dannhauser A, Raubenheimer JE & van den Berg VL. 2013. Knowledge, attitudes, and practices regarding iron deficiency among mothers in an anemia endemic population in Northern Region of Ghana. *Maternal and Child Nutrition*, (9) Suppl. 3:1. Available at: http://onlinelibrary.wiley.com/doi/10.1111/mcn.12094/pdf

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3. Abu BAZ, Louw VJ, Raubenheimer JE & van den Berg VL. Incorporating adult learning principles in an intervention implementation. Experiences from an Iron Deficiency (ID) education program in Ghana. *Poster presentation: Micronutrient Forum, 2nd - 6th June, 2014, Addis Abba, Ethiopia.*

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CHAPTER ONE (1):

INTRODUCTION AND MOTIVATION FOR THE STUDY

This chapter outlines the background of, and justification for this study.

1.1 Introduction

Anemia is a condition in which the number of red blood cells (RBC) or their capacity to carry oxygen is no longer sufficient to meet physiologic needs (WHO, 2001). The consequent low level of iron cause weakness and exhaustion, has a negative influence on immunity, and impairs cognitive development of children (Bunn, 2011:1033). Globally, anemia is also one of the major causes of death among women and children younger than 5 years. In 2000, anemia affected about 3.5 billion people in developing countries (ACC/SCN, 2000). A recent review of nationally representative surveys from 1993 to 2005 reported that anemia affects 42% of pregnant women and 47% of preschool children worldwide (MacLean *et al.*, 2007). In Africa, about 65% of people of all age communities suffer from anemia (Benoist *et al.*, 2008), of which 50% is attributed to iron deficiency (ID) (McLean *et al.*, 2007). Nutrition education programmes (NEPs) and other interventions aimed at preventing the development of ID are therefore important, especially in low-income countries, to reduce the global burden of anemia and the cost of managing the condition.

1.2 Background

Ghana is in the western part of Africa, bounded to the north by Burkina Faso, to the east by Togo, to the south by the Atlantic Ocean, and to the west by Côte d'Ivoire (Figure 1.1). Geographically the country is divided into the Southern and Northern Sectors and these are further divided in 10 administrative regions. The Southern Sector is divided into the Volta, Brong Ahafo, Greater Accra, Ashanti, Eastern, Western, and Central Regions; and the Northern Sector into the Upper West, Upper East, and Northern Regions. The capital city is Accra situated in the Greater Accra Region. These 10 regions are further divided into 138 districts, which, for the purpose of decentralisation, are further divided into sub-district administrations.

Figure 1.1: Map of Ghana and the ten regions

Ghana has 75 ethnic communities, and English is the official language, although nine of the local languages are also taught formally in schools. According to the 2010 census, the population of Ghana was about 24 million, with 51% females and 49% males (Ghana Statistical Service (GSS, 2011). About 70% of the total population lives in the southern half of the country. Two-fifths of the populations follow the traditional religion. The Christian population accounts for two-fifths of the total population and includes Roman Catholics, Baptist, and Protestants. The Muslim population, which makes up 12% of the population, is located predominantly in the northern part of the country.

According to the national census of 2010, literacy (referring to those that can read and write a simple sentence) among the population of 15 years and older, was 71.5%; and was higher among males (78.3%) than females (65.3%) (GSS, 2012:42). In the three northern regions however, literacy rates are low among the general population, ranging from 32% to 41% (GSS, 2012:42).

According to the millennium development goal indicators, in 2006 about a third (28.6%) of the Ghanaian population was living below US$ 1.25 per day (Millennium Development Goals Indicators, 2014: online). Poverty is most prevalent in the rural areas and across the three northern regions of Ghana (Hong, 2007:377; UNDP, 2005:6, 60). Food insecurity is endemic in Northern Ghana where communities experience food insecure periods ranging between three to seven months per year. The worst affected is the Upper East Region, which has the longest food insecurity period lasting six months per year. The Northern and Upper West Regions are the second most affected with food insecurity lasting five months per year (Quaye, 2008:339).

The main cash crops are cocoa, timber, and pineapples, while mining (mainly gold) has become one of the biggest sources of foreign exchange. The more recent discovery of oil hopes to bring in more revenue. The emerging industrial sector's products include cassava, fruits, and cocoa by-products (Facts about Ghana, 2011: online; GhanaWeb, 2011: online).

Ghana has three main types of vegetation, namely the coastal and forest vegetation found in the southern sector, and savanna found in the northern sector. The climate in the forest zone is characterised by heavy rainfall. Two rainy seasons enable crops like cocoa, cassava, pineapples, and cocoyam to grow very well. The savannah zone has one major raining season allowing crops like groundnut, millet, yam, maize, and beans. In the Northern Sector, some non-governmental organizations (NGOs) are supporting agriculture through irrigation programmes, which have positively affected food production, and the nutritional status of the population in this area (Steiner-Asiedu *et al.*, 2012; Abu *et al.*, 2010). A large proportion of the population depends on agriculture, for food, and as a source of income; however in the northern sector the farmers are mostly reliant on subsistence farming. Women contribute greatly to the work force in Ghana, especially in the agricultural sector.

1.3 General nutritional status of women and children in Ghana

In the 2008 Ghana Demographic and Health Survey (GDHS, 2008), 9% of women of reproductive age (WRA) (15-49 years) had a body mass index (BMI) of less than 18.5 kg/m^2, indicating underweight, and 59% of WRA and 65% of pregnant women were anemic. Among pregnant women, 2.7% were HIV positive. On the other hand, 30% of WRA were obese, which represented an increase of 5% over the previous five years (GDHS, 2008:199-203). This illustrates the double burden of malnutrition often recorded in developing countries, with underweight and overweight co-existing in the same communities (Prentice, 2006:97-98). This was also evident among children younger than 59 months, with a prevalence of 14% underweight, 9% wasting and 28% stunting on the one hand, and 5% obesity on the other. In this age group, deficiencies in vitamin A affected 72%, and anemia 78% (GDHS, 2008). Other nutrition gaps illustrated in the national survey were suboptimal breastfeeding and complementary feeding practices. Though 98% of children had been breastfed at some time, only 63% were exclusively breastfed for the first 6 months. In addition, 36% of children (6-23 months) were fed according to the WHO Infant and Young Child (IYCF) guidelines (GDHS, 2008).

Though no national data for zinc deficiency are available, a study involving 101 rural Ghanaian children (2-10 years old) found that 40.5% had low serum zinc concentrations (Egbi, 2012:5947). The International Zinc Nutrition Consultative Group (IZiNCG) estimated the risk of inadequate intake of zinc among Ghanaians to be 21%, which they categorise as medium risk (Hotz & Brown, 2004:S194). This coupled with the reported rate of stunting (28%) (Saaka *et al.*, 2009:55; Hotz & Brown, 2004:S194), supports the need for the promotion of zinc food sources and supplementation in severe cases.

As a prelude to the national iodisation of salt, a survey in 1994 indicated that iodine deficiency affected 33% of communities sampled by the Ministry of Health (MoH) and the University of Ghana (MoH/UG, 1994). Since then, no national survey on iodine deficiency has been published, in spite of the fact that the National Salt Fortification Programme has been running since 1996 (Nyumuah *et al.*, 2012) and iodised salt is being consumed by a third (32.4%) of the population (MICS, 2006:25).

According to the GDHS (2008:194,198) the prevalence of both micronutrient and macronutrients deficiencies in the three northern regions of Ghana appear to be higher than the national averages.

1.4 Anemia

Anemia is defined as a deficient hemoglobin concentration, which is also reflected in abnormally low hematocrit and RBC counts. This deficiency may result from blood loss, inadequacy of one or more essential nutrients for blood formation, suppressed RBC production processes, or increased RBC destruction. The cut-off level for hemoglobin may differ according to age, gender, and the altitude of area of residence (Bunn, 2011). Table 1.1 lists the WHO hemoglobin cut-off points to diagnose anemia at sea level. Because pregnancy causes hemodilution (Gibson, 2005), the cut-off point for pregnant women are lower.

Table 1.1: Hemoglobin cut-offs to diagnose anemia at sea level (g/dl) (WHO, Vitamin and Mineral Nutrition Information System) (WHO/UNICEF/UNU, 2001).

Population	Non-anemia	Mild anemia	Moderate anemia	Severe anemia
Children 6 - 59 months of age	≥11.0	10–10.9	7 – 9.9	<7
Children 5 – 11 years of age	≥11.5	11.0-11.4	8.0-10.9	<8
Children 12 - 14 years of age	≥12.0	11.0-11.9	8.0-10.9	<8
Non-pregnant women (≥ 15 years)	≥12.0	11.0-11.9	8.0-10.9	<8
Pregnant women	≥11.0	10.0-10.9	7.0-9.9	<7
Men (≥ 15 years)	≥13.0	11.0-12.9	8.0-10.9	<8

Anemia is caused by nutritional and non-nutritional factors. Anemia related nutritional factors include iron deficiency anemia (IDA), as well as megaloblastic anemia due to folate and/or vitamin B_{12} deficiency. Examples of non-nutritional anemia include aplastic anemia (due to bone marrow failure), and various types of genetic abnormalities of hemoglobin. Some of the inherited anemias include sickle cell anemia, thalassemia, and glucose-6-phosphate hydrogenase (G6PD) deficiency (Bunn, 2011:1031-1039).

1.5 The impact of anemia and ID on women and young children

IDA is the most common form of anemia (WHO, 2001:15), representing 50% of cases worldwide (McLean *et al.*, 2007:3). IDA is also one of the ten leading global risk factors in terms of the associated disease burden (McLean *et al.*, 2007:3). The most vulnerable communities to develop ID are young children (less than 5 years), pregnant and lactating women, and adolescents (Agarwal, 2010:2). The physiological functions of women (menstruation, pregnancy, and lactation) make them vulnerable to anemia, particularly IDA (Agarwal, 2010:2). Pregnant women have an increased need for iron to support the growth and development of the fetus and anemia in pregnancy affects not only the fetus, but may threaten the mother's life. Young children are vulnerable for ID due to increased needs for iron for growth and development (Agarwal, 2010:2). Iron needs in adolescence increase to meet the demands of the growth spurt. The onset of menstruation in girls adds to their increased iron needs (Denic & Agarwal, 2007). Clinical IDA is preceded in both genders and in all age categories, by low body stores of iron (sub-clinical ID) which advances as IDA with clinical symptoms, in times of physiological stress (Denic & Agarwal, 2007; Bunn, 2011).

The consequences of anemia can be detrimental and even life threatening for both mothers and children. Due to the decrease in oxygen carrying hemoglobin, physical signs and symptoms of anemia includes pale skin and pale conjunctiva, as well as hypothermia, as blood is diverted from the body surfaces to the vital organs (Bunn, 2011:1033) Anemia also result in dyspnea, increased heart rate, increased cardiac output, headaches, dizziness and sometimes vertigo, tinnitus or syncope (Bunn, 2011:1032-1033). Some people become irritable, which affects the attention span and negatively impact on education and productivity (Bunn, 2011:1033; Lozoff *et al.,* 2006). Others symptoms include insomnia which in chronic situations leads to impaired physical development. Some physical signs associated with anemia may suggest the type of anemia; for example, angular stomatitis may indicate pernicious anemia, while a smooth beefy tongue (glossitis) and koilonychias (spoon-shaped nails) are characteristics of IDA (Bunn, 2011:1033).

1.6 Risk factors for ID and IDA among women and young children

The risk factors for ID may be divided into four main sectors for the purposes of this study; including socio-demography and medical histories of women and children; dietary factors which impact on iron status and overall nutritional status; pica practices; and knowledge, attitudes and practices regarding the known risk factors for ID and IDA.

1.6.1 Medical history and socio-demography

The development of IDA occurs in stages with consistent depletion of iron stores without replacement, leading to ID and then to IDA (Cook and Skikne, 1989). Among women, losses due to menstruation, and other physiological expenditure may lead to IDA. The risk factor of each is dependent on the causes of anemia. Clinical anemia due to pregnancy is a cause of chronic ID, especially among women in Africa (Adam *et al.*, 2005: Ramakrishnan, 2002) usually resulting in premature delivery and low birth weight (LBW) (GDHS, 2008:193).

Infections affect iron status (WHO, 2001:8) due to malabsorption of iron and other nutrients necessary for normal iron and RBC physiology, during diarrheal episodes. Furthermore, infections cause anemia of chronic disease (ACD) because the inflammatory process inhibit erythropoiesis. These factors make environmental and personal hygiene important risk factors for ID management. Blood loss associated with parasitic infections such as worms, malaria, also contributes significantly to ID, and anemia levels (Thurnham & Northrop-Clewes, 2007:240-241). ACD also affects people with chronic illness and infections such as HIV/AIDS and kidney disease (Zaritsky, 2009:1055).

A recent study showed that in Ghana, children of mothers with little or no education are most affected by anemia (Abu *et al.*, 2010:124). Thus, the overall medical history and socio-demography of mothers and children are important to understand anemia in the context of a particular community.

1.6.2 Dietary factors

Chronic inadequate dietary intake of iron sources is a major cause of ID, whereas the regular intake of other nutrients, including vitamin A and C at adequate levels, also directly affect iron status, as is discussed in more depth in chapter 2. Similarly, regular inadequate intakes of folate and vitamin B_{12} are associated with pernicious anemia and megaloblastic anemia.

The iron content of the diet is however not the only dietary factor that determines iron intakes. The amount of iron absorbed is usually much lower than the iron content of the food consumed, and is affected by the physiological state of the body, the chemical state of the iron in food, the nature of the food eaten and the overall composition of the diet (Gibson & Ferguson, 2008:105).

Protein deficiency may also lead to ID/anemia due to decreased synthesis of the transport proteins, which affects the transport of nutrients, which are necessary for erythropoiesis. Protein deficient individuals may therefore have enough iron in their diets, but their bodies are not able to transport it to the cells, for normal physiological functioning (Agarwal, 2010:2).

Food security, defined as the availability of culturally safe foods all year round, is therefor relevant to ensure adequate iron intake at all levels (FAO, 2006). Foods security level is measured in terms of food availability, quality and acquisition (FAO, 2006; Abu *et al.*, 2010).

1.6.3 Pica practices

Pica is defined as the craving and compulsive intake of non-food substances and sometimes a craving for, and/or excessive ingestion of, specific food substances (Louw *et al.,* 2007). A strong association between pica and IDA was observed for the first time over 40 years ago (Reynolds *et al.,* 1968) and has since been confirmed in many studies, for example among non-pregnant outpatients (Barton *et al.,* 2010; Barton *et al.,* 2000). The intake of non-food substances such as clay and soil may pose the risk of worm infestation and intestinal bleeding, which in turn increase the risk for ID and IDA (Tano-Debrah & Bruce-Baiden, 2010:10).

1.6.4 Knowledge, attitudes and practices (KAP) regarding ID

Good practices to avoid the risk factors for ID and pica reduce the occurrence and severity of anemia in communities and populations (GDHS, 2008). Knowledge and attitudes, in turn, influences practices (Leung *et al.*, 2004). Therefore, an intervention that addresses knowledge, attitude and practices (KAP), can address the root causes of dietary behaviours (WHO, 2008:16).

A good example of this concept is iron supplementation among WRA to prevent anemia. Compliance among these women to iron supplementation is often poor due to lack of knowledge of how to manage the common gastro-intestinal side effects, or the mere fear of these side effects. Other women simply forget to take the supplement. Furthermore, studies have found that negative attitudes of communities towards supplementation could also contribute to the poor compliance. For example, in certain communities, people believe that a pregnant woman who takes iron pills will have a very large baby (Galloway *et al.*, 2002; Galloway & McGuire, 1994; Stoltzfus & Dreyfuss, 1998:21-25). Women learn some of these myths from family members, like grandmothers, who play a central role in childcare, as well as from their communities (Aubel, 2012).

1.7 Interventions addressing ID/IDA

Emphasis on bioavailable dietary iron sources within households, coupled with nutrition education, are theoretically the most cost-effective way to increase iron intake and prevent ID and IDA. In circumstances where foods with bioavailable iron are not available, fortification of commonly consumed foods improves access to iron (Hurrell, 2002), while supplementation (tablets or syrup) in high risk situations, such as pregnant women in highly affected areas, is another approach (Venkatesh Mannar, 2007:14). In all of these approaches, however, nutrition education is important. Nutrition education messages usually target improving knowledge, which may then translate to positive beliefs and practices (Balachander, 1991). Thus, the design of a NEP should endeavor to fill knowledge gaps. Practices such as cooking practices have the ability to influence iron absorption and bioavailability from foods (Porres *et al.*, 2001), as will be discussed in chapter 2. The implementation of NEPs should engage participants with simple doable messages to ensure the success of the intervention. Effectively monitoring and evaluation of these NEPs may also teach important lessons (Oshaug, 2011).

1.8 Problem Statement

According to the GDHS 2008, the prevalence of anemia among Ghanaian children and women at national level is high, and in northern Ghana the prevalence's in both physiological communities is even higher. Though the specific causes of the anemia in these regions are not documented, studies have shown that 50% of anemia worldwide is attributable to iron deficiency (WHO, 2001:15). Based on analysis of the NHANES 1976-80 data, it was suggested that, if the overall anemia prevalence in a population is above 40%, as is the case in these regions of Ghana, it may be assumed that the entire population suffers from some degree of iron deficiency (ID) (Maclean *et al.,* 2007: Asobayire *et al.,* 2001). Therefore, IDA according to the Ghana Health Service (GHS, 2003) and the GDHS (2008:193) may be expected to contribute substantially to anemia in northern Ghana.

To date no study on the KAP associated with ID in Ghana has been published. Similarly very little is known about pica practices in children and non-pregnant women in Ghana. In 1971, Vermeer reported pica practices among 46% of free living people in Ghana (Vermeer, 1971), but since then scientific literature on pica in Ghana has been scant and the few published studies mainly relate to the practice of pica among pregnant women (Mensah *et al.,* 2010; Tayie & Lartey, 1999).

A mother's exposure to nutrition education may increase her nutritional knowledge and influence her attitudes and practices towards improving her health and that of her children (Leung *et al.,* 2005). No published study to date has however used this approach to address anemia in Ghana.

1.9 Purpose of the study

This study intended to investigate the socio-demographics, nutritional status and KAP regarding pica and other known risk factors of ID, among mothers and their children, six to 59 months old, in the Northern Region of Ghana where the prevalence of anemia is known to be high. The study further intended to address the KAP with a targeted NEP based on the baseline findings; and to evaluate the success of this intervention.

1.10 Aims

The study first aimed to establish and describe the baseline socio-demographics, nutritional status, KAP regarding known risk factors for iron deficiency and anemia, and the prevalence of pica, among of mothers and their children six to 59 months old, in an area of Northern Ghana with known high prevalence of anemia. The second aim was to design and implement a NEP to address the risk factors for ID identified in the baseline, and to evaluate the impact thereof in this study population.

1.10.1 Objectives

In order to achieve the aims of the study, the study was conducted in three phases, each with the following objectives.

1.10.1.1 Phase I (Baseline)

The objective of the first phase was;

- To determine the socio-demographic characteristics and medical background among mothers and their children six to 59 months old from two similar districts in an area of Northern Ghana;
- To assess the nutritional status (anthropometry, physical signs of IDA, dietary intake and household food security); among mothers and their children six to 59 months old from two similar districts in an area of Northern Ghana;
- To determine the prevalence and types of pica practices among mothers and their children six to 59 months old from two similar districts in an area of Northern Ghana;
- To assess the KAP of the mothers with children six to 59months regarding the known dietary and other risk factors for ID and pica.

1.10.2 Phase II

The objective of the second phase was to develop a NEP for mothers, based on the findings of the baseline phase, to address the known risk factors for ID identified in the study population.

1.1.1 Phase III

The objectives of the third phase was to implement the NEP among the same mothers from one of the two communities evaluated at baseline, using the second community as control; and to evaluate the impact of the intervention by repeating and comparing change in the following between the two communities. The obejectives are;

- To assess the change in nutritional status (anthropometry, physical signs of IDA, dietary intake and household food security); among mothers and their children six to 59 months old from two similar districts in an area of Northern Ghana;
- To assess the change in KAP of the mothers with young children regarding the known dietary and other risk factors for ID and pica.

1.11 Study Design

The study design is illustrated in figure 1.2.

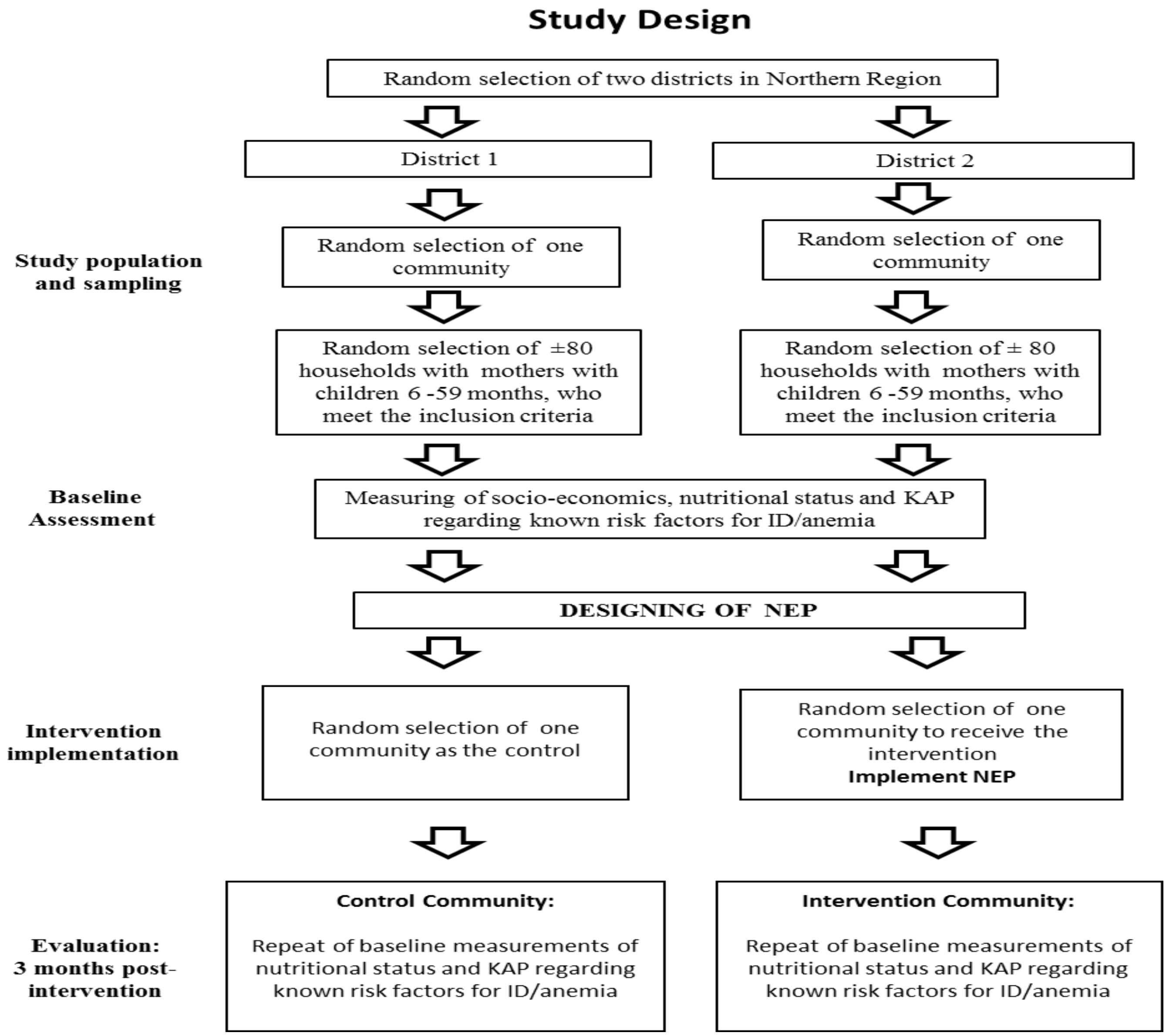

Figure 1.2: The study design

1.12 Structure of the thesis

This thesis is structured as a series of articles arranged according to the aims and objectives of the study.

Chapter 1 provides the background and motivation for the study.

Chapter 2 is an in-depth literature review of the variables investigated in the study, as well as related and relevant topics.

Chapter 3 outlines the methodology used in the study.

Chapters 4 to 11 consist of manuscripts prepared for publication in peer reviewed journals. The results reported in each of these manuscripts have been presented at various international congresses during 2013/2014. Each manuscript is introduced with the abstract(s) as accepted for oral or poster presentations.

Chapters 4 to 7 report and discuss the baseline findings regarding dietary and others risk factors of ID and pica among the mothers and their young children in the study population.

Chapter 8 discusses the design and implementation of the NEP to address the challenges identified at baseline; and

Chapters 9 to 11 evaluate the impact of the NEP. Each chapter was written to be able to stand as an independent manuscript; this may lead to some repatiiton of results such as the socio-demographic charactersitics.

Chapter 12 summarises the conclusions drawn from the study and the recommendations for future work and research.

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CHAPTER 2:

2 LITERATURE REVIEW

This chapter is an indepth review of iron physiology, the stages in the development of ID, risk factors for IDA, the consequences of IDA and the state of IDA in the world and in Ghana. The chapter futher dicusses pica, the relationship thereof with IDA, and the associated risks. Lastly the chapter explores the assessment of dietary iron intakes.

2.1 Introduction

In ancient Greece, Hippocrates documented the use of iron to treat a condition then called "chlorosis" which he described as a "disease of virgins." Though he was describing IDA, iron was not identified as the major constituent of blood until in the 18th century. By 1832, iron was used to treat young women with a lack of "colouring matter" in the blood. Soon afterwards, hemoglobin was discovered, and it was shown that a deficiency of iron decreases hemoglobin production (Reilly, 2004). Despite iron being one of the most extensively studied minerals, ID remains the most common nutritional deficiency worldwide.

2.2 Iron Physiology

As an integral part of the hemoglobin molecule in red blood cells (RBCs), iron is critical for transporting oxygen in the blood; while in muscle it forms an integral part of myoglobin which supplies oxygen to the muscles (Gallagher, 2008:114-115). Iron also has the ability to switch back and forth between two ionic states, namely from ferrous iron (Fe^{+2}) in the reduced state, to ferric iron (Fe^{+3}) in the oxidised state. Based on this characteristic, iron is important in the mitochondria of every cell as part of the electron transport chain responsible for cellular respiration. Iron also occurs in enzymes that oxidise compounds in the body; and is required for producing new cells, amino acids, hormones, and neurotransmitters (Gallagher, 2008:114-115).

2.2.1 Total body iron

An average adult male has 3.6g – 4g of total body iron (Waldvogel-Abramowski *et al.*, 2014:215; Gallagher, 2008:114-115), of which about 2.5g occurs in hemoglobin in the circulation and bone marrow; 1g is stored in the liver and spleen; and the rest exist in myoglobin and other iron-containing proteins. In a healthy male only about 1–2 mg of iron is lost daily mainly through desquamation of cells from the gastrointestinal tract and skin, as well as urinary tract losses, and losses through sweating. This loss is balanced by intestinal absorption. Iron homeostasis is therefore mostly achieved through recycling.

WRA lose an additional 0.5-1 mg of iron per day during menstruation. About 5% of normal women have been reported to have menstrual iron losses of >1.4 mg daily (Cook, 2005). Thus an average woman has 2.4 grams of total body iron (Gallagher, 2008:114-115), due to increased losses related to menstruation, pregnancy and lactation (Bunn, 2011:1031). This situation has been the centre of controversial discussions on whether this should be viewed as normal, or whether it actually represents widespread ID (Waldvogel-Abramowski *et al.*, 2014:215).

Other forms of bleeding, and parasite infestations are also important causes of iron loss, and the amount of blood loss could affect iron status greatly. Dietary iron is therefore needed to compensate for losses (Cook, 2005).

2.2.2 Iron recycling

The concept of iron recycling is illustrated in Figure 2.1. The body has two mechanisms for obtaining iron from the gastrointestinal tract: one protein that absorbs iron in the intestines and transports it into the blood, and another that stores some iron in the mucosal cells, and releases it when iron is needed. Intestinal mucosal cells live for three weeks, after which they are desquamated and are lost in the feces. When needed, iron from the intestinal cells is captured by the protein transferrin (Tf) in the blood, and transported to the bone marrow, liver and other blood manufacturing sites (Gallagher, 2008:115). A large proportion of dietary iron is taken up by the bone marrow and liver and used for the manufacture of RBCs (Fleming & Bacon, 2005:1741-1742). In pregnancy, the placenta delivers large quantities of iron to the baby even at the expense of the mother. Increased needs for iron during periods of rapid growth in children, during pregnancies or after acute losses of blood, draws iron from the stores, making the patient vulnerable to anemia. On the other hand, if there is surplus iron in the body, iron is stored in ferritin in the bone marrow and other organs that take up the excess iron.

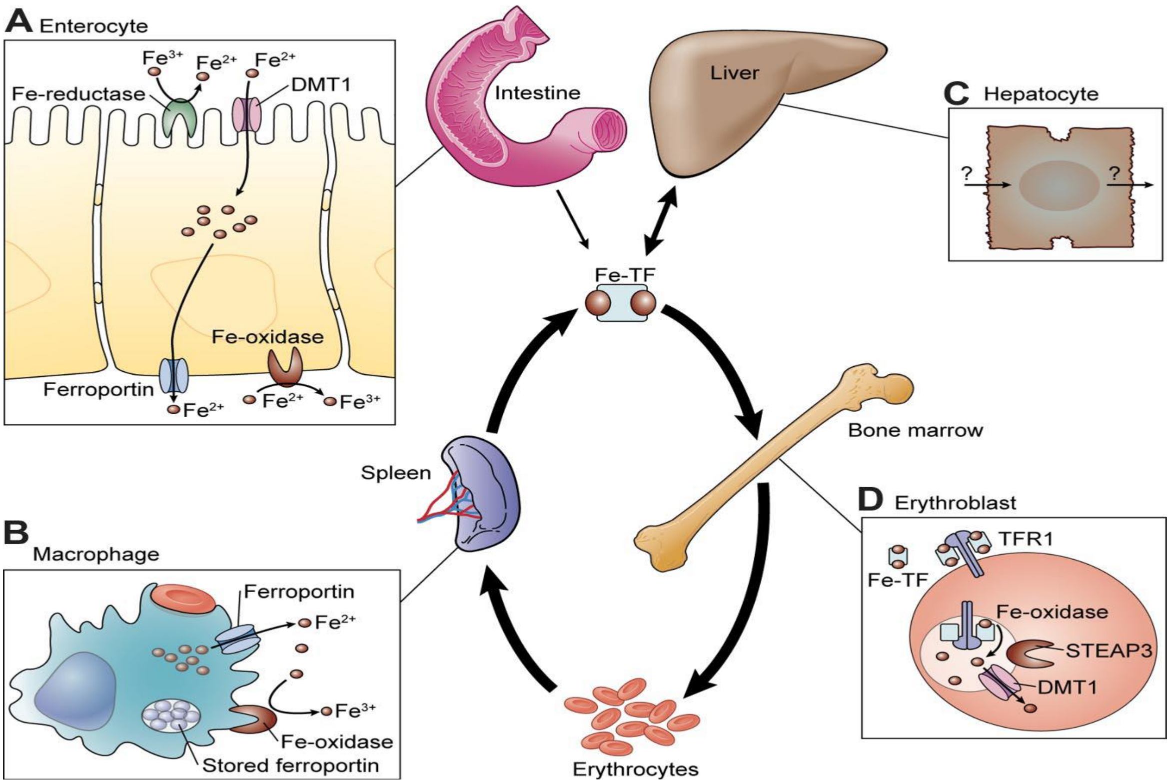

Figure 2.1: The homeostasis of iron in the body (Andrews, 2008:220).

The central portion of the figure depicts the flow of iron into the body (through the small intestine), to transferrin (Tf), to the major site of utilization (the erythroid bone marrow), to circulating RBC, to tissue macrophages that phagocytise aged RBC and recycle iron (spleen), to the storage sites in hepatocytes, and back to TF through mobilization of iron stores. Cellular iron transport is shown in schematic form on the *outside edges of this figure. (A) Non-heme iron transport across an intestinal mucosal cell. (B) RBC breakdown and iron recycling in a tissue macrophage. The aqua oval in the cytoplasm represents a storage depot for ferroportin protein within the cell. (C) Hepatocyte iron transport, with arrows indicating that neither import nor export is well understood. (D) Iron uptake through the transferrin cycle in the RBC precursor cells (erythroblast).*

RBCs live an average of four months, after which the aged RBC is taken up by the spleen and liver, and broken down by macrophages. The iron removed from these phagocytised RBCs, is recycled and returned to the bone marrow for RBC production, or stored. The liver stores iron in ferritin, from where iron may be transported back to the bone marrow for RBC formation as needed, by Tf (Cook, 2005; Cook *et al.*, 1976).

The efficiency of iron absorption in the intestine depends on the type of iron in the diet. Iron exists in food as heme iron and non-heme iron. Heme is the active molecule of hemoglobin in blood and myoglobin in muscle, and is therefore mainly in meat, fish, and poultry (MFP). In the intestines, heme is released from food (muscle meat) by digestive enzymes, after which the whole heme molecule is taken up into the mucosal cells. Inside the mucosal cells, enzymes remove ferrous iron from the heme-complex (Fleming & Bacon, 2005:1741).

All other iron in food is called non-heme iron (from both animal and plant sources). The non-heme iron occurs in the form of iron salts in both plant and animal foods and as a contaminant from processing methods and the soil (Gibson & Ferguson, 2008:105). Non-heme iron in foods must first be released by digestive enzymes and made available in the duodenum / upper jejunum as free, soluble ionic iron, preferably in the ferrous form, before it can be absorbed across the brush border into the mucosal cells (some soluble free ionic ion in the ferric form is also transferred across the brush border) (Fleming & Bacon, 2005:1741).

Though heme iron represents only ±10% of the total daily iron intake, about 25-30% of heme iron is absorbed. By contrast, only 5-10% of non-heme iron, which represents 90% of the daily iron intake, is absorbed. Heme iron is thus far more bioavailable than non-heme iron. Even though only 10% of non-heme iron is absorbed under normal circumstances, the absorption rate increases when the need for iron in the body increases. Thus, more mucosal cells and blood transferrin are produced to increase absorption in the intestines when the body needs more iron (Fleming & Bacon, 2005:1741). ID progresses through different stages, from initial ID without anemia, to ID with mild anemia, and finally ID with severe anemia (Cook & Skikne, 1989).

2.3 Proteins in iron homeostasis

Four major groups of functional proteins play a role in the homeostasis of iron. The first group is the proteins that aid iron transport within the cells. These include the divalent metal-ion transporter1 (DMT1), which is responsible for the absorption of dietary non-heme iron and the endosomal release of transferrin-bound iron. Heme transporters exist in different forms and the heme carrier protein 1 (HCP1) is thought to facilitate the absorption of dietary heme in the duodenum. This remains controversial, however, and other heme carriers have recently been suggested. The heme-regulated gene protein (HRG) is another transport protein that aids heme transport and homeostasis in nemodes. Recently its orthologs have been found in humans, which suggests that it may be an important heme transporter protein (Srai & Sharp, 2012; Rajagopal *et al.*, 2008). Other iron mediating proteins are ferroportin, transferrin receptors, mitoferrin, and the natural resistance–associated macrophage protein (NRAMP) which exists in two forms the NRAMP1 (SLC11A1) and NRAMP2.

The second groups of proteins are the enzymes reductases and oxidases that facilitate the movement of iron across the cells. Among these enzymes are the duodenal cytochromes b (Dcytb), the six transmembrane epithelial antigens of the prostate (STEAP), ceruloplasmin, and hephaestin. These proteins help maintain iron homeostasis by converting (oxidising) non-heme iron from ferric salts to absorbable ferrous iron.

Another group of proteins is involved in the transport in the blood, and the storage of iron within the cells. These proteins are Tf and ferritin, respectively. Tf is responsible for iron transportation to the sites where it either is used immediately, or is stored for future use. There are a number of different variants of Tf, however only one Tf is found in the majority of humans (Beden *et al.,* 2009:60, 64). Ferritin is the protein that stores iron in the body. Ferritin exists in two forms, namely L-, and H- ferritin. L-ferritin stores iron for longer periods, hence contain more iron, and is found in the liver or spleen. H-ferritin on the other hand contain less iron, stores iron for shorter periods, and is found in areas of the body where stored irons are in transit for shorter periods like the heart and the brain (Srai & Sharp, 2012:11).

The last groups of proteins are the proteins that control all the other proteins that maintain iron homeostasis. These include the iron regulatory proteins (IRP), HFE protein (HFE), hepcidin, the transmembrane protease, serine 6 (TMPRSS6), hemojuvelin (HJV) and frataxin. During periods of increased need for iron or when iron is in excess, these proteins are able to regulate the activities of the proteins in the above-mentioned communities to bring about a change in iron absorption in an attempt to maintain iron homeostasis in the body (Srai & Sharp, 2012:12-16). Figure 2.1 illustrates the iron processing in the bone marrow, spleen, liver, and intestines.

2.3.1 Iron processing in the intestines

In the duodenum, nutritional iron is absorbed by the activity of enzymes like duodenal cytochrome b (Dcytb), which is an example of a ferric reductase, which reduces Fe^{3t} to Fe^{2+}. The Fe^{2+} is then transported across the apical enterocyte membranes by a solute carrier (SLC or SLC11A2) called divalent metal transporter 1 (DMT1). In some situations, heme oxygenase-1 (HO-1) converts heme-iron to Fe^{2+} in the duodenum through a not so well defined mechanism. In both cases, the eventual Fe^{2+} is transported across the basolateral enterocyte membrane into the blood stream. This is exported by the SLC and Fe^{2+} exporter ferroportin, also called the (SLC11A3). Ferroportin is the critical control point for intestinal iron absorption. The transportation process is coupled with the re-oxidation of Fe^{2+} back to Fe^{3+} due to the reaction of ferrioxidase hephaestin bound to the membranes and the ferroportin (Yeh *et al.,* 2009: G62-65). The re-oxidation process could also be attributed to plasma homologue ceruloplasmin (Wang & Pantapoulos, 2011: 365), which shares great homology with hephaestin. Tf scavenges the Fe^{3+} in the bloodstream and delivers it to the tissues. The approximate amount of iron associated with Tf in the body, is about 3mg. Iron in Tf is replaced mostly by iron from the damaged RBC and to a lesser extent by newly absorbed heme-iron (Wang & Pantopoulos, 2011:366). Iron that is not absorbed from the enterocytes are shed with dead enterocytes and excreted with the feces.

2.3.2 Transport of iron in the plasma

In the plasma, old RBCs are eliminated through reticulo-endothelial macrophages. Iron in hemoglobin and heme are mobilised and released into the bloodstream. The Fe^{2+} is exported from the cell by ferroportin, re-oxidised to Fe^{3+} by ceruloplasmin, and subsequently loaded on, and transported by Tf (Donovan *et al.,* 2005:197). Free hemoglobin is taken up by haptoglobin (Hp) (Kristiansen *et al.*, 2001) and haemopexin (Hpx) (Hvidberg *et al.,* 2005). The plasma Tf delivers iron to all tissues except those separated by endothelial cells with tight junctions, which forms tight physical barriers as is seen in the brain and testis (Rouault *et al.,* 2009:675; Rouault & Cooperman, 2006).

2.3.3 Processing of iron in the muscles

Within cells, iron is generally used in the mitochondria for the synthesis of heme and iron-sulfur clusters (ISC). Though there are lapses in the understanding of the transport of intra-cellular iron, there are postulates that Tf-iron is delivered to the mitochondria when it touches the endosome. This was discovered by kinetic evidence and microscopic studies of cells. In some cells, when Tf-derived iron enters the cell, iron is released into the lysosome and then later transported to the mitochondria. This mechanism is called the "kiss and run" hypothesis. The release of iron into the mitochondria requires the SLC transporter mitoferrin (SLCA2537), which is in the inner membrane of the mitochondrion (Richardson *et al.,* 2010:10776). The homologues, mitoferrin 1 and 2, play a vital role, since over-expression of mitoferrin 2 does not enable the absorption of mitochondrial iron in the erythroid cell that are deficient in mitoferrin 1. Mutations may therefore affect RBC formation (Divereddy *et al.*, 2010).

2.3.4 Processing of iron in the liver

The efflux of Fe^{2+} from the enterocytes and macrophages into the plasma helps with iron homeostasis. Hepcidin has recently been identified as the primary mechanism for regulating iron status in the body. Hepcidin is produced by the liver in response to positive iron balance. Therefore, levels of hepcidin increase after the absorption of dietary iron. Hepcidin is first released as a pro-peptide, and is proteolysed in the bloodstream to yield a bioactive molecule with 25 amino acids. Activated hepcidine inhibits iron absorption from the gastrointestinal tract by binding to the iron exporter, ferroportin, which is located on the basolateral surface of the enterocytes of the intestinal walls. It also inhibits the release of iron from macrophages in the reticulo-endothelial system in the liver and spleen for example, which also carries ferroportin on the plasma membrane, thus shutting off the iron transport out of these cells, which store iron (Ganz, 2011:4427; Nemeth & Ganz, 2009:81; Xia *et al.*, 2008).

Hepcidine is also released in response to inflammation and infection, in order to prevent bacterial access to iron that would increase their growth (Lee & Beutler, 2009). Hence, hepcidin levels are low during IDA, but high during inflammation, leading to anemia of chronic disease (Weiss & Goodnough, 2005). This function of hepcidin may make it an important indicator for the identification of ID and the presence of inflammation (Ganz, 2011:4427).

The reverse happens when the body has excess iron. When hepcidin concentration is high, the ferroportin is internalised and the iron is trapped in the sites of iron processing; in other words in the macrophages, hepatocytes and enterocytes. Excessive production of hepcidin could lead to IDA since it reduces iron absorption (Ganz, 2011:4430).

During pregnancy, fetal hepcidin controls the placental flow of maternal iron into the fetus plasma. Therefore, hepcidin plays a critical role in maintaining the body iron status. The homeostasis of iron in the body within the various organs is indicated in Figure 2.1.

2.4 Iron deficiency anemia (IDA)

Anemia is one result of advanced-stage iron ID. Iron stores are depleted in a progressive way, causing anemia to develop over several steps. Therefore, many people may have ID without anemia. During periods of increased iron utilisation or loss without replacement, the deficiency advances to IDA (Cook & Skikne, 1989).

2.4.1 Diagnosis of IDA

In the first stage of iron depletion, the blood ferritin levels, which are at equilibrium with intracellular ferritin iron stores, decrease. Therefore, serum ferritin levels are the most sensitive indicator of early ID and the best measure to screen for ID.

The serum total iron-binding capacity (TIBC) is a measure of the total amount of Tf available to bind to iron and provides a good indicator at the stage of Tf saturation. Many people, especially women, are in this stage of ID without anemia (Cook *et al.*, 1986).

When iron stores become depleted to the point that RBC production can no longer be sustained at normal levels, RBC become microcytic and hypochromic. Table 2.1 summarises the types of laboratory test that are used to identify the various stages in the development of IDA.

Table 2.1: Laboratory tests in iron deficiency of increasing severity (Cook and Skikne, 1989)

	Normal	ID without anemia	ID with mild anemia	Severe ID with severe anemia
Marrow reticulo-endothelial iron	2+ to 3+	None	None	None
Serum iron (SI) (µg/dL)	60 to 150	60 to 150	<60	<40

Total iron binding capacity (transferrin, TIBC) (µg/dL)	300 to 360	300 to 390	350 to 400	>410
Transferrin saturation (SI/TIBC) (%)	20 to 50	30	<15	<10
Hemoglobin (g/dL)	Normal	Normal	9 to 12	6 to 7
Red cell morphology	Normal	Normal	Normal /light hypochromia	Hypochromia microcytosis
Plasma or serum ferritin (ng/mL)	40 to 200	<40	<20	<10
Erythrocyte protoporphyrin (ng/ml)	30 to 70	30 to 70	>100	100 to 200
Other tissue changes	None	None	None	Nail and epithelial changes

Note: Test results outlined in bold type are the ones most likely to define the various stages of iron deficiency. Thus, the presence or absence of iron stores (marrow reticuloendothelial iron) in a non-anemic patient serves to distinguish normal subjects from those with iron deficiency without anemia, respectively.

2.4.2 Clinical manifestation of IDA

ID may not present symptoms until a late stage when hemoglobin levels drop and anemia develops. With anemia, a fair person’s skin becomes pale, because there are fewer, less hemoglobinised RBCs, in the circulation. Because of the anemia, delivery of oxygen from the lungs to the tissues is decreased. Energy release is thus hindered with resulting fatigue, weakness, headaches, and apathy, while the fingernails in adults may become spoon-shaped (koilonychias) if the anemia persists in the long-term (Ogilvia, 2010:2).

Even before the RBCs are affected, the slight reduction in iron levels prevents the complete oxidation of pyruvate; thus reducing physical work capacity and productivity. Children become irritable when iron levels drop because the stress hormones in their systems are elevated. This change in behaviour is very responsive to increased iron intake. The most vulnerable communities of people to ID are children, especially those younger than five years when growth and development is rapid; pregnant and lactating women; and adolescents (Agarwal, 2010:2). Anemia in pregnancy affects the fetus and is a threat to the mother's life (Agarwal, 2010:2). Anemia affects about half of all pregnant women in Africa, contributing substantially to maternal mortality, loss in productivity and a diminished health and mental capacity of the next generation, as the fetus is also affected (MOST/USAID, 2004). A mother's risk for IDA (with negative effects on pregnancy outcome) increases with young age (<15years) at first pregnancy, increased number of pregnancies, and short spacing between pregnancies (Shabert, 2004:183-187).

Due to the outlined functions of iron in the body, IDA causes a range of complications including reduced productivity, weakness, and reduced resistance to infections, pica (discussed below) and sometimes death. For a manual worker with anemia, IDA is estimated to reduce productivity and endurance by about 17%, thus affecting income levels. Anemia in children could lead to impaired cognitive development and consequently impaired learning abilities, increased distractibility, impaired attention span, as well as impaired reaction and coordination (Lozoff *et al.,* 2006). IDA is also associated with a suppressed immune response, leading to increased infections (WHO, 2001:8). Patients with IDA, for example, have been found to have reduced T lymphocyte counts (Ozcan *et al.,* 2011:2-3) and reduced lymphocyte percentages (Lurashi *et al.,* 1991), due to suppression of T-lymphocyte production with a concomitant increase in lymphocyte destruction. ID also negatively affects leukocytes, erythrocytes, thrombocytes, and neutrophils (Ozcan *et al.,* 2011:3). Anemic individuals also have increased metal absorption rates making them more susceptible to toxic metals like lead and cadmium (WHO, 2001:10).

Anemia therefore has enormous implications for society and health care resources. The reduction of micronutrient deficiency, including iron deficiency, is associated with reduced morbidity and mortality and enhancing productivity (Alderman & Horton, 2007:20). In infants and children, reversing micronutrient deficiencies translates into decreased child mortality; decreased health care cost for neonates, infants, and children; improved physical capacity, gains from increased cognitive development; decreased cost of chronic disease; and improved intergenerational health. The effect on productivity level is measured as the effects on intelligence quotient (IQ) and disability -adjusted life years (DALYs). An individual's DALYs are the sum of number of years of life lost (due to premature death) and years of life lived with disease. Anemia increases the DALYs in affected persons (WHO, 2001:11).

2.5 Factors that affect iron status in the body

Iron status may be affected by various diseases, physiological processes and feeding practices.

2.5.1 Interaction between iron status and disease state

Inflammation is associated with anemia of chronic disease (ACD) because inflammatory stimuli induces hypoferremia (redistribution of iron in the body) and suppresses erythropoiesis; partly due to the release of hepcidine (Thurnham & Northrop-Clewes, 2007:233). Initially, it was thought that ACD was only associated with inflammation, infectious disease, or cancer, but it occurs in other conditions too, including severe trauma, diabetes mellitus, heart disease and renal failure, and in older adults. ACD is usually caused by the reduced production of RBC by the bone marrow or the shortening of the life of RBC and is characterised by the normochromic, normocytic or hypochromic, microcytic RBCs (Zaritsky, 2009:1055). Furthermore, serum ferritin which represents the body iron stores, is an ideal indicator of ID in an infection-free individual, but not if the mechanisms that underlie ACD is present (Agarwal, 2011:1). An inflammatory response is one of the leading causes of anemia among children and adults in developing countries where infection is common. The simultaneous supplementation of vitamin A and iron is efficient to improve anemia, since the vitamin A reduces inflammation thus improving iron status (Tanumihardjo, 2002).

In chronic kidney disease (CKD), serum hepicidin may be a good biomarker for iron status, because impaired kidney function reduces removal of hepcidine from the blood, leading to iron-impaired erythropoiesis and consequently anemia (Zaritsky, 2009:1054-

1055). In the case of hepatitis C or alcoholic liver disease, iron accumulation may be due to altered iron metabolism. This physiological process may complicate the live disease and its progression. Iron depletion by hepcidin is beneficial in such disease conditions (Fargion *et al.*, 2011:93).

In HIV/AIDS, anemia is linked to the frequent opportunistic infections that lead to ACD. Thus inhibits iron absorption and mobilisation of iron stores (Dobosz & Marczynska, 2004).

Diarrhea, caused by bacterial and viral infections, may cause an inflammatory response, which impairs iron absorption and may cause anemia (Thurnham & Northrop-Clewes, 2007:240-241).

Blood loss due to schistosomiasis, hookworm infestation, trichuriasis and other gastrointestinal parasitic infections also contribute significantly to anemia, especially among children (Thurnham & Northrop-Clewes, 2007:244-246).

The interaction between malaria and iron is complex. On the one hand, acute malaria infections cause anemia, by decreasing erythropoiesis in the bone marrow; increasing hemolysis and mobilsation of hemozoin; increasing urination; reducing intake of dietary iron through reduced appetite, nausea, vomiting, diarrhea; and reducing the absorption of iron from foods consumed (Spottiswoode *et al*., 2012; Osei & Harmer, 2008). These pathways contribute to the lower iron status in vulnerable communities who may be infected with malaria. Preventive measures against malaria, including the use of insecticide-treated nets or chemoprophylaxis, decreased anemia prevalence in susceptible populations in malaria endemic populations, also protect against anemia (Spottiswoode *et al.*, 2012).

On the other hand, the Pemba Study (Sazawal *et al.*, 2006) was the first to show a statistically significant association between iron supplementation, and increased hospitalisation with malaria infections and death among children, in a supplementation programme in a malaria endemic area. This lead to the premature end of the study, and sparked public health interest on how these relations interplayed. Numerous studies have confirmed that iron supplementation of vulnerable people, in the absence of effective malaria surveillance, prevention, and treatment; contribute to the likelihood of malarial infection (Spottiswoode *et al.,* 2012). Ironically, the populations in greatest need of iron supplementation, namely young children and pregnant women, are also those at greatest risk of malaria (Spottiswoode *et al*., 2012). Studies have shown that absorption of orally administered iron is diminished in subjects infected with malaria. Consequently, the efficacy of iron supplementation may be generally reduced in populations with malaria. As the plasmodium parasite needs iron for its survival, reduced levels of bioavailable iron inhibit the growth of the malaria parasite through a mechanism that is not fully understood (Portugal *et al.,* 2013; Spottiswoode *et al.,* 2012; Wienberg & Moon, 2009). Hepcidin may play a key role in the interaction of iron and malaria. Malaria infections have been shown to lead to increased hepcidin levels in the blood, which binds iron and hepcidin levels were seen to reduce when the malaria was treated (Spottiswoode *et al*., 2012).

Two recent Cochrane reviews concluded that iron is not harmful as long as 'regular malaria surveillance and treatment services are provided' (Okebe *et al.*, 2011; Ojukwu *et al*., 2009).

2.5.2 Breast feeding and complementary feeding practices

Children, who are born premature, with low birth weights, are at higher risk of developing ID (Collard, 2014). Premature babies are born with low iron stores; have low levels of hepcidin; may have poor absorption of iron in the gastrointestinal tract, despite decreased ferritin levels; and often require blood transfusion, which also poses its own risk (Collard, 2009).

Infants born at term, have iron stores of about 75mg/kg, an amount that is usually sufficient for the first five to six months of the child's life (Ohls, 2000; Kivivuori *et al.,* 1999). Breast milk contains iron and, though at relatively low concentration, it is easily absorbed due to the protein, lactoferrin, in breast milk that binds iron and makes it very bioavailable; while also keeping iron unavailable to bacteria, which may cause gastrointestinal infections. Cows' milk has higher iron content than breast milk, but without lactoferrin, this iron is not as easily absorbed. Maternal iron status negatively affects the iron content of breast milk in severe anemia cases (Kumar *et al.,* 2008:e676).

For children who are not breastfed at all, or those fed with breast milk without supplementation, the risk of ID increases (Ohls, 2000:137). If infants are not breastfed, a suitable substitute should be given. The use of unmodified cows' milk instead of iron-fortified infant formula puts children younger than 12 months at risk of ID (Woldu *et al.,* 2014). Cows' milk protein may induce colitis, which may lead to occult bleeding (Hopkins *et al.,* 2007; Ziegler *et al.,* 1990). Bottle-feeding, compared to cup feeding, was also found to increase the risk of ID among Mexican Americans infants and two to three year olds. The authors speculated that it could be due to the intake of large amounts of cow's milk and they associated the practice to inadequate education intervention programmes (Sutcliffe *et al., 2006*).

According to European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) position paper on iron requirements for infants and toddlers, iron status becomes depleated at about six months of age and iron-rich complementary foods need to be introduced (Domellöf *et al*., 2014). In a child between six and 24 months of age, the frequency and diversity of iron rich foods included as complementary feeds, affect iron status and the risk for ID. ID usually develops among children older than six months when complementary foods are inadequate in terms of iron content. This is even seen in some exclusively breastfed (EBF) children (WHO, 2001:20). Complementary feeds should therefore contain increased sources of heme iron at least one serving of vitamin C-rich food per day to increase the bioavailability of non-heme iron (as discussed in the following section) (Fitch *et al.,* 2008).

2.5.3 Availability of iron sources

Household food insecurity affects the intake of several nutrients, including iron. Where food insecurity exists, the quantity and quality of the diet is compromised (Abu *et al*., 2010; Nyanteng & Asuming-Brepong, 2003). The prevalence of ID and anemia are also high among children from low socioeconomic backgrounds (Brotanek *et al.*, 2008; Cusick *et al.*, 2007). To cope with food insecurity, primary caregivers in the household may reduce food portions, forgo food for children, and resort to less expensive and sometimes low nutrient quality-foods, as has been observed in several studies (Abu *et al.*, 2010; Nyanteng & Asuming-Brepong, 2003).

2.5.4 Bioavailability of dietary iron

The quality of the diet is one of the major factors that influence iron status. Standard tables and food composition databases offer detailed information on the iron content of various foods. These values refer to the absolute chemical iron content of these foods. However, the chemical iron content in food eaten is usually not the same amount that is absorbed and used by the body. The amount absorbed is usually much lower and is affected by the physiological state of the body, the chemical state of the iron in food, the nature of the food eaten and the composition of the diet (Gibson & Ferguson, 2008:105). The amount of the nutrient absorbed from food eaten through normal physiological function of the body is referred to as the bioavailable component (Hurrell, 2002). The bioavailability of iron is affected by diet- and host-related factors.

The host-related factors include the health status and physiological state of the body. For example, being in a state of ID, enhances iron absorption by 50%. Steatorrhea may also affect iron absorption through loss of blood in the stool, while increased intestinal movement (diarrhea) reduces iron absorption by reducing the contact time between food and the intestines (Gibson & Ferguson, 2008:105-106). The nutritional status and nutrient intake also affect iron absorption. When the body is deficient in protein, it is unable to transport minerals and other nutrients because of a decreased synthesis of the transport proteins. Such individuals may have enough iron in their diet, but the body is unable to transport sufficient iron to the cells that require it (Agarwal, 2010:2). The availability of foods that are rich in heme iron, as well as enhancers to release and increase absorption of iron from non-heme iron, may improve iron status in populations.

2.5.4.1.1 Factors that inhibit iron absorption

Among the diet-related factors that influence iron bioavailability, are diets or nutrients that enhance or inhibit iron absorption. Most inhibitors affect non-heme iron bioavailability by forming complexes with the ingested iron ion in the gastrointestinal system, and preventing the body from absorbing it. These inhibitors include phytates (phytic acid) in cereal grains, cereal bran, highly-extracted flour, nuts, seeds, soybeans and other legumes, and foods with high inositol content, iron-binding phenolic compounds like tannins found in teas, coffees, cocoa, some herbal infusions and some vegetables (Ogilvie, 2010:1, 2). Dietary practices like drinking tea directly after, or with meals may inhibit the absorption of non-heme iron. Oxalates from spinach, rhubarb, beet greens, and chocolates also inhibit iron absorption (Ogilvie, 2010:1, 2).

Hurrell *et al.* (1999) found that black (Ceylon) tea inhibits iron absorption by between 79% and 94%, peppermint tea by 84%, and cocoa by 71%. The team made a further observation that adding milk to tea or coffee did not reduce the inhibitory effect on iron absorption. Not all studies confirmed that tea intake is associated with decreased iron status, though. A number of studies, including that of Mennen *et al.* (2006) among French adults, concluded that tea drinking had no effect on iron status; but many studies found otherwise. A review by Nelson & Poulter (2004) concluded that there is no need to advise restriction of tea intake among people with adequate iron status; however, population at risk of ID, should be advised to allow an hour after or before meals, and tea drinking in order to reduce interactions between the tannins in tea and iron in food. A review by Temme & van Hoydonck (2002) concluded that, in populations with marginal iron status, a negative association exists between tea consumption and iron status. Thankachan *et al.*, (2008) made a similar conclusion, and mentioned that the rate of inhibition of iron uptake is determined by the iron status of the individual.

The iron content of dairy products is very low, and furthermore calcium and magnesium from milk, milk products and supplements, inhibits the absorption of both heme and non-heme iron by chelating metal irons in the gastrointestinal tract, making them unavailable for absorption. The iron in egg yolk is also poorly absorbed due to the presence of phosvitin. Overall, this implies that vegans, lacto-vegetarians and lacto-ovo vegetarians are at a higher risk of ID, than people on a mixed diet (Ogilvie, 2010:2).

Other inhibitors of iron absorption include preservatives, such as ethylene-diamine-tetra-acetic acid (EDTA) used in food processing (WHO, 2001:50).

2.5.4.1.2 Factors that enhance iron absorption

Ascorbic acid (vitamin C), which is present in fruits and fruit juices, some tubers like potatoes, and green leafy vegetables, enhances iron absorption by reducing iron to its bioavailable ferrous form. It also forms a soluble iron-ascorbate chelate with heme-iron in the acidic medium of the stomach, preventing it from forming insoluble complexes with phytates or tannins (Teucher *et al.,* 2004). Therefore, practices like eating a vitamin C-rich fruit together with iron-rich foods, renders non-heme more bioavailable. The enhancing effect of dietary vitamin C on iron absorption is determined by the iron status of an individual (Thankachan *et al.,* 2008). Furthermore, meat, fish, and poultry (MFP), besides being sources of heme-iron, also increase uptake of non-heme iron through what is referred to as the MFP factor. The simultaneous intake of vitamin C and MFP is recommended for mixed meals (Zijp *et al.,* 2010).

Some spices and condiments, like soy sauce (WHO 2001:49), as well as some food, processing methods, enhance iron bioavailability and absorption. During fermentation, organic compounds are produced which form soluble ligands in the gastrointestinal tract. These ligands may bind to phytate molecules and liberate them for enzyme action, while at the same time generating a pH that optimises the activity of phytase on cereals and legume flours (Porres *et al.,* 2001).

The use of iron and stainless steel cooking utensils in food preparation can also be a source of iron. The acidity of foods reduces iron to its soluble ferrous form thus leaching it out from the utensils and enriching the food. The longer the food stays in the utensil, or the more acidic the food, the more iron is leached. Similarly, fruits dried in/on iron utensils or sheets, may also be a source of iron (Snyder, 2008:1). Among men in Central and sub-Saharan African countries, the brewing of traditional beer in iron pots or steel drums have been known to cause iron overload and consequent organ damage. During fermentation of sorghum, maize, or other locally grown crops, the pH of the ferment decreases to a very low level (pH 3.5–3.8), which leaches iron from the container into the contents as ionised, highly bioavailable, ferrous form. Women are less susceptible to this phenomenon since they lose blood during menstruation, pregnancy, and lactation, and tend to drink the lighter, shorter fermented beer. Men, who have no means of getting rid of the excess iron, may accumulate the ingested iron, which may lead to iron overload (Kew & Asare, 2007:735).

2.5.5 Smoking

In the assessment of anemia in populations, adjustment is made for people who smoke, since they need more hemoglobin than non-smoking people (Centre for Disease Control and Prevention, 1998). Smoking also indirectly affects iron status by reducing the serum vitamin C levels (Bashar & Mitra, 2004). Furthermore, maternal smoking during pregnancy could lead to subclinical ID in newborns (Chełchowska *et al.,* 2008).

2.5.6 Contraceptives

The use of contraceptives also affects iron status. Hormone-based contraceptives reduce heavy menstrual bleeding and iron losses, whereas the intra-uterine device (IUD) may negatively affect iron stores, by inducing heavy menstrual bleeding (Milman *et al.,* 1998).

2.6 Pica

Pica is defined as the craving and compulsive intake of non-food substances and sometimes an enhanced craving for, or ingestion of food substances (Louw *et al.*, 2007). The practice is highly associated with women, but is also prevalent in men and children (Louw *et al.*, 2007:1069; Saathoff *et al.*, 2002). Pica has been reported in association with psychiatric conditions, autism, gastric bypass to reduce obesity, sickle cell disease and dialysis (Williams & McAdams, 2012; Ellis, 2009; Lofts *et al.*, 1990), but is most commonly associated with pregnant women (Young *et al.*, 2010, Adam *et al.*, 2005; Antelman *et al.*, 2000). In Africa, pica, especially among pregnant women, has been reported in Tanzania (Kawai *et al.*, 2009; Antelman *et al.*, 2000), Kenya (Luoba *et al.*, 2004), Ghana (Mensah *et al.*, 2010; Vermeer, 1971), South Africa (Louw *et al.*, 2007), and Namibia (Thomson, 1997). In Ghana, the prevalence of pica was found to be 48% (Tayie & Lartey, 1999), and 47% (Mensah *et al.*, 2010:283) among pregnant women.

Many different types of pica have been described, including craving for soil, dirt or clay, ice, cigarettes and cigarette ashes, paper, heads of burnt matches (cautopyreiophagia), starch (amylophagia), popcorn (arabositophagia), stones (lithophagia), mothballs, hair (trichophagia), crayons, cardboard, faeces (coprophagia), egg shells, aspirin, coins, foam rubber, vinyl gloves, and baking powder (Louw *et al.*, 2007). Mensah *et al*. (2010:283-285) described pica for white clay, ice, corn dough, paint, damp soil and dust among pregnant women in Ghana. Furthermore, in South Africa, enhanced craving of food substances such as brown bread, dry macaroni, cucumbers, cheese, tomatoes and uncooked rice, among others, have also been described as a possible form of pica (Louw *et al.*, 2007).

Many studies have found that people who are iron or zinc deficient practice more pica compared to controls (Barton, 2010:10; Federman *et al.*, 1997). Interestingly, in South African market places, clay is sold as a cure for 'tiredness' (Louw *et al.*, 2007:1070). A recent meta-analysis of 43 studies including 6 407 individuals with pica behaviour and 10 277 controls, found that pica was associated with 2.35 times greater odds of anemia and zinc deficiency (Miao *et al*., 2015). The direction of the relationship between pica and micronutrient deficiencies is not well-understood (Young *et al.*, 2010). On the one hand, pica may contribute to ID by pica materials adhering to the mucosal layer of the gut, and preventing the absorption of iron; or absorbing iron from ingested food, preventing it from being metabolised. On the other hand, pica may be a symptom of micronutrient deficiencies like ID, which may cause humans to seek out iron in non-food substances; or pica may be a non-adaptive response to ID, possibly operating through neurological disturbances (Miao *et al.*, 2015).

Though pica is often thought to be harmless, a wide range of complications has been described. As far back as 1942, Dickins & Ford found that geophagia could cause constipation. Other serious complications include abdominal problems (sometimes requiring surgery), potassium disturbances, dental injury, naphthalene poisoning (in pica for moth balls or toilet air-freshener blocks), and phosphorus poisoning (in pica for burnt matches), peritoneal mesothelioma (geophagia of asbestos-rich soil), mercury poisoning (in paper pica), lead poisoning (in dried paint pica and geophagia), and a pre-eclampsia-like syndrome (baking powder pica) (Gonyea, 2007; Louw *et al*., 2007:1070). Nutritional dwarfism and parasitic infections were also found to be associated with pica (Danford, 1982; Prasad *et al.*, 1961).

While some researchers suggest that soils eaten by people practicing geophagia could be a source of nutrients for them, especially iron and zinc (Tayie *et al.*, 2013; Abrahams, 1997; Halsted, 1968), others contested the scientific reason. Hooda *et al.* (2004:86; 2002) suggested that, though soil or clay eaten by some geophagics may contain some amount of iron and other mineral nutrients, these would not be bioavailable. In this regard, geophagia may have repercussions for anemia depending on the source of soil or clay, which may lead to worm infestation or some poisonous metals (Louw *et al.*, 2007:1070). In South Africa, pupils who ate soil from termite mounds were found to have more *Ascaris lumbricoides* than their non-geophagous peers (Saathoff *et al.*, 2002). Blood loss due to gastrointestinal parasitic infections contributes significantly to anemia, especially among children (Thurnham & Northrop-Clewes, 2007:244-246). Processed white clay is a common pica substance (25% as reported by Mensah *et al.*, 2010:284-285); 28% as reported by Tayie & Lartey, (1999) used by pregnant women in Ghana. Microorganisms, which have been isolated from the external surface of this clay, include *coliform bacteria, Staphylococcus* species and yeasts (Tano-Debrah & Bruce-Baiden, 2010:10). These findings add to the fact that people practicing pica may be exposed to disease-causing infections.

2.7 The global IDA situation

While more than half of the world's anemic population is in Asia, for all three physiological communities; children (six months to 59 months), non-pregnant women and pregnant women, the highest prevalence has been recorded in Africa. Africa and Asia are also the poorest regions in the world (McLean *et al.*, 2007:8). Anemia is estimated to be responsible for 0.8 million (1.5%) deaths and known to cause the loss of 35 million lives or 2.4% of global DALYs, of which 15 million or 29% of this burden is in Africa (McLean *et al.*, 2007:8). In South Africa, IDA was found to be 10% among children aged six to 71 months in 1994 (Labadarios & Van MiddelKoop, 1995). According to McLean *et al.*, 47.4% of preschoolers, 41.8% of pregnant women and 30.2% of non-pregnant women are anemic worldwide. In Africa, 64.6% preschoolers, 55.8% for pregnant women, and 44.4% non–pregnant women are anemic (de Benoist *et al.*, 2008; McLean *et al.*, 2007:7).

2.7.1 Causes of ID and IDA among WRA and children in Ghana in the context of malnutrition

Malnutrition, in the context of inadequate or overconsumption of nutrients like iron, manifests in growth deficits, disease and/or nutrient deficiency diseases. The United Nations Children's Fund (UNICEF's) Conceptual Framework of Malnutrition (Figure 2.2) distinguishes three levels of causes of malnutrition, namely immediate causes, underlying causes and basic causes. According to the Lancet Series on Maternal and Child Nutrition, immediate causes operate at the individual level, underlying causes at the household and community levels, and the basic causes at the level of societal structures and processes (Black *et al*., 2008). In the following section, the Conceptual Framework is applied to the ID and IDA situation in Ghana.

2.7.2 Manifestation of ID in Ghana

Over the past two decades, the prevalence of childhood stunting has been around 30% in Ghana, leading to the country's inclusion in the list of 36 high-burden countries for malnutrition (GDHS, 2008:182). In Ghana, malnutrition also manifests in the very high prevalence of anemia. According to the GDHS, the national prevalence of anemia among children (six to 59 months) was 76.6% in 2003, and remained high at 78% in 2008 (GDHS, 2008:194). About half of all WRA in the Upper East (51%), Upper West (49.7%) and Northern Regions (49.8%), were anemic in 2003; and in the 2008 GDHS the situation had worsened to 48.8%, 66.9% and 59.5% in the Upper East, Upper West Region and Northern Regions (GDHS, 2008:203).

2.7.3 Immediate causes of ID

According to the Conceptual Framework, the immediate causes of malnutrition may be classified as inadequate iron intake, as well as diseases, and the interplay between these factors (Figure 2.2). In the context of the UNICEF Conceptual Framework (Black *et al.*, 2008), ID and IDA, results from inadequate iron intake, as well as diseases, and the interplay between these factors (Figure 2.2). Several of the factors that have been associated with anemia in Ghana, and which may be classified as immediate causes of ID and IDA, include infections malaria and hookworm infestation (Ronald *et al.*, 2006:7; Koram *et al*., 2003:793; GHS, 2003).

While ID predisposes the individual to infection, infections and diseases, in turn, negatively affect iron status by causing ACD, which essentially traps iron in the iron stores. Gastrointestinal infections and diseases with associated diarrhoea, may contribute to inadequate intakes and aggravated losses of iron by inducing malabsorption and loss of appetite.

Ghana records about 3.2 million cases of malaria annually (GHS, 2008). The interplay between malaria and iron metabolism is complex, but malaria infections are known to cause anemia (Spottiswoode *et al.*, 2012).

Hookworm infection is also very common among children in Ghana (Humphries *et al.*, 2012) and may contribute to ID and IDA due to gastrointestinal blood loss (Thurnham & Northrop-Clewes, 2007:244-246).

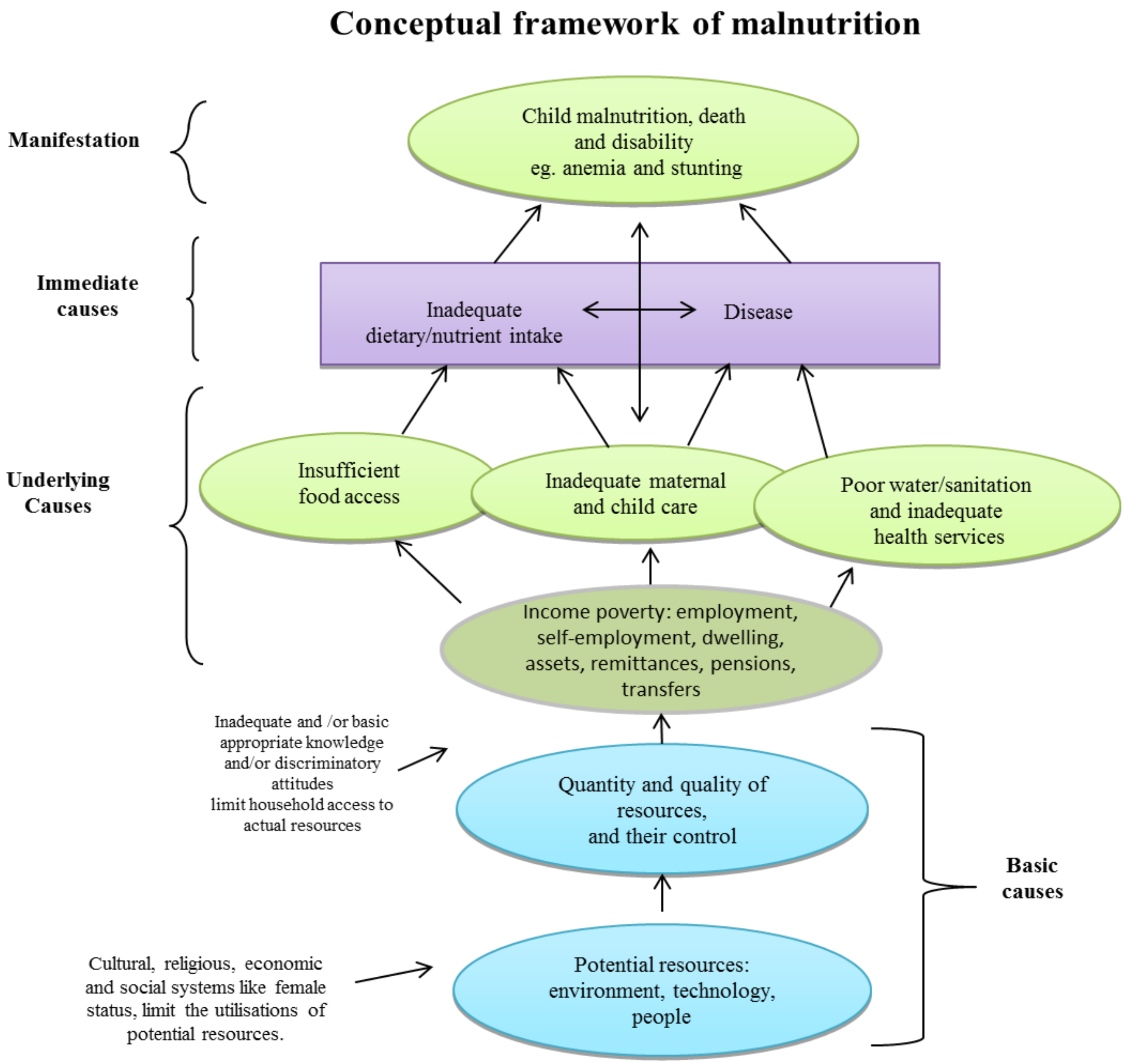

Figure 2.2 : UNICEF's Conceptual Framework of Malnutrition (adapted by Black *et al*., 2008)

2.7.4 Underlying causes of ID

The underlying causes of malnutrition include insufficient access to food, poor water/sanitation and poor hygiene practices, inadequate maternal and childcare, and inadequate health services.

Others casues are the quality and quantity of resources and the control of income, employment, remittance and assets. Thus, access to clean water, a safe environment, and quality of housing are heavily dependent on income levels, since cost of service, quality of care and food prices may be dependent on purchasing power. Employment status also affects the time women have available to give quality care to their children and households (UNICEF, 2015). Earning capacity is, in turn, reliant on level of education. In Ghana, children of mothers with little or no education were found to be most likely to also suffer from anemia (Abu *et al.,* 2010; MICS, 2006:19); and this was also found for levels of stunting and wasting in the country (Colecraft *et al.,* 2011:11).

The underlying causes of ID and IDA are further compounded by inadequate and/or inappropriate knowledge, and/or discriminatory attitudes, which may limit access of the resources that are available and negatively impact on iron status of mothers and children (UNICEF, 2015). The 2008 GDHS, for example, reported that only 36% of Ghanaian children six to 23 months were fed appropriately for their age. This was attributed to general inadequate nutrition knowledge and dietary practices in Ghana (GHDS, 2008).

2.7.4.1 Food insecurity

Underlying causes of inadequate iron intake may be insufficient access to food defined as food insecurity. Food security is defined as access by all individuals to enough nutritious and culturally acceptable food, at all times (throughout the year) to ensure an active and healthy life (FAO, 2010; World Bank, 1998). Conversely, food insecurity is defined as "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways", and interpreted as "not having sufficient food; experiencing hunger as a result of running out of food and being unable to afford more; eating a poor-quality diet as a result of limited food options; anxiety about acquiring food; or having to rely on food relief" (Panel to Review US Department of Agriculture's Measurement of Food Insecurity and Hunger, 2006).

On the household level, two types of food insecurity are distinguished, namely chronic food insecurity, which refers to the persistent inability of a household to access food, and transitory food insecurity, which occurs when temporary food insecurity is induced by for example natural disaster or financial constraints. During periods of food insecurity, households employ several mechanisms in order to survive. These include buying staples from the market (especially among smallholder farmers), reducing the frequency or number of meals per day, reducing the quantity of food per meal, and/or resorting to less preferred or less varied foods (Quaye, 2008; Nyanteng & Asuming-Brempong, 2003).

Food insecurity is seen as part of a continuum with long-term lack of food security eventually becomes hunger (Panel to Review US Department of Agriculture's Measurement of Food Insecurity and Hunger, 2006). In developing countries, food insecurity and poverty challenge the general growth and health of people. According to the United Nation's (UN) Millennium Task Force on Hunger, these effects are disproportionally dire in rural communities (UNDO, 2005). In Africa, 27.4% of the population is undernourished (FAO, 2003). In Ghana, food insecurity measured using household food consumption, is reported to be 5% nationally, but there are regional variations (Biederlack & Rivers, 2009:13). The Northern Sector is disproportionately affected with between 10 and 34% of the population being food insecure. This has been attributed to lack or irrigation services for the dry season, outbreaks of diseases, and lack of access to land by women (Quaye, 2008). Quaye (2008) also reported that 97% of households interviewed in the Upper East, Northern and Upper West regions of the country experienced food insecure periods within the year, spanning three to seven months during the dry season when communities in these areas, who are mostly rural and dependant of on subsistence farming, are under pressure of food shortages.

The inabiltity to meet adequate nutrients intakes may lead to micronutient deficiencies including iron deficiency. Child level food insecurity was reported to affect on IDA among young children and toddlers in low-income households in the United States of America (Skalicky *et al*., 2006). Similar associations were seen for adolescents (Eicher-Miller *et al.*, 2009). In Napal, food insecurity at the household level was reported to be a determinant of anemia among the poor but more of an issue related to other causative factors in households (Nisar *et al*., 2013). Among women in low income households, food security interventions were effective in improving nutritional status and anemia status (Talukder *et al.*, 2010).

2.7.4.2 Mother and childcare and adequacy of health services

The 2003 GDHS survey indicated that 80.6% of mothers with anemia had a child with anemia (GDHS, 2003:186-187). Health care in Ghana is made up of the government and private health care, as well as traditional healthcare systems. According to the 2003 GDHS data, women in urban centres had increased physical and psychological access to health care centres, compared to their counterparts in rural communities (Boateng & Flanagan, 2008). According to a study in Accra (Pehr, 2010), factors that negatively affected the access of Ghanaian women to health care, included availability of drugs (45%) and money for drugs (45%), as well as the availability of health care providers (44%). At the time of the study in 2010, the doctor to patient ratio in Accra was 1:12 000, and the nurse to patient ratio 1:1837. Other problems identified in the survey, were related to infrastructural defects in facilities, such as number of beds (Pehr, 2010).

Therefore, rural communities may have more problems with health care access and quality. The Community Health-based Planning and Services (CHPS) have been initiated in Ghana to help provide health services to communities without health centres. Positive effects of this initiative on maternal and child health in rural communities have been reported so that it is being scaled up to reach more communities (Nyonator *et al.,* 2005; Phillips *et al.,* 2006).

As iron status may also be negatively affected by the consumption of a diet that lacks bioavailable iron, even with access to food, inadequate access to sources of bioavailable iron, may contribute to ID and IDA. This relates to childcare practices such as breastfeeding and complementary feeding, as well as dietary habits such as the drinking of tea with, or within an hour, of a meal.

Although the practice of exclusive breastfeeding has improved significantly between 1998 and 2008, complementary feeding practices have not improved. A study by Colecraft *et al*. (2011) found that the iron content in complementary feeds among Ghanaian children six to 11 months was about 57% lower than the estimated requirements and for children six to eight months the shortfall was more than 70%. Nti & Lartey (2007) also reported that mean nutrient intake of Ghanaian infants fell short of WHO recommendations for most nutrients, with children six to eight months who are fed foods, having the largest deficit in iron. In a comparative analysis of weighed food data from Ghana and four other developing countries in Southeast Asia and Latin America, Lutter & Rivera (2003:294S) showed that, although complementary foods consumed by Ghanaian children basically met WHO/FAO recommendations and daily recommended intake (DRI) for protein, their micronutrient density was suboptimal. Promotion, protection, and support of optimal breastfeeding, together with appropriate complementary feeding, are therefore some of the key public health strategies to improve the nutritional status of the young child. The iron-folate supplementation program in Ghana stresses that as part of food-based efforts, special emphasis should be placed on fortifying both commercially produced and home-prepared complementary foods for children six to 24 months.

2.7.4.3 Poor water quality and sanitation

Diarrheal diseases, which results from poor water quality, are a leading cause of death in the developing world, killing approximately 1.8 million people per year (Berry *et al.*, 2008). Achieving the poverty Millennium Development Goals of reducing the proportion of people without sustainable access to safe drinking water is especially difficult for the rural poor. Diarrheal diseases account for 12% of childhood deaths in Ghana, and are the third largest cause of death for children under the age of five years. These diseases are caused by the ingestion of water contaminated by faecal matter. According to the GDHS, 2008 on average only 11% of households in Ghana used improved water, and did not use shared toilet facilities; 16% in urban areas; 7% in rural settings. The major source of drinking water for about half of rural communities was tube wells and boreholes. Another 20% used public taps or stand pipes. Nine in every ten households did not treat water before drinking it, and of those who did, 4% would merely strain water through a cloth, whereas only 2% would boil the water before drinking (GDHS, 2008:24). The sparsely populated Northern Region is one of the least developed parts of Ghana, and has even less access to clean water than the national statistics would suggest. The majority of its residents make their living in agriculture, living far away from one another. This low population density makes any state- or community-wide water treatment intervention costly and impractical (Berry *et al.*, 2008).

2.7.5 Basic causes of ID

People and their potential, are affected by the cultural, religious, economic and social systems they exist in. The basic causes of malnutrition, including ID and IDA, are linked to the potential available resources, constituted by human, financial, technological and structural resources, and how these are used in the cultural, political and legal context to promote the household food security, care practices and health services.

In emergencies, such as natural disasters, wars or in the case of political minorities, the effects of all causes are maximised due to a disabled structure. In such cases, the aged, people living with HIV and AIDS, infants and pregnant women are most vulnerable to ID and IDA (as well as other manifestations of malnutrition) due to their increased need for quality care and balanced diets to meet iron requirements (UNICEF, 2015).

The impact of this dependence of dietary habits and patterns on cultural beliefs and practices, on iron status, is illustrated by a comparative study of breastfeeding and complementary feeding patterns among Ghanaian and Peruvian mothers. This study found that Ghanaian children (six to 18 months) who were still breastfeeding were less likely to be fed foods besides the traditional cereal porridge, called koko, compared to children of the same age who were not being breastfed. The authors suggested that children six to 18 months of mothers, who were still breastfeeding, might be seen as still being “babies”, and therefore less likely to be fed other foods besides koko (Marquis *et al.*, 2004).

2.8 Policies to manage anemia in Ghana

In early 2000, MOST/USAID collaborated with the Ghana Health Services (GHS) to develop an integrated anemia control strategy for Ghana and establish an Anemia Control Coordinating Committee (ACCC) to guide design and implementation of a national anemia control program (GHS/USAID/MOST, 2003). Preceding this, there was no national policy on anemia control for children. Iron and folic acid supplementation for pregnant women was however, a routine practice as a directive of the National Reproductive Health Service Policy (FAO/FIVIMS, 2009).

The objective of the integrated anemia control strategy for Ghana is ‘to contribute to the health of women in the fertile age group and the growth and development of children by reducing morbidity and mortality due to anemia.’ Thus, the target communities for the strategy include pregnant women, children under five years, and children aged five to 14 years. The strategy aimed to reduce anemia prevalence by 25% in each target group by 2007. This has not yet been achieved nationally. The strategy has five key components on food-based approaches, emphasising food fortification and dietary diversification, iron-folate supplementation, malaria control, helminthes infection control, and information, education and communication (GHS/USAID/MOST, 2003). Current nutrition policy in Ghana, which is still in the draft form demands that the government incoporates nutrition into policies on economic growth and development which is intended toin turn benefit nutrition. The draft policy has twelve focal points which hinges on the nutrition as a human right issue, alleviation of poverty, awarenes of nutrition at all level of governance, food production, trade, prioritisations of people with special nutrition needs, gender, building capacity and all the other areas that may impact on nutrition. The overall goal therefore is “to improve the nutritional status of all Ghanaians, particularly of the most vulnerable groups, by making adequate food accessible both in quantity and quality as well as to control environmental factors which affect the biological utilization of nutrients, in order to ensure health and well-being for sustainable economic growth and development in order to achieve the MDG 1, 4, 5 (poverty and hunger, child mortality and, maternal health) (GNNP, 2011)".

2.9 Methods to assess dietary intakes

Dietary intakes may be assessed through direct and indirect approaches.

2.9.1 Indirect approaches

Among indirect approaches food security/insecurity assessment is often used to quantify and evaluate the access to food of populations on household and/or individual levels (FAO, 2010; World Bank, 1998).

Three components of food security are defined, namely availability of food, access to food and utilisation of available food. Several scoring systems have been developed and validated to access food security. These include several questionnaires included in the USDA Community Food Security Assessment Toolkit (USDA, 2012), the Household Food Insecurity Access Scale (HFIAS) created by Food and Nutrition Technical Assistance Project (FANTA) (Ballard *et al.*, 2012), and the CCHIP Household Hunger Scale (Wehler *et al*., 1992).

Another indicator of household food security is the household and individual dietary diversity score (DDS). Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods (Kennedy *et al.*, 2010). DDS questionnaires assess the number of different foods from various food communities that are consumed in the household or by the individual, within a specified period of time (Swindale & Bilinsky, 2006; Hoddinott & Yisehac, 2002). Studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security (Hoddinot & Yohannes, 2002; Hatloy *et al*., 2000). The household dietary diversity score (HDDS) serves as a snapshot of the economic ability of a household to access a variety of foods. It is also used as a proxy for nutrient adequacy of the diet of individuals. The individual dietary diversity does not include foods such as sugar/honey since they contribute little to nutrient intake; however, this is included in the HDD to measure socio-economic status. Thus, the HDD is a measure of socio-economic status while the individual status is a measure of nutritional status (Swindale & Bilinsky, 2006; Ruel, 2002). Among validated DDS questionnaires and scoring systems, are the FANTA (Food and Nutrition Technical Assistance III Project) Household Dietary Diversity Score Indicator Guide (Swindale and Bilinsky, 2006), which includes a list of twelve food communities and therefore uses a score of zero to 12 (Swindale & Bilinsky, 2006). The FAO adapted this questionnaire to include 16 food communities, and uses a score from zero to 16 (Kennedy *et al*., 2010). The individual DSS is mostly used for children, and classifies food into only eight groups, with a score between zero and eight (Swindale & Bilinsky, 2006).

In periods of food insecurity, households adopt coping strategies to deal with inadequate food access. Some households, for example, reduce food quantity or quality, reduce the frequency of meal intake from three to two, and/or resort to cheap, less nutritious diets (Walsh & van Rooyen, 2015; Abu et al., 2010). Others just go without food until they have access to food. Most of these coping strategies affect nutritional status, since the intake of required nutrients are compromised. Therefore, coping strategies are also assessed as part of food security assessments, for example measuring the ability to produce enough to supply food needs from one harvest period until the next, or the ability to purchase enough food all year round (Quaye, 2008).

Food frequency measurement is another indirect way of collecting data on dietary intake on an individual level. Foods eaten are listed on a food frequency questionnaire (FFQ) and the respondent states the number of times the food is consumed within a reference period. This method, while giving information on the diversity of foods eaten, is not sensitive in measuring the day-to-day variations of individual food intakes. Although a FFQ can be adapted and used effectively, to collect data for micronutrient analysis (Gibson, 2005:130), it also provides a snapshot of usual dietary intakes that may give insight into biochemical and clinical evidence of nutrient deficiencies (Allen *et al*., 2006:141). For example, if the intake of foods from animal origin in an individual or community is low, this may cause possible deficiencies in nutrient like thiamine, calcium, iron, zinc, vitamin B12 and fat-soluble vitamins, like vitamin A. Furthermore, in populations where there are high intakes of phytates and polyphenols, which inhibit the bioavailability of iron and zinc (Allen *et al*., 2006:141) reported intakes of these micronutrients may not be reflected in the nutritional status of the people.

2.9.2 Methods of assessing dietary iron intake

Food intake can be directly assessed at household or individual levels. Household food acquisition refers to the energy or food nutrients available per household members over a given period of time (Hoddinott, 1999). In this method of data collection, the person responsible for food preparation is required to account for all food prepared over a certain time period (usually seven days), and nutrient lost during processing is taken into consideration. All quantities are converted into kilograms. The energy and nutrient conversions are compared to what is required (Smith & Subandoro, 2007:8-9,13-16; Hoddinott, 1999).

At the individual level, 24-hour recalls and food records are most commonly used. The 24-hour recall is a valid method of making a participant recall all foods consumed in the last 24-hours. The recall includes the intake of foods, fruits, snacks and foods eaten within and outside the household. It is most effective when done in a participatory manner (Gibson & Ferguson, 2008:31). To conduct this method is easy; takes little time, and needs minimal training of participants. Being reliant on the participant's memory and thus subject to potential recall bias, dietary recall may be associated with under- or over-reporting of foods eaten. Foods like alcohol (similar to tobacco use) are more likely to be under-reported due to cultural or religious beliefs and associations (Gibson & Ferguson, 2008:31). Another source of potential bias is the interviewer; the result of an interview is different depending on the level of probing of the interviewer, whether the interviewer is male or female, whether the interviewer is from the community, or is a known health worker (Gibson, 2005: 106-109).

Other limitations to this method include the fact that the interviewer may incorrectly estimate food quantity consumed because the respondent fails to describe it accurately. The omissions of supplements may introduce inaccuracies in evaluating the micronutrient intakes. The conversion of data from portion sizes to grams could also introduce biases into the data. In spite of these possible biases, effective training of interviewers and also creating cordial, but confidential environments for recalls, may increase the quality and usefulness of the data collected (Gibson & Ferguson, 2008). In addition to the food portion sizes, information on food handling and preparation are collected. Due to the effects of memory and recall bias, this method is more effective when the period of recall is reduced. The shorter the time, the lower the burden is on the individuals' memory. The respondent bias is also reduced by collecting data for more than one day and, if possible, for non-consecutive days. Since most households are becoming urban and work, their weekend dietary choices may be different from their weekdays. Hence, it is always advisable to include the weekend in the days of dietary data collection. In order to ensure reproducibility in data collections, the procedure has to be standardised (Gibson & Fugerson, 2008:63). This method is also very effective in the measurement of intra-household food security.

The weighed-food record is a more tedious method of data collection. In this method, the respondent is visited at home and all foods and drinks are weighed before and after cooking. When foods are served, the amount of food dished up for the respondent, is measured before eating and the surplus left after eating is measured. The difference between the before and after amounts represents the actual food consumed by the respondent. This method of dietary assessment is tedious and inconveniencing for both the researcher and respondent. However, it provides the closest estimate of the amount of food eaten and does not rely on the respondent's memory (Gibson & Ferguson, 2008:53).

2.10 Food composition tables/databases

To calculate the nutrient intakes of individuals and populations, food composition tables and/or databases are used, which lists representative average compositions of different foods (Gibson, 2005:65). Composition is usually expressed as the nutrient content per 100g of a particular food (Charrondiere, 2014a).

Data for food composition tables/databases should ideally be obtained from direct chemical analysis of foods. This is expensive, therefore the borrowing from other trusted databases are encouraged; unless the food is commonly consumed, but in small portions, in which case chemical analysis is encouraged. During the compilation of the tables, the processing methods should be considered. For example, the germination, and fermentation and soaking of cereals affect the phytic acid content of the final food (Gibson, 2005:66).

When calculating nutrient intakes, the potential weaknesses of the relevant food composition table/database used, must be kept in mind. Systematic errors may occur in the compilation of food composition tables. Some sources of errors are sampling procedures not being representative enough, the use of inappropriate analytical methods, some errors in the use of the analytical methods themselves, conversion factors inconsistencies in terminologies, incorrect description of individual foods items, and genetics, the environment, food preparation or processing factors (Gibson, 2005:74). Other important factors to consider as possible sources of errors include the following: Food composition tables/databases only list the amounts of different nutrients in the food items, without consideration of the bioavailability thereof. The rate of the bioavailability of most nutrients have not been determined or quantified. When analysis data is borrowed from other databases, another consideration is that the soil, in which the food is grown, has an effect on the nutrient content, so that nutrient profiles of similar foods, cultivated in different areas, may differ particularly for nutrients such as iodine, zinc and selenium. The geographical sources of the foods listed, are therefore important (Charrondiere, 2014a).

When borrowing values from a different database, the quality of the data also has to be ascertained. When data is obtained from different sources, a mean for normal data, or median for skewed data is used to calculate the representative values. (Gibson, 2005:66).

For calculating nutrient values in recipes, the type of foods included, whether these were cooked or raw, the amount of moisture and fat lost or gained during cooking, and the nutrient retention of various nutrients after cooking, must all be considered and mentioned. Yield and retention factors should also be considered (Gibson 2005:67; Charrondiere, 2014b).

Factors to consider when adopting a particular database include consideration of the comprehensiveness of the list of foods, and the methods used to obtain the nutrient values, and the indication of missing data. The United States Nutrient database (USDA nutrient database for standard reference) which is available online is one of the most widely used and borrowed from other databases. Other databases include the Canadian Nutrient File, as well as the United Kingdom database and the European Food Composition Tables. For Africa, examples include the West African Food Composition Tables and the South African Food Composition Tables (Stadlmayr *et al*., 2012).

For Ghana, the Ghana Food Composition Tables and the accompanying software, namely the Food Processor Plus was originally developed, borrowing analysis from the USDA nutrient database and Canadian databases. Composition information was adapted for Ghanaian use, using the European Small Hydropower Association (ESHA) research from 1987-1994, with inclusion of local cooking methods and preparation yields. This software still uses the DOS format and is therefore tedious to use. Since its inception, many studies have relied on this software for analysis and many diet-related decisions have been based on dietary analysis performed with this software. However, no evaluation on the content and quality of analysis has been published yet. Very little effort has also been made to update the software to increase ease of usage and to enhance its compatibility with advance computers. This poses a limitation to the dietary analysis in Ghana.

Recently, Armah *et al*. (2014; 2015), recognising that the existing Ghanaian food composition tables lack information on some micronutrients, particularly amino acids and some vitamins, created a revised database, with an accompanying software package, namely the Ghana Nutrient Database (not yet commercially available). The database was originally developed as part of a large clinical trial conducted in the Greater Accra Region by the Lysine Project Ghana Community (Ghosh *et al*., 2010). The database was compiled from field survey data, the USDA nutrient database for standard reference, and the Ghana Food Composition tables (Eyeson & Ankrah, 1975). Nutrient compositions for individual foods were based on the USDA nutrient database. For each food, the total nutrient composition which was obtained was compared to values in the Ghanaian Food Composition tables to ensure that the two sets of values, particularly for the macronutrients, were reasonably close. Local composite foods were included, based on the types and quantities of ingredients used in the preparation Armah *et al.* (2014). The software operates in the Access format. As the Lysine Project was done in Accra, in the Southern Sector, however, the software has some limitations regarding the analysis of foods typical to the Northern Sector. Also, as stated by Armah *et al*. (2015), the major shortcoming of the software, is that it, just like the original Food Processor Plus, does not take into account the amount of the nutrients lost or enhanced during cooking.

2.11 Adjusting intake data for variability

When dietary data is collected for a number of days, either through 24-hour recall, food weighing or food records, there is a variation of intake even in the same individual for different days, known as intra-person variability. There is also variability between different individuals in the same community, known as inter-person variability. Before data on usual intakes is used, it should ideally be adjusted to correct for the intra-person variability. Without this adjustment, the estimates of the inadequate intakes are incorrect since the mean remains the same, but the variability is reduced. Biases introduced due to under- or over-reporting are, however, not removed by this adjustment process (Allen *et al*., 2006:157). With a sample size above 100, the inter-person variability of 24h recall data may be adjusted for, either through a manual calculation or by using a software programme in the statically analysis system (SAS). Adjustment cannot, however, be done on data collected by FFQ (Gibson *et al.,* 2005:212-215).

For iron, the bioavailability levels must also be noted. For each range of inadequacy, the product of the percentage of individuals with intakes in that group and the probability of inadequacy is calculated. The sum of the prevalence of the product gives the total prevalence of inadequate intake of iron in that population (Allen *et al.*, 2006:157).

2.12 Reference data for nutrient intakes

The first reference levels for nutrients were developed in 1940s and were based on the average levels of intakes needed for a healthy life. Factors like stress, illness, and bioavailability and nutrient-nutrient interactions were not considered. It was also assumed that requirements of energy and all other nutrients are met (Gibson, 2005:198).

In 1994, the scientists of the US Food and Nutrition Board of the Institute of Medicine of the Academy of Sciences proposed revising the former reference data to overcome the many limitations of the former system. The systematic implementation of a new set of recommendations called Dietary Reference Intakes (DRIs) in place of the US RDA and the Canadian RNI started in 1997. The DRIs represents a paradigm shift from just avoiding deficiency states, as determined by clinical manifestation, to supporting optimal activities within the body and preventing chronic diseases, thereby maximizing heath and increasing quality of life as well. The DRI is therefore a set of reference values, which consist of the EAR, RDA or AI, and the UL for each nutrient as appropriate.

Similar sets of recommendations have been published for populations in at least 40 different countries, as well as organisations like the WHO. Slight differences are due to variations in the interpretation of the scientific data on which the standards are based, as well as differences in the food habits and physical activity of the populations they serve. The WHO and FAO (Food & Agricultural Organisation) recommendations are considered sufficient to maintain health in nearly all healthy people worldwide.

Over the years, reference levels for nutrients continuously undergo revision as new and evolving issues of nutrition are considered. One such advancement for example, was recognition of the contribution of dietary fibre, carotenoids, and lycopene among others to health and hence the need to have reference levels for these (Gibson, 2005:200).

2.12.1 The Estimated Average Requirement (EAR)

The EAR is defined as the dietary intake of a specific nutrient that meets the estimated needs of 50% of the healthy individuals of a specific gender group at the given life-stage (Figure 2.3).

2.12.2 Recommended daily allowance (RDA)

The RDA is the recommended intake that is sufficient to meet the nutrient requirement of 97-98% of a population of healthy individuals in a particular sex and physiological group (WHO/FAO, 2004). The RDA is usually set at two standard deviations above the average intake or the EAR. This is done in order to meet the intake of all the individuals. The RDA therefore should be used to assess the intakes of individuals and not populations. Using RDA as an estimation of the EAR leads to an overestimation of the number of people with inadequate intakes (Gibson, 2005:206). The relationship between EAR and RDA are shown in figure 2.3.

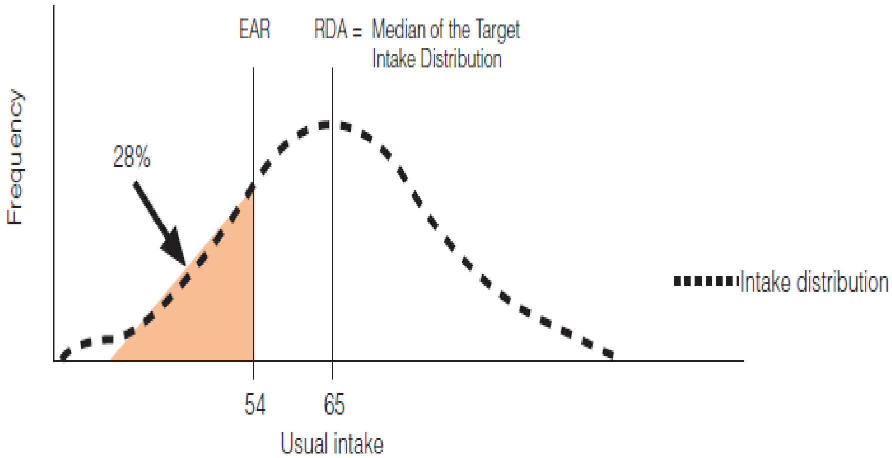

Figure 2.3: Diagram showing the dietary references and its relations with the EARs and intake distributions (Allen *et al.*, 2006:144).

In the place of the standard deviation, the coefficient of variation (CV) is sometime used, which is the standard deviation divided by the mean and expressed as a percentage. The CV of the requirement for the various sub-communities is usually between 10% and 20%. It is possible to convert RDAs to EARs by dividing the RDA of the nutrient requirement by 1.4 (i.e., 1+2(0.2) (Gibson, 2005:206).

2.13 Adequate Intakes (AI)

Adequate intake is the recommended average daily intake level based on observed or experimentally determined approximations and estimates of nutrient intakes by a group of apparrently healthy people who are maintaining an adequate nutritional state. Adequate intakes are set in situations where insufficient or conflicting evidence exist to set an EAR or RDI. Nutrients with recommended AI include water, Vitamin K and potassium for children 0-12months (Gibson, 2005).

2.13.1 Upper limit of intake (UL)

The tolerable upper intake level (UL) is the highest average amount of a specific nutrient an individual can ingest without any risks of adverse health effects for any individual in a population. The risk of adverse health effects increases when nutrient intake is above the UL. The UL for a specific nutrient is also specific for different age communities. There are, however, no UL established for many nutrients (IoM, 1998: online; IoM, 2001: online). Furthermore, the ULs serve as a guide and may not apply to people who are sensitive to a nutrient or are on treatment for a particular nutrient under medical supervision (IoM, 2014: online).

2.14 Interpreting nutrient intakes in populations

Within a population, it is often necessary to estimate the proportion of a group with intakes of specific nutrients that do not meet the requirements of that group, as well as the proportion with excessive intakes that may predispose them to risk. The recommended approach to evaluate the adequacy of nutrient intakes of population communities is to use the EAR. As indicated above, the EAR is the average daily intake estimated to meet the requirement of half of the healthy individuals in a population in a particular life stage and gender sub-group. Two methods based on the EAR have been developed, namely the probability approach and the EAR cut-point method. Both are applicable to nutrients for which reliable EARs have been established (Gibson, 2005).

2.14.1 Probability approach

This method combines estimates the proportion of individuals at risk for inadequate intakes in a group by combining the distribution of requirements and the individual usual nutrient intakes. It expresses the percentage of the population who are at risk for inadequate intakes. In this approach, the prevalence of inadequate intake is calculated from the estimates of the percentage of people in a predefined range, at risk of inadequate intakes. Because there is no actual requirement of the individual in a group, the method does not identify the individuals at risk, but gives an estimation of the prevalence of inadequate intake in the population under study (Gibson, 2005:215). To determine this, the method uses the EAR, an assumed CV, and the data on the usual intake of food, and the expected correlation between intakes and requirements.

2.14.2 The EAR cut-point method

The EAR cut-point approach is recommended by the WHO guidelines for assessing intake levels of most micronutrients (Allen *et al.,* 2006:143). The EARs for protein, vitamins A, B12, and C and the probability tables are provided in Appendix 7. This method does not require information on the exact nutrient requirement distribution (Gibson, 2005:217). This method’s main assertion is that the intake of a nutrient below the EAR in a population indicates the proportion of the population with inadequate intake. It is used based on the assumptions that the amount of nutrient intake and requirement are independent for all nutrients except for energy; that the variability in intake is greater than that of the requirement; and lastly that the distribution of nutrient requirement is symmetrical (Allen *et al*., 2006:156). In order to use the method, the data on intakes in a population, after adjustment for the with-in subject variability is used and the number of people with intakes below the EAR is counted. The total number of the population with intakes below the EARs represents the population at risk. This method is most useful when the prevalence of inadequate intake approaches 50%, but the performance of the method declines as the prevalence approaches 0% or 100% (Gibson, 2005:218).

This method is recommended to assess the adequacy of intakes of vitamins A, B6, B12, C, E, thiamine, riboflavin, niacin and folate, as well as copper, iodine, magnesium, molybdenum, phosphorus, zinc and selenium (Gibson, 2005:218).

2.14.3 Other approaches

In the absence of the EAR for nutrients, an assumed 77% of the RDA provided for a nutrient, can be used. This percentage of the RDA assumes a CV of 15% about the EAR. An assumed CV of 10% about the EAR results in 83% of the RDA, which may lead to a high estimation of the inadequate intake group, compared to the latter (Gibson, 2005:218).

2.15 Interpreting iron intakes in a population

For iron, the EAR cut-point method cannot be used for assessing iron intakes in WRA, as their distribution of iron requirements are skewed. For survey studies, the probability approach is therefore recommended to evaluate the adequacy of iron intake at different levels of assumed bioavailability (Gibson, 2005:215).

Food composition tables represent maximum levels of micronutrient available to the body in particular portions of foods. For iron, the amount that the body can actually absorb and use from the particular food, referred to as the bioavailable proportion, is lower than the total intake and dependent on the chemical form of iron in the food, the nature of the food ingested, and the overall composition of the diet (Gibson & Ferguson, 2008:105).

The estimated bioavailability of iron from the habitual local diets must be considered when selecting the appropriate EAR for comparison with the usual intake data derived from the 24-hour recalls. The amount of iron absorbed also depends on the iron status of the individual and certain host-related factors. Normative EARs are thus calculated for iron for each life-stage communities adjusted for dietary iron bioavailability at 5%, 10%, and 15%. The WHO/FAO approach (2004) recommends using iron bioavailability figures of 5% and 10% percent for diets in developing countries (Gibson & Ferguson, 2008).

2.16 Summary

Anemia is a global nutrition problem, which affects mothers and children. The short-term consequences include increased morbidity and mortality, whereas in the long-term anemia negatively affects human capital, productivity, cognitive development and DALYs. When the prevalence of anemia is above 40% in a population, the entire population is assumed to be suffering from ID. ID is strongly associated with pica, and nn spite of the unclear relationship between the two, pica practices pose several health risk to the people who practice it. These include micronutrient deficiencies, dental injury, abdominal problems like impaction or malabsorption, and parasite infestations. The known risk factors for ID include food insecurity, and dietary and other practices, which may cause inadequate intake or excessive loss of iron. Studying the contextual risk factors for ID/ anemia and pica in a community and assessing their KAP regarding ID and pica, is therefore important to inform targeted education massages.

(Note that the theory underlying NEPs are presented in chapter 8, in order to link it to the application of the theory in the development of the NEP for this study).

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CHAPTER 3:

3 METHODOLOGY

3.1 Introduction

This chapter describes the location and demographics of the study area, the data collection tools used, the method used and the statistical methods used to interpret the results.

3.2 Study area

The study was conducted in the northern and largest region in Ghana, which consists of 20 districts. The northern region of Ghana is the largest and consists of 20 districts. The region is close to the Sahel and the Sahara, making it drier compared to the southern part of Ghana. The vegetation is mostly grassland with savanna, with draught resistant trees like the baobab and acacia. The northern region, like the rest of the sectors, has a wet season between May and October and a dry season between November and April. The rainfall during the wet season is between 750 to 1050 mm. The Harmattan winds from the Sahara blow between December and February. The temperature varies from 14℃ at night and 40℃ during the day. The Dagomba and Mamprissi are the largest ethnic communities. The Gurma and Kokombas constitute 21% of the population, while the Dagombas constitute about a third.

Among the inhabitants, 52% speak the Mole-Dagbani language, a dialect from Niger-Congolese; and 56% follow Islam, 21% follow a traditional religion, and 19% follow Christianity.

3.3 Study design and sample selection

The study was conducted in three phases as discussed below (as illustrated in the conceptual framework in Figure 1.2).

3.3.1 Phase I

The first phase of the study was a quantitative, descriptive survey conducted in April 2012 in the Northern Region to establish the socio-demographics, and the baseline nutritional status and KAP regarding the known risk factors for ID/anemia. From the 20 districts that make up the region, two districts, namely Tolon-Kumbumgu district and Tamale metropolis, were randomly selected (map of study area). Tolon-Kumbungu traditionally consists of 237 communities, but is divided into 278 communities in five sub-districts by the GHS for Community Based Surveillance (CBS). The Tolon-Kumbungu district has 19 health facilities: five health centres and nine Community-Based Health Planning and Services (CHPS) Zones, two community clinics, two reproductive and child health (RCH) clinics, and one private mission hospital (King's Village Medical Centre) at Bontanga in the Dalun sub-district (GHS, 2012a). The Tamale metropolitan is made up of a population of 406 696 in six sub-districts, and has 40 health facilities, which excludes the number of teaching hospitals and traditional birth attendants (TBAs). It has 205-trained TBAs, 145 who were active at the time of the baseline, and 510 untrained TBAs. There are 840 CBS volunteers (males and females) and 480 Red Cross mothers who assist in various health needs within the communities (GHS, 2012b).

From each of these two districts, one village (community) was randomly selected. The two communities, namely Tugu and Gbullung, were comparable in terms of socioeconomic status, infrastructure, and social amenities. In these two communities, randomly selected households were approached, and all mothers who fitted the inclusion criteria were recruited to the study.

3.3.1.1 Inclusion Criteria

A mother was included in the study if:

- She lived in the selected communities, and at the beginning of the study, had one or more children aged six to 59 months (referred to in this study as the index children). Mothers with twins, triplets, and quadruplets would also be included in the study;

- She voluntarily agreed to be part of the study and signed an informed consent form after the study procedures were explained to her;
- She was not known to be pregnant at the beginning of the study;
- She was the primary caregiver of the index child(ren); and
- She was able to speak the local language (Dagbani) or English.

3.3.1.2 Exclusion Criteria

A mother was excluded from the study if:

- She lived outside of the selected communities;
- All her children were younger than six months and/or older than 59 months;
- She was known to be pregnant at the beginning of the study;
- She did not sign informed consent;
- She (or her index children) had active infections in the two to three weeks (marked by fever) or had clinically diagnosed cancer prior to the beginning of the study; and
- She (or her index children) was receiving treatment for ID at the time of the study.

The final sample included 161 mothers; 81 from the Tolon-Kumbumgu district and 80 from Tamale metropolis. This sample size was chosen in order to engage mothers in a subsequent longitudinal study with a NEP regarding ID and anemia. It was felt that two communities of approximately 80 households would be the limit in terms of cost-effectiveness for the study and intervention, while still allowing for some attrition during follow-up.

During the planning of the study the possibility was foreseen that 80 participants might not be obtained in a selected village, and in such case, the closest village to the selected village would be used and the household identification process repeated there until 80 households (80 mothers) were included. This process would be repeated until the total sample was obtained in the selected district. This was to ensure proximity to the venue of the intervention. Since such selected communities would come from one region, environmental and geographical factors like the soil composition, pattern of rainfall, types of crops grown, and vegetation would be comparable. This occurred in the case of Tamale Metropolitan area, where only 56 mothers could be recruited in Tugu. The closest village to the selected village was then added as second village and the household identification and sampling process repeated, until a further 24 mothers in Tugu-yepala, a new settlement of people of Tugu, were recruited.

3.3.2 Phase II

This phase involved the design of a NEP training manual based on the results from phase I, as well as the literature on ID and pica.

3.3.3 Phase III

Gbullung was randomly selected as the intervention community, where the NEP was implemented. Tugu became the control village. Of the 81 mothers that participated in the baseline in Gbullung, only 73 took part in the intervention, as eight mothers were absent from the village at the time of the intervention. To evaluate the impact of the NEP, the same variables measured in phase I, were measured again in both communities three months after the implementation of the NEP, using the same techniques as at baseline.

3.4 Variables and operational definitions

UNICEF’s conceptual framework for malnutrition (Figure 2.2) was used to design the objectives of the baseline survey, and to choose the variables to assess in this survey. Data were therefore collected regarding the basic, underlying and immediate causes of ID and anemia in the community as summarised in figure 3.1.

3.4.1 Socio-demographic characteristics and medical backgrounds

Socio-economic status is associated with the nutritional status of children and adults. Studies have shown that the burden of nutritional status disproportionately affects communities with a low socio-economic status (Hong, 2007). Socio-demographic characteristics for the purpose of this study referred to the ages of mother and children, gender of the children, mothers' ethnicity and marital status, level of education, and employment status. The characteristics of the household was also assessed regarding the type of housing, utilities, cooking and cooling facilities, and household income. The mothers also identified the principal decision maker of the households.

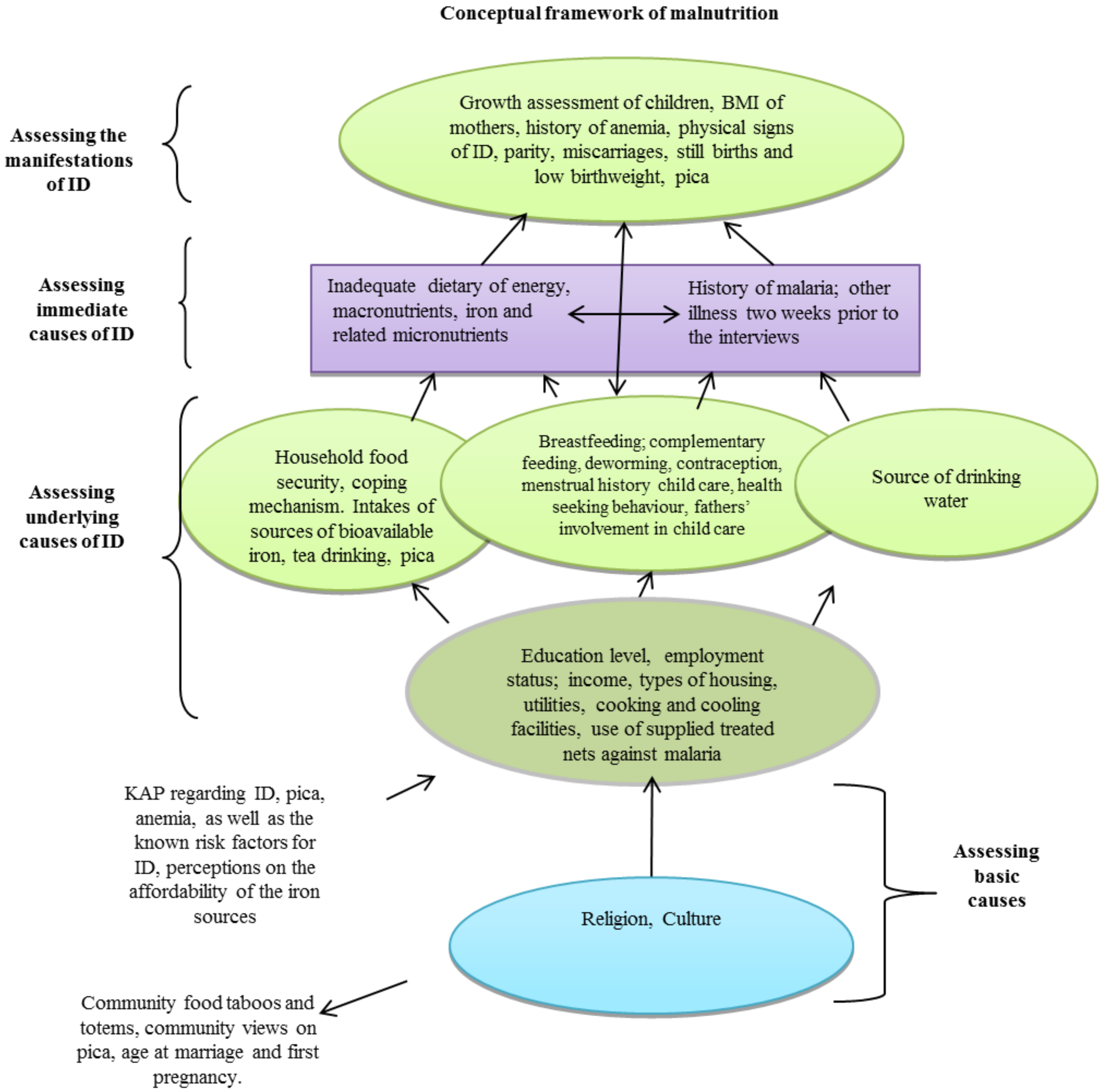

Figure 3.1: The variables which were measures for the purposes of this study

Medical history for the purpose of this study referred to parity, the mother's menstrual history, gestational ages and birth weights of children, spacing of pregnancies, and history of miscarriages, and stillbirths. The mother/child(ren)'s history of anemia, malaria and worm infections, as well as treatment of these conditions; the mother's history of anemia during pregnancy, her use of contraception; smoking; and the use of iron supplements were also assessed. A child with a birth weight ≤2.5kg was classified as a child born with low birth weight (LBW) (Gluckman & Pinal, 2003; Roche, 1994:2)

3.4.2 Nutritional status

Nutritional status may be assessed based on various different parameters. The major parameters include anthropometric measurements, biochemical tests, nutritional intake, and physical findings (Maqbool *et al.*, 2011; Maqbool *et al*., 2008). For the purpose of this study, nutritional status was evaluated using anthropometry, physical signs and symptoms of IDA, dietary intake, and household food security.

3.4.2.1 Anthropometry

Body measurements are taken in order to assess body composition by comparison with published standards for a particular age and gender (Gibson, 2005:273). For the purpose of this study, body composition of a mother was assessed based on body mass index (BMI), and that of a child based on the relevant WHO Z-scores.

3.4.2.1.1 Body Mass Index (BMI)

For the mothers, BMI was calculated as weight in kilograms divided by the height in meters squared (kg/m2) (WHO, 2004:157). BMI may classify very muscular people as being obese, and does not reflect fat distribution. Yet, it is still accepted as the universal reference to assess health risks associated with body composition (WHO, 2004:157). BMI was used to categorise mothers as underweight, normal and overweight/obese (Table 3.1).

3.4.2.1.2 Z-scores

For the children, weight and height were evaluated according to the WHO Z-score. Underweight (based on weight-for-age), wasting (based on weight-for-height), and stunting (based on height-for-age) were assessed (Gibson, 2005: 336-338). The Z–scores were calculated using the WHO Anthro Plus software (Version 3.2.2) based on standards for children under 60 months (WHO, 2006), and classified according to the categories and inferences in Tables 3.2, 3.3 and 3.4.

Table 3.1: International BMI classifications for adults (WHO, 2004, WHO, 2000.1995)

Classifications	**BMI (kg/m2)**
Severe thinness	<16.00
Moderate thinness	16.00 – 16.99
Mild thinness	17.00 – 18.49
Underweight	< 18.50
Normal range	18.50 – 24.99
Overweight	≥ 25.00
Pre – Obese	25.00 – 29.99
Obese	≥ 30.00
Obese Class I	30.00 – 34.99
Obese Class II	35.00 – 39.99
Obese Class III	≥ 40.00

Table 3.2: Z-score categories for weight-for-age (Seal & Kerac, 2007; WHO, 2006)

Z-score	**Indication**
-1 to 1	No malnutrition (normal weight)
-1.1 to -2	Mild malnutrition
-2.1 to -3	Moderate malnutrition (underweight)
< -3	Severe malnutrition (severe underweight)

Table 3.3: Z-score categories for weight-for-height (Seal and Kerac, 2007; WHO, 2006)

Z-score	Indication
-1 to 1	No malnutrition (normal size)
-1.1 to -2	Mild malnutrition
-2.1 to -3	Moderate malnutrition (wasted)
< -3	Severe malnutrition (severe wasting)

Table 3.4: Z-score categories for length/height-for-age (Seal & Kerac, 2007; WHO, 2006)

Z-score	Indication
-1 to 1	No malnutrition (normal height)
-1.1 to -2	Mild malnutrition
-2.1 to -3	Moderate malnutrition (stunted)
< -3	Severe malnutrition (severe stunting)

3.4.2.2 Physical signs of IDA

For the purposes of this study, participants were examined for koilonychias (spoon-shaped nails), angular stomatitis, and atrophic glossitis as physical signs of IDA.

3.4.2.3 Dietary intakes

For the purposes of this study, dietary intake referred to the usual daily food and nutrient intakes.

3.4.2.4 Frequency of intake of iron sources, and food/drinks that influence bioavailability of iron.

Frequency of intake of iron sources and food/drinks that influence bioavailability of iron in the diet were assessed and interpreted based on existing literature (Gibson & Fugerson, 2008).

3.4.2.5 Energy, macronutrient and specific micronutrient intakes

The daily intakes of energy, protein, carbohydrates, fat, and vitamins A, B12, and C, folate and iron (specific micronutrients involved in iron physiology and anemia) (FAO/WHO, 1998) were assessed using the *F-pro (Version 6.02)* software. This database was originally developed for assessing of dietary quality in Canada and United States of America and was then adapted by the University of Ghana, Department of Nutrition, and Food Science, for Ghanaian purposes. The averages of the three days' intakes were used to represent the daily intakes. After analysis of the baseline dietary intake data with this software, some inconsistencies seemed apparent and a second, new database, the Ghana Foods Nutrient Database *(Version 1.0)* was used (Armah *et al*., 2014; 2015). The calculated average daily macronutrient and micronutrient intakes were compared to the age specific EARs and for the energy, intakes with the estimated energy requirements (EER). The EAR is defined as the average daily nutrient intake level sufficient to meet the nutrient requirements of 50% of "healthy" individuals in a particular age and gender group. For energy requirements, the EERs set by the WHO/FAO (2004) for communities in developing countries, were used. For protein requirements, the earlier WHO recommendations (1985) were used as recommended by Gibson and Ferguson (2008:117). For infants the recommendations of the Dietary Energy Consultative Group regarding the protein requirements for infants (0-24 months) in developing countries (Dewey *et al.,* 1996) were used.

The dietary intakes of vitamins A, B12, C, and folate were also compared to the EARs set by the WHO/FAO (2004) for communities in developing countries (Gibson & Ferguson, 2008:118). For iron, the probability approach as recommended by Allen *et al*., 2006 and described in chapter two, was used to assess the bioavailability of iron in the diet at 5% and 10% assumed bioavailability.

3.4.2.6 Household food security

Food security is achieved when all people at all times have both physical and economic access to sufficient food for an active and productive life (FAO, 2004; USAID, 1999). For the purposes of this study household food security was assessed according to an 8-item hunger scale from the Community Childhood Hunger Identification Project (CCHIP) (Wehler *et al*., 1992), which is internationally used, and validated to measure of food security in households with children (Hanekom, 1999). According to this score, a final total score of zero indicates that a household is food secure; a score of 1-4 indicates that the household is at risk of hunger, and a score of ≥5 indicates that the household is experiencing hunger (SANHANES-1, 2013:145; Wehler *et al*., 1992). Questions related to coping mechanisms during times of food insecurity were also included.

3.4.3 The prevalence and types of pica

For the purpose of this study, the prevalence of pica, as well as the types of pica was determined among the study population. Usual pica material, food cravings and polypica were investigated. Pica history during the pregnancy of the index child was also investigated. A history of the mother’s pica practice was explored to investigate recurrent pica or otherwise.

3.4.4 KAP on ID and pica

In this study, knowledge was defined as a mother’s ability to define anemia and pica. To distinguish the vulnerable communities affected by ID, the symptoms thereof, the causes thereof, and impact thereof on the health of women and children, as well as the ability to distinguish the food sources of iron, and dietary factors that relate to iron bioavailability in the diet. The mothers’ source(s) of information on anemia was also determined. Her knowledge related to pica was also assessed.

Attitudes for the purposes of this study referred to a mother’s views (positive or negative) and judgments towards issues related to ID. Her attitude, as well as that of the community, toward pica was also addressed.

Knowledge regarding measures that prevent ID, knowledge of risk factors for ID, and symptoms associated with anemia, as well as the mothers’ attitudes (defined for the purpose of the study as approval of certain behaviours associated with poor iron status); and practices regarding the use of iron supplements and mosquito nets, drinking tea or milk with meals, and deworming, were assessed with multiple choice questions, sets of test statements, and questions to which the mothers could answer "yes/no", "agree/don't agree", or "I don't know". Knowledge of food sources of iron and enhancers of iron absorption were assessed with sets of paired foods from which the better source had to be selected. To assess knowledge, a score of one was allocated if the mother could identify a measure, which prevents ID, or an incorrect test statement regarding ID and associated risk factors; a zero score was allocated if she chose an incorrect answer or the "do not know option". The same method was used to evaluate knowledge regarding food sources of iron and iron absorption enhancers, and risk factors and symptoms of ID. To assess attitudes regarding ID and risk factors, a score of zero was allocated for a high-risk behaviour, or a "do not know option" that she chose from a list of multiple choice questions. To assess practices regarding ID and risk factors, a score of one was allocated for each positive preventive measure a mother reported practicing and each negative practice that she reported to abstain from.

Open-ended questions were also included to allow mothers to share their own ideas about ID and anemia. Manual content analysis was done on open-ended questions by categorising responses into themes. Additional KAP questions, which were not scored, because a "right/wrong" approach was not possible, assessed the mothers' perceptions on the availability of food sources of iron, cooking methods, as well as where the mothers had learned what they knew about anemia. Additional questions were also included on smoking habits of the mothers; breastfeeding practices with the index child (ren), iron supplementation in the mothers and children; tea/coffee/milk intake in relation to meals; dietary taboos; food processing methods and cooking utensils; and practices to control malaria and intestinal parasites.

3.5 Measuring techniques

A questionnaire (Appendix 6), anthropometric measurements and physical examinations were used to measure the variables in this study. The questionnaire was developed to record socio-demographics, medical histories, dietary information, and KAP. The questionnaire was administered during structured interviews with the mothers in/at their homes. All interviews occurred in a one-on-one setting with the mother, in a private environment to encourage her to answer truthfully. Probing questions were also used to encourage her to answer questions in more detail. As there were mothers in the study population who could not read or write, all questions were verbally translated from English into the local languages. The checklist in Appendix 8 was used to conduct an observation of each included household.

3.5.1 Socio-demographic characteristics and medical histories

Socio-demographic characteristics and medical histories were assessed with the structured questionnaire in Appendix 6. Children's birth weights were collected from the child record card (CRC) or "weighing card". Each child is given a CRC at birth in which birth weight and immunisation history, as well as growth monitoring is recorded.

3.5.2 Nutritional status

The following techniques were used to measure the various parameters used to assess nutritional status of the mothers and index child (ren).

3.5.2.1 Anthropometry

To calculate BMI the weights and heights of the mothers was measured.

Weight

Weight was determined with an electronic scale according to the standard procedures recommended by Gibson (2005: 247-252) and Lee & Nieman, (2007:173). The scale was placed on a hard, flat surface, checked and adjusted to zero before each measurement. The participants wore minimal clothing (remove jacket, shoes, and jewellery) and had to stand still in the middle of the scale's platform without touching anything and with the weight equally distributed on both feet. Weight was recorded to the nearest 10g. To ensure reliability, the batteries for the scales were changed every other day of usage, the scales were calibrated with a known weight at the beginning of the day and after every 20 readings. The same trained researcher, with the assistance of a research assistant, weighed all participants (Katzenellenbogan & Abdool Karim, 2014; Katzenellenbogan *et al*., 1997: 126-275).

For mothers

The measurement was done after the bladder had been emptied and before a meal (Gibson, 2005: 370; Hammond, 2008: 399-400).

For children

Children who could stand were weighed according to the standard method described above. For children who could not stand on the scale by themselves or children who were too scared, an adult was weighed as described above, after which the child with minimal clothing and no shoes was handed to the adult and their combined weight was recorded. To obtain the child's weight, the weight of the adult was subtracted from their combined weight (Gibson, 2005:252).

i. **Standing height / length: For mothers and children (≥ 24-months)**

Height was determined by means of a mobile tape (Microtoise) to the nearest 0.1 cm. One trained researcher measured participants to ensure reliability and to avoid inter-observer bias. Participants stood without shoes, heels together and back as straight as possible. The heels, buttocks, shoulders, and head touched the vertical surface of the measuring device. The hands hung freely by the sides, with palms facing the thighs. Subjects maintained a fully erect position. The height measurement was defined as the distance from the floor to the top of the head (Gibson, 2005:247; Lee & Nieman, 2007:171).

ii. **Recumbent length: for children <24 months**

Recumbent length was measured according to the standard procedures recommended by Lee & Nieman (2007:171). The length was measured to the nearest millimetre using an infantometer. This was taken with the child lying in the recumbent position (Gibson, 2005; 246-247). A field assistant placed and gently held the child on the infantometer facing upwards with the head towards the fixed end. Another field assistant held the feet, without shoes, pointing 90 degrees upwards, knees straight, and moved the movable board to rest firmly against the heels. Readings were then recorded to the nearest millimetre.

3.5.2.2 Physical examination

A physical examination was done by the researcher at the same venue (WFP feeding centre) in the community where anthropometry was also taken. The researcher was previously trained in the physical identification of the following physical signs of IDA: koilonychias (spoon-shaped nails) by observing the shape of the nails, angular stomatitis by observing the corners of the mouth, and atrophic glossitis (by inspecting the tongue).

3.5.2.3 Dietary intake

The following techniques were used in the evaluation of dietary assessment:

Frequency of intake of iron sources and food/drinks that influence bioavailability of iron

Frequency of intake of iron sources and food/drinks that influence bioavailability of iron in the diet was assessed with a food frequency questionnaire (FFQ) based on published literature regarding dietary sources of iron and dietary factors that affect iron bioavailability (Appendix 6).

24-hour recall:

In accordance with the recommendations of Gibson & Ferguson (2008), 24-hour recalls of three non-consecutive days were used to assess dietary intake of the mother and child/children (Appendix 6). The mother was asked to recall all food and beverages consumed by her and her child/children in the 24 hours prior to the interview. This was repeated on two other days within the same week (for practical purposes). People tend to under or overestimate the foods they have eaten. To reduce these biases mothers were given privacy during the interviews and interviews were conducted in the participants' homes to ensure that they were comfortable in the environment. Probing questions were asked to clarify responses and particularly to gain accurate information regarding snacks and foods eaten outside the home (Gibson & Ferguson, 2008:47). To enable mothers to describe the portion sizes of foods eaten, calibrated food models were provided. Household measures from the communities were also used as visual aids to help in estimations (Gibson & Ferguson, 2008:48). The equivalent weight in grams of the portion described, were subsequently estimated. In the case of foods purchased from outside, the monetary values were asked to help give an accurate estimation of the amounts of food consumed. To improve understanding of the local situation and contextualise the findings, the researcher observed the local customs related and recorded these in a field journal.

3.5.2.4 Household food security

Food security and the coping mechanisms during times of food insecurity, were assessed with a questionnaire adapted from the PURE Study (which included 15 countries) (Hanekom, 1999) and the AHA Free State Study (on rural communities in South Africa) (Walsh & van Rooyen, 2015), to reflect the local situation (Section F of Appendix 6). The 8-item CCHIP questionnaires (Wehler *et al*., 1992), as well as questions related to coping strategies were incorporated into the questionnaire.

3.5.3 The prevalence and types of pica

A questionnaire (Appendix 6) to assess pica was adapted and modified from Louw et al. (2007) and administered during the structured interview with the mother.

3.5.4 KAP on ID and pica

In the absence of a published formally validated KAP questionnaire related to ID, a KAP questionnaire (Appendix 6) was developed for the study, based on a thorough literature review on the dietary factors that may influence the risk for ID and IDA.

3.5.5 Developing, implementing and evaluating the training manual

A document review was done by interpreting and coordinating all data from the questionnaires. The NEP manual was then developed to address these baseline findings, which were organised into ten themes with sets of key messages (Abu, 2015:253-298). The

NEP was implemented in the intervention community, and was designed to applaud and reiterate good KAP, correct myths and misinformation, and encourage mothers to adopt KAP that would reduce the risk for ID and IDA among themselves and their young children. Training of mothers was performed over three consecutive days in 90-minute sessions, conducted in a relaxed atmosphere. During these training sessions, information was imparted by the researcher and translated into Dabgani by the RA in simple language to reduce bias. Local foods were used for demonstrations and good cooking and processing methods were showcased. After training, and within a week of the intervention, mothers were visited in their homes to reinforce the messages and to answer any questions or address problems with implementation of the NEP themes and key messages.

The intervention was evaluated by repeating the baseline measurements in both communities, three months after the implementation of the NEP in the intervention community.The three months time lapse between intervention and follow-up was to allow some time for NEP educations messages to be accepted and implememnted.

The development and implementation of the intervention is discussed in detail in chapter eight.

3.6 Data analysis

Z–scores were calculated using the WHO Anthro Plus software (Seal & Kerac 2007; WHO, 2006). The Food Processor Plus® (Version 6.02) and Microsoft Office Excel were used to convert food intake from 24-hour recall into nutrient content. The data weres statistically analysed with SAS/STAT software (version 9.3) of the SAS system for Windows (Copyright © 2010 SAS Institute Inc). Manual content analysis was done on data from open-ended questions. Data were summarised by means of descriptive statistic as means and standard deviations for continuous data and frequencies and percentages for categorical data. Chi-square test, paired t test and Fisher's exact test were used as appropriate, to asses for possible associations between variables. $P<0.05$ was considered significant.

For daily nutrient intake of mothers and children, paired t-test was used to test the associations between variables. Food security levels were also cross tabulated with nutritional status and frequency of food intake.

The KAP questions were scored as discussed above. Chi-square and t-test analysis were used to test for associations between KAP and socio-demographic and medical factors that were known risk factors for ID/anemia.

Fisher exact tests were used to test for associations between a mothers current pica practice and that of the index child's; and the association between the mothers pica practice while pregnant with an index child and that child's current pica practice was.

To evaluate changes that occurred in the variables after the intervention was implemented, the changes in the responses and scores of the individual mothers were classified into four communities. The first group ("correct pre - correct post") referred to participants who correctly answered the test question at baseline and post intervention. The second group ("correct pre - incorrect post") refers to the participants correctly answered the test question at baseline, but incorrectly post intervention. The third group ("incorrect pre-correct post") referred to the participants who answered the test question at baseline incorrectly, but correctly post intervention (being the category where the desired change took place). The fourth group 'incorrect pre - incorrect post" referred to participants who answered the test question incorrectly at baseline, as well as post intervention. The Chi-square, paired t-test and Fisher's exact test were used to infer mean significant changes in the scores.

Similarly, to assess the individual mothers change from baseline to post-intervention for categorical data, each mother was assessed on her response at baseline and post-intervention. The changes in responses were classified into these four communities. The first group ("yes pre - yes post") referred to participants who correctly answered the test question at baseline and post intervention. The second group ("yes pre - no post") refers to the participants correctly answered the test question at baseline, but incorrectly post intervention. The third group ("no pre - yes post") referred to the participants who answered the test question at baseline incorrectly, but correctly post intervention (being the category where the desired change took place). The fourth group"no pre - no post" referred to participants who answered the test question incorrectly at baseline, as well as post intervention.

3.7 Validity, reliability and foreseen limitations of the study

Care was taken to ensure validity and reliability, and to identify and overcome limitations, in order to prevent bias in the study.

3.7.1 Validity

The validity of a study is the ability of the method used to measure accurately that which it is supposed to measure. It is also the ability of the methods to meet the set objectives of the study and give true results from the sample (Golafshani, 2003: Joppe, 2000:1).

To ensure validity, gold standard procedures published by the HarvestPlus group was used in the study to assess dietary intake and bioavailability of iron (Gibson & Fugerson, 2008). Furthermore, to ensure content validity, all questions in the questionnaires were based on an in-depth literature review and were related to the set objectives of the study. Questionnaires were translated from English to Dagbani and then from Dagbani to English during the pilot study to ensure that translations were the same as the questions. Data collection was performed during the dry season to capture data during the most pressing times. Pictures of the physical signs were used during training to ensure RAs were trained. For anthropometry, a precaution to ensure the accurate information is taken.

3.7.2 Reliability

Reliability is defined as the extent to which results are consistent over time and an accurate representation of situations in the total population. Reliability is also the ability of a study getting similar results using similar methodology anytime it is used in identical circumstances (Golafshani, 2003; Joppe, 2000:1; Lewis, 1999). To ensure reliability all standard methods and standard published procedures were followed accurately.

Research assistants were properly trained, in order to ensure accurate data collection. In The more technical data collection methods, like anthropometry and dietary data collection, was performed by the researcher only. To reduce the effects of recall bias, different methods of data collection acted as validation for each other, for example FFQ validated the data on 24-hour recall. In order to collect reliable data on usual dietary intakes and food security, data was not collected during the Christmas or New Year season, as festive seasons may affect dietary intakes and not reflect usual diets. Care was taken to perform the baseline and follow-up evaluations in the same season, to reduce the impact of seasonal effects.

3.7.3 Limitations

Several limitations were foreseen during the planning of the study and the appropriate steps were taken to minimise the effect thereof.

Recall bias may have been introduced in some instances, especially on questions that depended on the mothers' memory. Sections on pregnancy history and practices during the mother's pregnancy with the index child were carefully explained, and probing was used to get accurate information as much as possible.

Mothers may also have under- or overestimated the foods that they or their children had eaten. This was also likely for children who were a little older, attended school, or played outside the home, in which cases mothers may not always have been able to account for food eaten outside the household. There may also have been seasonal effects on dietary data. To address this probing was done. To avoid skewing of data, dietary data were not collected close to the EidFitr and Eid Adha celebrations in order to gain a true reflection of usual daily nutrient intake and frequency. The only ditary data analysis software was adopted from Canada and this may mean some approximations and some foods found in Ghana may not are currately calculated for nutrient content.

3.8 Study procedure

The study was conducted in the following three phases,

3.8.1 Phase I

The study was perfomed according to the following steps:

Step 1: Obtaining permission and ethical approvals

Approval to conduct the study

Approval was obtained from the Ethics Committee of the Faculty of Health Sciences, UFS and the Ethical Review Board of the Noguchi Memorial Institute of Medical Research (NMIMR) of the University of Ghana.

Permissions

The Regional Director of Health and Regional Nutrition Officer in the Northern Region of Ghana was contacted to seek permission and then briefed on the study. Copies of the ethics approval request application letters are shown in Appendix 4.

i) The two districts were selected at the Regional Health Directorate level according to the protocol.

ii) The two Districts Health Directorates were visited and permission letters submitted to the District Directors and then later introduced to the District Nutrition officers. A community from each district was selected with the help of the District Nutrition Officers according to the protocol; the research team was later introduced to the community volunteers they usually work with.

iii) With the help of the community volunteers, the community leaders (chief and elders) were informed and permission sought.

iv) In addition, the team also visited the community clinic in each of the selected villages and permission was sought from the head staff

Step 2: Preparation for data collection

Training of research assistants (RA):

Four RAs (two were nutritionists and had with B.Sc. in Nutrition degrees; two were community health nurses with Certificates in Community Health were trained for two days on the recruitment of participants into the study, questionnaire administration, and use of tools (scale, Microtoise and infantometer). All the techniques required for the accurate collection of data were practiced. The RAs assisted in the administration of questionnaires and the taking of anthropometric measurements.

Pilot study:

A pilot study was done in the Northern Region using five mothers. A pilot study is defined as a test of methods and procedures to be used in a larger anticipated study to be conducted to enable the researcher to improve upon the planning and protocol of the main study (Epidemiology Dictionary, 2008:185). Pilot studies are also performed to make sure that tools that are to be used for the large-scale study are comprehensive and suitable. This may include questionnaires and consent forms (Thabane *et al*., 2010; Lancaster *et al*., 2004; Carfoot *et al*., 2003).

A pilot study was undertaken with five children and their mothers in April of 2012. These participants were randomly selected by community health workers in the selected community in the Northern Region. Responses from the pilot study were not included in the main study sample in order to reduce type 1 error as much as possible (Lancaster *et al*., 2004). If data from pilot is included in the main study, type 1 errors could occur due to sampling bias.

The purpose of the pilot study was to ensure that respondents clearly understood the questions and that the translation from the English language to the local language was consistent. Translation from English to Dagbani and back to English was done by the researcher and research assistants. The average time used to complete the questionnaire was determined, and it also it helped assess the' burden on the respondents.

Step 3: Sample selection and obtaining of informed consent

Within the selected districts, the sample of mothers and child/children who fit the inclusion criteria was selected according to the protocol. This was done by the researcher and the RAs.

The selected mothers were approached in their households and invited to participate in the study. Informed consent was obtained from each participant. Consent forms were signed or thumb printed in a case where a mother could not sign. Children who could speak and understand, and indicated their willingness to participate in the study, were given an assent form to thumb print.

A maximum of 20 households were processed per day (if the mother was illiterate then questions were translated to her into her own language). Dietary data collection, physical examination and anthropometry were performed with the help of the RAs, while the other questionnaires on socio-economic background, medical background and KAPs were conducted by the RAs under the supervision of the researcher.

Step 4: Data management and analysis

All data collected during Phase I were entered in various software packages and analysed with the assistance of the Department of Biostatistics of the University of the Free State.

3.8.2 Phase II

Step 5: Developing the NEP

The findings from Phase I were used to develop training manual and key messages.

Step 6: Implementation of the NEP

Of the two communities each representing a district in Phase I, one was randomly selected for the intervention while the other acted as the control. The participating mothers in the intervention community were approached again and training days were scheduled with them. These mothers then gathered at the appointed time with the researcher in a suitable designated community location for the training (see Chapter 8). Training based on the manual was performed on five consecutive days in the community to the mothers from Phase I. Reports on the proceedings of the training programme were written in a journal which is attached as Appendix 11.

3.8.3 Phase III

Step 7: Evaluation of the NEP

Three months after the training, the data collection process from Phase I was repeated in both communities. Data collected were entered, analysed and compared between the two communities. Manuscripts for publication in peer reviewed journals and for submission as part of the thesis were completed.

Step 8: Data management and analysis

All data collected during Phase III were entered in various software packages and analysed with the assistance of the Department of Biostatistics of the University of the Free State.

Step 9: Offering training in control community

Three months after the effect of the NEP was assessed, the NEP was repeated in the control community since it was found to have some positive impact on nutritional status, knowledge, attitudes and practices. The report on this is included as Appendix 14.

3.9 Ethical considerations

The guidelines in the Helsinki declaration on ethics in handling research participants was followed (CIOMS, 1991). Ethical clearance was sought from the Ethics Committee of the

Faculty of Health Sciences (FHS) in the University of the Free State, South Africa, and NMIMR in Ghana of the University of Ghana.

Mothers were educated on their rights as a participant in the research and the fact that their participation was voluntary and without compensation, and without any costs to them or their families. She was also remunerated with a token worth $3-$5. Mothers were also informed that they would be free to withdraw from the study at any time without any consequences to them.

An informed consent form in Appendix 1 and 2 in English and Dagbani was read out to all participants and also given to literate participants to read for themselves. Those who understood, and agreed to volunteer, were asked to sign or thumb prints the consent form. Signing a consent form also meant that the mother agreed that her child/children take part in the study (Gibson, 2005:19). The assent form was read aloud to children who could speak and understand (Appendix 3). Children who resisted being measured were not forced. There was no discrimination in the sampling method and all participants meeting the inclusion criteria had an equal opportunity to participate. Terminology was expressed in the information letter in simple non-technical language, for example referring to “inadequate blood” in the consent forms to represent anemia.

Although there was no monetary benefit to the participant, in instances where children or mothers were identified as malnourished, they were counselled and referred to the nearest hospital or health centre for assistance. Mothers were assured of the confidentiality of all data collected. All procedures were conducted without compromising the integrity of the participant and without being too intrusive. (Gibson, 2005:19). For mothers who did not speak English, questions were translated to Dagbani to enable the mother to fully comprehend the study and answer the questions as accurately and truthfully as possible.

The names of mothers had to be recorded to enable the research team to identify mothers for the intervention. However, all names were coded (Appendix 5) and only codes were written on the questionnaires. The list of names was only accessible to the researcher.

Due to the findings that the NEP did bring about some positive changes in the intervention community, the NEP was administered to the control community as well, after the completion of the study.

3.10 Problems encountered during the study

When the nutrient content analysis was done using the Food Processor Plus, as planned in the protocol, suspiciously high nutrient intake values for iron, with a mean of above the UL for mothers, were encountered. The data were reanalysis using the Ghana Nutrient Database, which is not yet commercially available, but was obtained directly from the research community who developed the software. The comparison using the paired t-test, between the mean daily intakes of nutrients analysed with the two different software programmes, is shown in Table 3.5

Table 3.5: Comparison of nutrient intake analysis for a data sample using Food Processor Plus and the Ghana Nutrient Database.

Mean daily intake for mothers (N=161)	***Food Processor Plus*** **Mean ± SD**	***Ghana Nutrient Database*** **Mean ± SD**	**p-values**
Energy (kCal)	2478.2 ±797.8	3120.1 ± 1166.2	0.0001
Protein (g)	69.3±28.5	72.8 ± 388.3	0.1228
Carbohydrate (g)	418.2 ± 129.9	493.5 ± 190.7	0.0001
Fat (g)	65.1 ± 32.3	104.8 ± 44.	0.0001
Dietary fibre (g)	29.0 ± 19.8	47.9 ± 19.1	0.0001
Vitamin A (IU)	1100.79 ± 906.4	12070.0 ± 1166.2	0.0001
Iron (mg)	50.1± 14.8	20.4 ± 10.0	0.0001
Zinc (mg)	15.9 ± 5.2	13.6 ± 6.0	0.0001
Calcium (mg)	1069.6 ± 377.6	663.9 ± 743.7	0.0001
Vitamin C (mg)	186.8 ± 85.4	197.6 ± 67.0	0.1063
Vitamin B_{12} (µg)	1.4 ± 1.3	0.7 ± 2.6	0.002
Folate (µg)	349.4 ± 455.2	756.1 ± 600	0.0001
Mean daily intake for children (n=175)			
Energy (kCal)	1082.6 ± 704.8	1330.3 ± 867.1	0.0001
Protein (g)	30.5 ± 22.9	30.4 ± 23.3	0.6157
Carbohydrate (g)	186.8 ± 118.4	212.8 ± 139.3	0.0001
Fat (g)	26.3 ± 21.4	43.3 ± 43.3	0.0001

Dietary fibre (g)	13.4 ± 13.6	19.8 ± 13.9	0.0001
Vitamin A (IU)	470.6 ± 502.0	4977 ± 3823.1	0.0001
Iron (mg)	20.6 ± 14.1	9.2 ± 7.1	0.0001
Zinc (mg)	6.8 ± 4.8	5.7 ± 4.3	0.0001
Calcium (mg)	425.6 ± 282.9	259.6 ± 181.4	0.0001
Vitamin C (mg)	74.0 ± 58.5	89.9 ± 64.0	0.0001
Vitamin B-12 (μg)	0.5 ± 0.6	0.13 ± 0.2	0.0001
Folate (μg)	181.8 ± 327.4	361.5 ± 404.6	0.0001

Compared by the paired-t test; p-value was considered significant at $p<0.05$

All nutrient analysis reported in the results sections were done using the Ghana Nutrient Database software.

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SCENES FROM THE FIELD

Baseline training session

Pilot interview

Starting data collection

Baseline : labelled handy measures used for 24-hour recall

Baseline: sampling procedure using community sections with the help of the Assembly man and the community volunteer

Baseline- household visitations for interview session

A mother giving a 24-hour recall for herself and her index child

A structured interview being conducted with a mother at her household.

Household observation: tea being brewed for breakfast in a household

Household observation: breakfast being prepared and distributed

Household observation: tuo-zaafi served for lunch with peanut and dry okra soup (observe the individual portion sizes)

Drinking water being drawn from the dam where animals also drink

Household observation: Tuo-zaafi served for supper.

Household observation: group eating among children.

Observation: pit dug for a KVIP in Tugu; the clay was used for pica by both children and adults.

Clay sold in the market and also used for pica

NEP: mothers holding their key messages cards during an intervention session

NEP: mothers in performing an animation during an intervention session

Intervention: Goat meat being prepared for use in an intervention session - teaching the addition of organ meat and red meat to meals prepared

Intervention: Foods assembled for practical sessions; all obtained from within the community except oranges which were bought in the local market which the community patronises

Intervention: Day 5-The mothers performing their practical session- food demonstration and facilitated by the researcher and an assistant.

Intervention: Foods prepared and displayed

Education session in control community- after evaluation, intervention was implemented in the control community for a day (6hours).

Group practical session in the control community

PHASE I –BASELINE

CHAPTER 4:

KNOWN DIETARY RISK FACTORS FOR IRON DEFICIENCY AMONG MOTHERS WITH CHILDREN 6-59 MONTHS IN THE NORTHERN REGION OF GHANA

This section of the research was presented at the

Hidden Hunger Conference, March 2013, Stuttgart, Germany.

4 KNOWN DIETARY RISK FACTORS FOR IRON DEFICIENCY AMONG MOTHERS WITH CHILDREN 6-59 MONTHS IN THE NORTHERN REGION OF GHANA

4.1 Abstract

Objective: This study sought to assess the nutrient intakes using 24hour recall and a food frequency questionnaire (FFQ) among mothers with children six to 59 months in an agrarian society in the Northern Region of Ghana.

Design: Descriptive survey

Setting: Rural farming communities in Tolon Kumbumgu District and Tamale Metropolis, where anemia is endemic.

Subjects: Mothers with children, 6-59 months.

Outcome measures: A questionnaire on socio-demographics, household food production, food frequencies, household food security (CHIPP index), and three 24-hour recalls, were administered via structured interviews; and BMI was assessed. Dietary intakes were analysed with the Ghana Nutrient Database® (Version 6.02). Iron intakes were assessed by the probability method, and vitamins A, B12 and folate and vitamin C intakes in relation to estimated average requirements (EAR) cut-points. Data was analysed with SAS® version 16.0.

Results: These mothers (N=161), from low socio-economic communities, were unschooled (91.9%). Despite high energy intakes, 10% were underweight, and mean BMI was 20.8 ± 3.7 kg/m2. Overall, 43.8% of households were a risk of food insecurity and 6.9% were experiencing chronic hunger, mainly due to periods of food shortage lasting 11.5 ± 6.7 weeks over the prior 12 months. The daily staple for 96.2% was unrefined homemade (and unfortified) maize meal. Green leafy vegetables (mostly amaranth), butternut, tomatoes, onions and legumes were consumed several times per week, when in season. Heme-iron sources were only occasionally consumed. The probability of

inadequate intake of iron at 5% bioavailability was estimated at 80.3%, and at 10% bioavailability, 33.1%. Inadequate intakes of protein (in 30.6%), vitamin A (in 9.9%), folate (in 46.6%) and vitamin B12 (98.8%) were reported. High intakes of fibre (47.8 ± 19.0 g/day) and high tea intakes were reported,

Conclusion: Periods of food shortage, seasonality of vegetables, low intakes of meat, and high intakes of fibre, phytates and tea, may exacerbate ID risk among mothers in northern Ghana.

Key words: iron deficiency; dietary risk factors; mothers with children 6-59 months; Northern Ghana

4.2 Introduction

A recent review of nationally representative surveys from 1993 to 2005 reported that anemia affects 47.4% of pre-schoolers, 41.8% of pregnant women, and 30.2% of non-pregnant women worldwide. Based on analysis of the National Health and Nutrition Examination Survey (NHANES) 1976-80 data, it is suggested that, if the overall anemia prevalence in a population is above 40%, it may be assumed that the entire population suffers from some degree of iron deficiency (ID) (Maclean *et al.*, 2007). In Ghana, the prevalence of anemia among children and women at the national level is 78% and 59%, respectively (GDHS, 2008). Among Ghanaian women, anemia is most prevalent among pregnant and lactating mothers, and mothers with children, particularly in rural compared to urban settings (GDHS, 2003; 2008). The high prevalence of anemia contributes substantially to loss of productivity, maternal mortality and the diminished health and mental capacity of children (Agarwal, 2010; MOST/USAID, 2004).

Food insecurity, defined as limited or uncertain availability of nutritionally adequate and safe foods, is also associated with ID. The bioavailability of iron from the diet is highly dependent on both host-related and diet-related factors. The physiological state of the body, for example pregnancy or ID, can enhance iron absorption by as much as 50% (Fleming & Bacon, 2005). Symptoms like steatorrhea may negatively affect iron absorption, while diarrhoea reduces the contact time between food and the intestines, therefore reducing iron absorption (Agarwal, 2010; Gibson & Ferguson, 2008). In mixed diets, an estimated 25% of iron in the heme form, mostly from meat and organ meat, is absorbed, compared to only 5% of non-heme iron from animal and plant sources (Gallagher, 2008). Other diet-related factors include dietary components or nutrients that enhance, or inhibit, iron absorption. Most inhibitors, such as tannins in tea, phytates in cereals, and dietary fibre, affect the bioavailability of non-heme iron by forming non-absorbable complexes with the ingested iron ion in the gastrointestinal system (Ogilvie, 2010). Tea has been shown to inhibit iron absorption from food by 79-94% (Hurrell *et al*., 1999) and to negatively affect iron status.

Enhancers of iron absorption reduce iron to the ferrous iron form, which is more bioavailable than the oxidised form. The most efficient enhancer of non-heme iron is vitamin C, which reduces iron to the more bioavailable ferrous form, while also forming a soluble iron-acerbate chelate with heme-iron in the acidic medium of the stomach, thus preventing non-heme iron from forming insoluble complexes with phytate or tannins (Teucher *et al*., 2013).

Other micronutrients important for iron status, include folate/folic acid, vitamin B12 and vitamin A. Vitamin A plays an essential role in the immune status and has a complementary role in erythropoiesis in the presence of other essential nutrients and vitamins. Vitamin A is therefore important for iron metabolism (IVACG, 1998; FAO/WHO, 1998). Folate/folic acid and vitamin B12 are required for erythropoiesis (Bunn, 2011) and are therefore also used as indicators of anemia status (Janz & Hamilton, 2014).

Ghana, like other developing countries, is experiencing a nutrition transition that leads to a double burden of disease, which manifests in communities as over nutrition and under nutrition which co-exists in the same households (Popkin & Fordon-Larsen, 2004; WHO, 2007). To achieve sustainable reductions in malnutrition, community-centred approaches for improving nutrition should be emphasised. Key to this approach is empowering households to use existing household resources to maximise their food security and nutrition (FAO, 2010).

This study sought to assess the nutrient intakes, by 24hour recall and FFQ of mothers with children six to 59 months in an agrarian society in the Northern Region of Ghana where the prevalence of anemia is even higher than the national statistics (GHDS, 2008). The findings of this work will inform the goals of a follow-up education intervention to address the knowledge, attitudes and practices (KAP) regarding anemia among these women. The information may also contribute to the understanding of known dietary risk factors for ID and nutritional anemia in developing countries, which is needed to direct research, policy, and nutrition interventions in similar communities.

4.3 Methods

4.3.1 Study design, population and selection of subjects

A cross-sectional quantitative descriptive survey was conducted in April 2012, at the beginning of the wet season, in the Northern Region of Ghana. Tolon-Kumbumgu district and Tamale metropolis were randomly selected from a list of the 20 districts that constitutes the region, and from each district, one community was randomly selected. In these two communities, randomly selected households were approached and all mothers who had lived in the selected community for at least 12 months, were not pregnant, and had children aged six to 59 months old, were invited to participate in the study. The final sample included 161 mothers; 81 from Gbullung in the Tolon-Kumbumgu district and 80 from Tugu in the Tamale metropolis. The sample size was based on the prospect of later engaging mothers of one community in a NEP regarding ID and anemia, designed to address the baseline findings, with the other community serving as control. It was deemed that two communities of approximately 80 households would be the limit in terms of cost-effectiveness for this study and effective engagement in the later NEP, while still allowing for some attrition during follow-up.

The study was approved by the institutional review boards of Noguchi Memorial Institute of Medical Research (NMIMR), Ghana (NMIMR-IRB CPN 064/11-12) and the Ethics Committee of the Faculty of Health Sciences, University of the Free State, South Africa (ECUFS NR 24/2012). All rights of the participants were observed according to the Helsinki declaration on ethics in handling research participants (CIOMS, 1991). Mothers, who volunteered, signed or thumb printed an informed consent form after the study procedures were explained to them.

4.3.2 Data collection

The researchers developed a questionnaire, based on an in-depth survey of the literature on ID, to assess the socio-demographics, food production practices, dietary intakes and usual eating patterns related to ID and anemia; as well as food security and other known dietary risk factors for ID. The questionnaire was administered during structured interviews conducted with the mothers in their homes.

The researcher and two trained field workers measured the women's heights and weights, observing all standard protocols (Gibson, 2005). All mothers were assessed for physical signs of chronic anemia, namely angular stomatitis, atrophic glossitis and koilonychias. Pictures were used to train the assistants to recognise these signs.

To assess the dietary patterns of the study population, a 75-item FFQ was developed to include the 16 food communities used in the FAO Dietary Diversity Questionnaire (Kennedy *et al*., 2011), and adapted to reflect foods commonly consumed in this population. The reference period of the recall was three months prior of the interview.

To assess dietary intakes, 24hr-recalls for three non-consecutive days were included in the questionnaire and administered according to a multiple-pass interview approach (Lee & Nieman, 2013) in which mothers were facilitated to give an account for all foods eaten, the amount consumed, and the mode of preparation of the foods.

To assess food security, a questionnaire was adapted and modified from the 15-country PURE Study (Hankou, 1999) and the AHA Free State Study (performed among Black

South Africans) (Walsh & van Rooyen, 2014), to reflect the local situation. This incorporated the validated 8-item Community Childhood Hunger Identification Project (CCHIP) Household Hunger Scale (Wehler *et al*., 1992), as well as questions to assess household income, money spent on food, mechanisms adopted by families to cope with food shortages, and food production. Questions regarding dietary factors that are known to affect the bioavailability of iron were compiled based on an in-depth literature review and included in the questionnaire.

To ensure reliability, all standard methods and published procedures were followed accurately. The scale was calibrated every morning, using a known weight. Research assistants were properly trained to improve skills on estimation and non-bias probing of participants to ensure accurate questionnaire data collection. Calibrated food models and household measures from the communities were used to help mothers describe portion sizes of foods eaten (Gibson & Ferguson, 2008:48). In the case of foods purchased from outside, the monetary values were asked to assist the accurate estimation of the amounts of these food consumed. To maximise truthful and accurate information, interviews were conducted in the privacy of each woman's own home and they were assured of the confidentiality of data collected. Since most mothers were not formally educated, questions were read to them in Dagbani and these responses were then captured by the researcher in English. To improve understanding of the local situation and contextualise the findings, the primary researcher observed the local customs and recorded these in a field journal.

4.3.3 Data analysis

Data were analysed using SAS/STAT software (Version 9.3 of the SAS system for Windows; Copyright © 2010 SAS Institute Inc.). Socio-demographic, household food production, food frequencies, and responses to questions related to inhibitors and enhancers of iron bioavailability, as well as coping mechanisms for food insecurity, were summarised as frequencies and percentages for categorical data and medians, means and standard deviations (SD) for continuous data. BMI (kg/m2) was calculated and interpreted according to the WHO guidelines (WHO, 2004). The intakes of energy, macronutrients and the micronutrients relevant to iron status, namely vitamins C, A, B12, folate and iron, were calculated from the three 24-hour recalls using the Ghana Nutrient Database (Version 6.02); and the averages of the three days' intakes were calculated with Microsoft Office Excel to express the final absolute intake values. The age-specific estimated average requirements (EAR) cut-points were used to evaluate the adequacy of intakes of all the nutrients (except iron) and EER according to the FAO/WHO (2004) vitamin and mineral requirements in human nutrition (Gibson & Ferguson, 2008). For iron, the probability method was used to assess the adequacy of iron intake at 5% and 10% bioavailability (Gibson & Ferguson, 2008; Allen *et al*., 2006; WHO/FAO, 2004). Food security was scored and classified according to the CCHIP index (Wehler *et al.*, 1992). Chi-square analysis was used to test for associations between variables, and $p<0.05$ was considered statistically significant.

4.4 Results

4.4.1 Socio-demographic characteristics household food production

The final sample consisted of 161 households, with one mother representing a household. Table 4.1 summarises the socio-demographic characteristics of these mothers. Their mean age was 33.0 ± 8.3 years. Most were married (97.5%) and all were in polygamist marriages. Most (96.3%) were from the Dagomba ethnic group; and all but three practiced the Muslim religion (98.1%). Most of the mothers (91.9%) had no formal education and none were formally employed. All were engaged in subsistence farming, spending an average of 6.1 hours per day at work; 84.5% reported earning a living through petty trading and sale of food crop production or livestock, while the rest (15.5%) reported that they were unemployed. Housing constituted of huts, with mostly thatched roofs (61.9%) and cement floors (98.8%); 36.9% had piped water and electricity (79.2%), but all cooked on wood (98.7%) or charcoal fires. Only four households had a refrigerator and only one had a freezer as well. Clay pots (77.6%) and Veronica containers (2.5%) were the only cooling facilities for food. Mothers reported spending a mean of ₵10.5 (±$5) per week on food. Of the mothers, 76 (47.2%) were using an iron supplement and none smoked.

Table 4.1: Socio-demographics of mothers in the study

	n (%) / Mean ± SD / Median
Age (yrs) (n=146)	
≤ 19	2 (1.2)
20–29	38 (23.6)
30–39	70 (43.5)
40–49	28 (17.4)
>50	6 (3.7)
Did not know	17 (10.6)
Mean ± SD	33.0 ± 8.3
Highest level of education (n=161)	
None	148 (91.9)
Primary (1–6 yrs)	10 (6.2)
JSS level (7–10 yrs)#	2 (1.2)
SSS/Vocational school (11–14 yrs) #	1 (0.6)
Religion (n=161)	
Christian	3 (1.9)
Muslim	158 (98.1)
Ethnicity (n=161)	
Dagomba	155 (96.3)
Moshi	1 (0.6)
Hausa	1 (0.6)
Fulani	3 (1.9)
Ewe	1 (0.6)
Employment status (n=161)	
Self employed	136 (84.5)
Unemployment	25 (15.5)
Marital status (n=161)	
Married	157 (97.5)
Single	3 (1.9)
Cohabiting	1 (0.6)

#JSS= junior secondary school, SSS=senior secondary school

Table 4.2 summarises the household food production. Almost all households grew vegetables (mostly green leafy vegetables, peanuts and other legumes, as well as seasonal vegetables like tomatoes, onions and green pepper); cultivated cereal crops (mostly maize, sorghum, cassava and rice); and owned livestock (mostly sheep and goats, and some cattle). Almost 60% cultivated beans and 90% cultivated peanuts. About 40% grew fruit trees or has access to fruit trees. Most households (57.0%) produced food only for own consumption; 39.0% sold less than 50% of the food they produced; and 4.0% sold more than 50%.

Table 4.2: Household food production (N=161)

Variable	n (%)
Households that grew vegetables	154 (95.6)
Types of vegetables grown	
Cabbage	1 (0.6)
Carrot	71 (44.1)
Green leafy vegetables (mostly bitor/bra, amaranth)	103 (71.5)
Pumpkin	97 (67.4)
Beans (legumes)	83 (57.6)
Peanuts (groundnuts)	145 (90.1)
Others (okra, pepper, tomatoes,)	126 (78.3)
Household that cultivated crops	160 (99.4)
Types of crops cultivated	
Maize	159 (98.8)
Rice	155 (96.3)
Sorghum	121 (75.2)
Potatoes	80 (49.7)
Cassava	129 (80.1)
Cowpea	1 (0.6)
Millet	1 (0.6)
Household that grew / had access to fruit trees (n=159)	62(39.0)
Types of fruits (n=105)	
Mango	49 (46.6)
Cashew	20 (19.0)
Guava	5 (4.8)
Baobab	19 (18.1)
Others (banana, pawpaw, moringa, shea nut)	12 (11.4)
Household that owned livestock (n=159)	140(88.0)
Animals owned	
Beef Cattle (n=29)	
Unknown number	9 (31.0)
1-10	16 (57.1)
11-20	2 (7.1)
31-40	1 (3.6)
Mean ± SD	5.9 ± 8.9
Dairy Cattle (n=17)	
Unknown number	9 (52.9)
1-5	6 (35.3)
6-10	1 (5.9)
20-25	1 (5.9)
Mean ± SD	3.4 ± 6.3
Sheep (n=102)	
Unknown number	29 (28.4)
1-10	60 (58.8)
11-20	11 (10.8)
21-30	1 (1.0)
91-100	1 (1.0)
Mean ± SD	6.3 ± 11.0
Goats (n=112)	
Unknown number	29 (25.9)

1-10	75 (67.0)
11-20	8 (7.1)
Mean ± SD	4.6 ± 4.7
Chicken (n=99)	
Unknown number	37 (37.4)
1-10	44 (44.4)
11-20	13 (13.1)
21-30	4 (4.1)
41-50	1 (1.0)
Mean ± SD	6.8 ± 8.9

4.4.2 Nutritional status

The nutritional status of the mothers based on BMI classification is summarised in Table 4.3. Overall, 10% were underweight and 11.3% were overweight or obese (class 1). No physical signs of chronic anemia were observed in any of the mothers. The mean BMI was 20.8%.

Table 4.3: BMI of mothers in the study

BMI (kg/m2) ¥ (n=159)	n (%)
Underweight (<18.5)	16 (10.0)
Normal (18.5-24.99)	125 (78.6)
Overweight (25.0-29.99)	14 (8.8)
Obese Class 1 (30.0-39.99)	4 (2.5)
Mean ± SD	20.8 ± 3.7

4.4.3 Adequacy of nutrient intakes

The mean daily intakes of energy, macronutrients, and micronutrients relevant to anemia estimated from the average of three 24hr-recalls for non-consecutive days, as well as the analysis of the adequacy of these intakes, are summarised in Table 4.4. Energy intakes were high, with a mean of around 13 000 kJ per day; only two mothers had an inadequate energy intake. Mean protein (72 g/day; 1224 kJ), carbohydrate (492 g/day; 8364 kJ) and fat intakes (104.8 g/day; 3982 kJ) constituted about 9.3%, 63.9% and 30.4% of mean total daily energy intake. The whole population had adequate intakes of carbohydrate, but a third (30.6%) had inadequate intakes of protein. The mean fibre intake was high at 47.8 ± 19.0 g/day.

If it was assumed that 10% of iron in the diet of these mothers was bioavailability, 33.1% was estimated to have inadequate iron intake. If it was assumed that only 5% of iron in the diet was bioavailability, 80.8% was estimated to have inadequate iron intakes.

Regarding the vitamins that are relevant to iron status and anemia, 9.9%, 94.4% and 46.6% had inadequate intakes of vitamins A, B12 and folate, whereas 12.4% had folate intakes above the UL. Almost all mothers (98.8%) had adequate vitamin C intakes.

Table 4.4: Evaluation of mean nutrient intakes estimated from 3x24h-recalls (N=161)

Variable	**Mean intake ± SD**	**Inadequate Intake n (%)**	**Adequate Inadequate n (%)**	**Excessive intake n (%)**
Energy (kCal/day)	3116.7 ± 1163.3	2(1.3)	158 (98.8)	
(kJ/day)	13 090 ± 4 886			
Macronutrients				
Protein (g/day)	72.0 ± 38.2	44 (30.6)	100 (69.4)	-
Carbohydrate (g/day)	492 ± 190. 2	0 (0.0)	161 (100.0)	
Fat (g/day)	104.8 ± 44.1			
Dietary fibre (g/day)	47.8 ± 19.0			
Vitamins				
Vitamin C (mg/day)	197.5 ± 66.8	0 (0.0)	161(100.0)	-
Vitamin A (µg RAE/day)	771.4 ± 394.8	16 (9.9)	145 (90.1)	-
Vitamin B_{12} (µg)	0.7 ± 2.6	152 (94.4)	9 (5.6)	-
Folate (µg)	785.7 ± 662.5	75 (46.6)	66 (41.0)	20 (12.4)
Minerals				
Iron (mg)	20.4 ± 9.9			

Percentage of population which probably have inadequate intakes of iron if 5% bioavailability of iron is assumed: 80.8%
Percentage of population which probably have inadequate intakes of iron if 10% bioavailability of iron is assumed: 33.1%

Intakes of folate, vitamins A, B12, and C were evaluated against the estimated average requirement (EAR) and upper limit (UL) (WHO/FAO, 1988; 2002; 2004 guidelines).

4.4.4 Dietary patterns

The responses of the mothers to the FFQ, are summarised in Table 4.5, and compared to the foods they listed in the 24h-recalls to account for seasonality and other factors, which may have influenced the nutrient analysis at the time of the interviews. In this study population, the daily staple was maize porridge (88.1%) and Tuo-zaafi (TZ) (96.2%), made from cooked fermented maize meal dough and cassava dough. Other cereals and starches that were consumed with high frequency (daily or 3-4 times per week) were tubers (mostly yams, when in season), potatoes and corn on the cob.

Table 4.5: Dietary patterns of the mothers in the study based on the foods reported in the 24h-recalls and FFQ (N=161)

Foods	24h recalls	FFQ						
	24h prior to interview	**Daily** n (%)	**3-4x/week** n (%)	**Weekly** n (%)	**2-3x/month** n (%)	**Monthly** n (%)	**Occasionally** n (%)	**Never** n (%)
Cereals, grains and starches								
Maize porridge	143 (90.5)	140 (88.1)	8 (5.0)	4 (2.5)	1 (0.6)	0 (0.0)	5 (3.1)	1 (0.6)
Sour porridge	41 (25.8)	27 (17.1)	18 (11.4)	21 (13.3)	1 (0.6)	0 (0.0)	85 (53.8)	6 (3.8)
Millet porridge	69 (43.4)	56 (35.4)	15 (9.5)	5 (3.2)	0 (0.0)	0 (0.0)	15 (9.5)	67 (42.4)
Tuo-zaafi (TZ) /Banku	158 (99.4)	153 (96.3)	5 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)
White Bread	66 (41.5)	18 (11.4)	45 (28.5)	30 (19.0)	5 (3.2)	0 (0.0)	60 (38.0)	0 (0.0)
Brown bread	2 (1.3)	0 (0.0)	1 (0.6)	8 (5.1)	6 (3.8)	0 (0.0)	47 (29.8)	96 (60.8)
Pasta	19 (12.0)	5 (3.2)	17(10.8)	23 (14.6)	11 (7.0)	0 (0.0)	100 (63.3)	2 (1.3)
Potatoes	4 (2.5)	30 (19.0)	92 (58.2)	20 (12.7)	8 (5.1)	0 (0.0)	8 (5.1)	0 (0.0)
Rice	90 (57.0)	4 (2.5)	123 (77.9)	24 (15.2)	2 (1.3)	0 (0.0)	5 (3.2)	0 (0.0)
Corn on cob	0 (0.0)	40 (25.3)	84 (53.1)	29 (18.4)	0 (0.0)	0 (0.0)	5 (3.2)	0 (0.0)
Popcorn	1 (0.6)	0 (0.0)	0 (0.0)	11 (7.0)	24 (15.2)	2 (1.3)	120 (76.0)	1 (0.6)
Tubers	98 (62.0)	84 (53.2)	52 (32.9)	13 (8.2)	1 (0.6)	0 (0.0)	8 (5.1)	0 (0.0)
Yellow vegetables (vit A sources)								
Butternut	149 (94.9)	95 (61.3)	54 (34.5)	1 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	5 (3.2)
Pumpkin	1 (0.6)	1 (0.6)	3 (1.9)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	154 (96.9)
Carrot	1 (0.6)	1 (0.6)	3 (1.9)	1 (0.6)	1 (0.6)	1 (0.6)	59 (37.3)	93 (58.9)
Sweet potato	0 (0.0)	0 (0.0)	84 (53.2)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)
Dark green leafy vegetables								
Amaranth leaves	134 (85.4)	11 (7.0)	113 (72.0)	30 (19.1)	1 (0.6)	0 (0.0)	2 (1.3)	0 (0.0)
Cassava leaves	18 (11.3)	2 (1.3)	45 (28.5)	80 (50.6)	9 (5.7)	1 (0.6)	20 (12.7)	1 (0.6)
"Spinach"/Nkontomire (cocoyam leaves)	3 (1.9)	0 (0.0)	7 (4.4)	10 (6.3)	4 (2.5)	0 (0.0)	102 (64.6)	35 (22.2)
Bean leaves	13 (8.2)	1(0.6)	86 (54.4)	44 (27.9)	7 (4.4)	0 (0.0)	16 (10.1)	4 (2.5)
Pumpkin leaves	1 (0.6)	1 (0.6)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	156 (98.7)
Mellon leaves	1 (0.6)	1 (0.6)	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	155 (98.1)
Bitor/Bra leaves (*Hibiscus sabdariffa*)	18 (11.4)	1 (0.6)	57 (36.1)	33 (20.9)	20 (12.7)	1 (0.6)	39 (24.7)	7 (4.4)
Wild leafy vegetables (Baobab leaves)	42 (26.6)	0 (0.0)	85 (54.1)	33 (21.0)	8 (5.1)	0 (0.0)	5 (3.2)	26 (16.6)
Other vegetables								
Green/sweet pepper	79 (49.7)	80(50.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	48 (30.2)
Tomatoes	139 (88.0)	84 (53.2)	71 (44.9)	1 (0.6)	0 (0.0)	0 (0.0)	2 (1.3)	0 (0.0)
Onions	157 (99.4)	155 (98.1)	2 (1.3)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Egg plant	7 (4.4)	3(1.9)	85 (54.1)	25 (15.9)	5 (3.2)	0 (0.0)	35 (22.3)	4 (2.6)
	24h prior to interviews	**Daily** n (%)	**3-4x/week** n (%)	**Weekly** n (%)	**2-3x/month** n (%)	**Monthly** n (%)	**Occasionally** n (%)	**Never** n (%)

Yellow/orange fruit (vit A sources)								
Mango	101 (64.3)	71(45.2)	47 (29.9)	28 (17.8)	5 (3.2)	0 (0.0)	6 (3.8)	0 (0.0)
Papaya	2 (1.3)	2 (1.3)	10 (6.4)	12 (7.6)	14 (8.9)	0 (0.0)	113(72.0)	6 (3.8)
100% apricot/cantaloupe juice	4 (2.6)	4 (2.6)	0 (0.0)	1 (0.6)	2 (1.3)	0 (0.0)	35 (22.6)	113 (72.9)
Other fruits and juice (vit C sources)		0 (0.0)	72 (47.1)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)
Orange	16 (10.1)	2 (1.3)	76 (48.4)	35 (22.3)	6 (3.8)	0 (0.0)	37 (23.6)	1 (0.6)
Orange juice	1 (0.6)	2 (1.3)	1 (0.6)	0 (0.0)	0 (0.0)	1 (0.6)	115 (73.3)	39 (24.8)
Berries	2 (1.3)	0 (0.0)	110 (70.0)	19 (12.1)	7 (4.5)	0 (0.0)	10 (6.4)	6 (3.8)
Vitamin C fortified juice	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.3)	0 (0.0)	0 (0.0)	113 (72.4)	41 (26.3)
Other fruits/wild fruits/100% juices	8 (5.0)	1 (0.6)	0 (0.0)	6 (3.7)	3 (1.9)	0 (0.0)	108 (67.1)	34 (21.1)
Meat (heme sources)								
Organ meat								
Liver	18 (11.5)	0(0.0)	11 (7.1)	12 (7.7)	10 (6.4)	1 (0.6)	122 (78.2)	0 (0.0)
Kidney	15 (9.5)	0 (0.0)	8 (5.1)	6 (3.8)	2 (1.3)	2 (1.3)	128 (81.5)	4 (2.6)
Heart	3 (1.9)	0 (0.0)	4 (2.6)	4 (2.6)	6 (3.8)	1 (0.6)	128 (81.5)	14 (8.9)
Blood based	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	56 (35.9)	99 (63.5)
Flesh meat								
Beef	27 (17.2)	0 (0.0)	24 (15.4)	31 (19.9)	16 (10.3)	0 (0.0)	81 (51.9)	4 (2.6)
Pork	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	5 (3.2)	151 (96.2)
Lamb	7 (4.4)	0 (0.0)	17 (10.8)	14 (8.9)	14 (8.9)	0 (0.0)	110 (70.1)	2 (1.3)
Goat	5 (3.2)	0 (0.0)	11 (7.0)	8 (5.1)	8 (5.1)	1 (0.6)	128 (81.5)	1 (0.6)
Game	1 (0.6)	3 (1.9)	40 (25.5)	24 (15.3)	5 (3.2)	0 (0.0)	85 (54.1)	0 (0.0)
Chicken	6 (3.7)	0 (0.0)	16 (10.3)	8 (3.9)	6 (3.9)	0 (0.0)	122 (78.2)	4 (2.6)
Duck	0 (0.0)	1 (0.6)	3 (1.9)	6 (3.9)	1 (0.6)	0 (0.0)	108 (69.2)	37 (23.7)
Worms	0 (0.0)	1 (0.7)	29 (18.9)	0 (0.0)	5 (3.3)	0 (0.0)	91 (59.5)	8 (5.2)
Fish and other seafood								
Anchovies, dried and pounded as a condiment)	151 (96.2)	152 (96.2)	0 (0.0)	3 (1.9)	0 (0.0)	0 (0.0)	3 (1.9)	0 (0.0)
Eggs	35 (22.3)	1 (0.6)	15 (9.6)	19 (12.1)	15 (9.6)	0 (0.0)	107 (68.2)	0 (0.0)
Legumes, nuts and seeds								
Dry beans	51 (32.3)	2 (1.3)	78 (50.0)	66 (42.3)	3 (1.9)	0 (0.0)	7 (4.5)	0 (0.0)
Dry peas	58 (36.7)	5 (3.2)	79 (50.6)	67 (43.0)	1 (0.6)	0 (0.0)	0 (0.0)	1 (0.6)
Peanuts	88 (55.7)	37 (23.7)	35 (22.4)	2 (1.3)	1 (0.6)	0 (0.0)		
Tree nuts	135 (86.0)	106 (68.8)	41 (26.6)	5 (3.3)	0 (0.0)	0 (0.0)	2 (1.3)	106 (68.8)
Melon seeds	2 (1.3)	1(0.6)	2 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	6 (3.9)	147 (94.2)
	24h prior to interviews	**Daily** n (%)	**3-4x/week** n (%)	**Weekly** n (%)	**2-3x/month** n (%)	**Monthly** n (%)	**Occasionally** n (%)	**Never** n (%)
Milk and milk products								
Cow's milk	30 (19.0)	3 (1.9)	3 (1.9)	9 (5.7)	5 (3.2)	1 (0.6)	127 (81.0)	9 (5.7)
Yoghurt	3 (1.9)	0 (0.0)	1 (0.6)	3 (1.9)	1 (0.6)	0 (0.0)	111 (70.7)	41 (26.1)
Goat's milk	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	161 (100.0)
Fats & Oils								

Shea oil used for cooking	152 (98.7)	66 (42.6)	89 (57.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sweets / Sugar	140 (89.7)	107 (68.6)	29 (19.6)	4 (2.6)	0 (0.0)	0 (0.0)	15 (9.6)	1 (0.6)
Beverages, alcohol								
Coffee	3 (1.9)	1 (0.6)	4 (2.5)	2 (1.3)	1 (0.6)	0 (0.0)	44 (27.9)	106 (67.1)
Tea	90 (56.6)	25 (15.7)	88 (55.4)	15 (9.4)	3 (1.9)	0 (0.0)	27 (17.0)	1 (0.6)
Green tea	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (1.9)
Chocolate drink	2 (1.3)	1 (0.6)	2 (1.3)	0 (0.0)	0 (0.0)	1 (0.6)	6 (3.7)	149
Milo	34 (21.1)	34 (21.4)	8 (5.0)	45 (28.0)	23 (14.3)	0(0.0)	67 (42.4)	7 (4.3)
Soft drinks	7 (8.8)	2 (1.3)	1 (0.6)	4 (2.5)	1 (0.6)	1 (0.6)	142 (89.9)	7 (4.4)
Alcohol	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	157 (99.4)
Locally brewed beer	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	157 (99.4)
Spices, condiments								
Soy products	13 (8.2)	0 (0.0)	11 (7.0)	11 (7.0)	2 (1.3)	0 (0.0)	77 (48.7)	57 (36.1)
Dawadawa (condiment)	148 (93.7)	149 (94.3)	2 (1.3)	2 (1.3)	0 (0.0)	0 (0.0)	5 (3.2)	0 (0.0)
Black pepper	95 (59.0)	89 (56.3)	20 (12.7)	15 (9.3)	1 (0.6)	0 (0.0)	15 (9.5)	18 (11.2)

153 households reported using whole maize meal that they produced from dried maize at home
Tz/Bank (cooked fermented maize meal dough and cassava dough)
128 households reported using legumes, nuts and seeds whole; 71 households reported processing and refining it

Whereas only 11.4% of the mothers reported consuming white bread on a daily basis, about half consumed it between once and 3-4 times per week. Most mothers consumed millet porridge, brown bread, pasta, and popcorn only occasionally.

Overall 95.8% of the mothers consumed butternut at least four times per week (61.3% plus 34.5%), when in season. At the time of the interviews most mothers (94.9%) reported having eaten butternut in the prior 24 hours. Other vitamin A-rich vegetables such as pumpkin, carrots, and sweet potato were rarely consumed.

Most mothers (72.0%) consumed amaranth leaves at least three times a week and 85.4% reported having eaten butternut in the 24 hours prior to the interviews. Other dark green leaves consumed by most mothers on a weekly basis, were bean leaves, baobab leaves, bra leaves and cassava leaves. All these are however, seasonal and not available throughout the year. At the time of the interviews these vegetables were in season and this is reflected by the fact that many mothers reported consuming it in the 24 hours prior to the interviews. More than 90% of the mothers consumed tomatoes and onions between three and seven times per week (mostly as soups or sauces); 50.3% consumed green/sweet peppers on a daily basis; and 70% consumed eggplant at least once per week.

Most mothers consumed mangoes, oranges and berries on a daily to weekly basis. Around 10% reported consuming oranges in the 24 hours prior to the study. Juice intake was low, and wild fruits such as shea nuts were only eaten when in season.

Almost nobody reported daily consumption of any heme source, except for anchovies. In 96.2% of households, dried anchovies were pounded into a powder and incorporated into food on a daily basis. On follow-up house visits, it became apparent, however, that the actual amount of fish consumed per person in a household was extremely small. Most (around 80%) only occasionally consumed organ meat such as liver, kidney, and heart; however in the 24h hours prior to the interviews around 10% of mothers reported having consumed liver and kidney. About a third (35.9%) ate blood-based foods (referring to blood collected when animals are killed, cooked and eaten by itself or with other foods) occasionally, whereas the rest reported never eating it.

Most mothers (96.2%) never ate pork. Beef and goat was the most commonly consumed red meats; eaten between one and four times per week by 35.3% and 40.8%, respectively. In the 24 hours prior to the interviews, 17% of the mothers reported having eaten beef. Between 10% and 20% reported that they consumed lamb (19.7%), chicken (14.2%), and worms (18.9%) between one and four times per week.

Eggs were consumed between one and four times per week by 21.7%, whereas most (68.2%) reported consuming eggs only occasionally. In the 24 hours prior to the interviews 22.3% of mothers reported that they had consumed eggs.

Legumes, nuts, and seeds were mostly used in the whole, unprocessed form. More than 90% of the mothers consumed dried beans and peas between one and four times per week. About a quarter of mothers reported eating peanuts (raw, roasted, or in a soup) daily, and another quarter 3-4 times per week. In the 24 hours prior to the interviews, 86% had consumed nuts and 55.7% had consumed peanuts.

Cow's milk and yoghurt were the most common dairy products eaten in the communities, but were only consumed occasionally by 81.0% and 70.7% of mothers, respectively. However, 19% reported that they had consumed cow's milk in the 24 hours prior to the interview.

Shea butter (semi-solid oil) was the main source of fat, mostly used for cooking. It was consumed on a daily basis by 42.6% of mothers, and 3-4 times per week by 57.4%. In the 24 hours prior to the interviews, 98.7% of mothers reported consuming it. Overall, 68.6% reported adding granular sugar to their tea and their breakfast porridge on a daily basis, with another 19.6% doing so 3-4 times per week. In the 24 hours prior to the interviews almost 90% reported having consumed sugar. Most mothers never consumed coffee or green tea. Overall, 15.7% and 55.4% consumed black tea daily and 3-4 times per week, respectively. In the 24 hours prior to the interviews, 56.6% of mothers had consumed black tea. Almost half consumed Milo (made with water) at least once per week (21.4% daily, 4% 3-4 times per week, and 28% once a week). About 94% of the mothers only occasionally consumed soft drinks (usually carbonated). Only one mother reported using any alcohol.

Dawadawa, a seasonal wild fruit that is dried and processed into a powder, was the most commonly used condiment (used daily by 94.3%).

4.4.5 Household food security

Overall 49.4% of this study population was food secure, 43.8% was at risk for hunger and 6.9% were hungry. Table 4.6 is a summary of the mother's responses to the food security questions, as well as coping mechanisms employed in times of food insecurity. About half of the households indicated that they ran out of food/money to buy food in the year prior to the study. In these 12 months before the study, 12.4% reported that they had relied on a limited number of foods to feed children; 14.3% they had cut the size of meals, or skipped meals, because there was not enough food; 18.0% they had eaten less than they should; 6.3% children had complained that they were hungry while there was no food for them; 6.7% the size of children's food was reduced or that children skipped meals because there was not enough money for food; and 3.1% children had gone to bed hungry, because there was not enough food.

When mothers were asked to define "eating enough" the majority of them (54.8%) said 'eating enough' for them meant 'enough food for everyone until the next harvest season'. However, 15.9% also defined 'eating enough' as eating to 'fullness' or 'fill the stomach'.

Overall, 79 (49.4%) of households reported having experienced periods of food shortages lasting a mean of 11.5 ± 6.7 weeks. About a quarter (25.3%) of these households reported shortages lasting more than 12 weeks at a stretch. In the periods of food shortages, most households (49.4%) reported that they found other food sources, 21.5% that they bought food from the market to supplement their own produce, 6.3% that they sold assets, 5.1% that they worked for payment in kind, and 12.7% that they borrowed money or food.

When mothers were asked which of the foods they produced lasted until the next harvest season, most (79.9%) reported that crops lasted, but less than half (43.1%) indicated that vegetables lasted and only 13.2%) that fruits lasted.

Table 4.6: Household food security (N=161)

HOUSEHOLD FOOD SECURITY CLASSIFICATION	**n (%)**
Food secure	79 (49.4)
At risk of hunger	70 (43.8)
Experiencing hunger	11 (6.9)
RESPONSES TO QUESTIONS IN THE CCHIP QUESTIONNAIRE **In last 12 months:**	**Yes answers** **n (%)**
Did the household ever run out of money to buy food?	80 (49.7)
Did the household ever rely on a limited number of foods to feed children?	20 (12.4)
Did the household ever cut the size of meals or skip any, because there is not enough food in the house?	23 (14.3)
Did the household ever eat less than they should because there is not enough money for food?	29 (18.0)
Did children in the household ever eat less than they feel they should, because there is not enough money for food?	13 (8.1)
Did children in the household ever say they are hungry, because there is not enough food in the house?	10 (6.3)
Did the household ever cut the size of the children's meals, or do they ever skip meals, because there is not enough money to buy food?	10 (6.7)
Did children in the household ever go to bed hungry, because there is not enough money to buy food?	5 (3.1)
MOTHERS' DEFINITION OF 'EATING ENOUGH FOOD' (n=157)	
'Enough money to buy all needs'	17 (10.8)
'Ability to save some money'	1 (0.6)
'When there is enough food for everyone'	14 (8.9)
'Enough food for everyone until the nest harvest season'	80 (54.8)
'To be satisfied (to fill the stomach)'	25 (15.9)
'When children in the house do not cry of hunger'	1(0.6)
'I do not know'	13(8.3)
HOUSEHOLD COPING STRATEGY DURING PERIOD OF FOOD SHORTAGE	
Has the household ever experienced periods of food shortage (n=160)	79 (49.4)
If yes, state the total number of weeks the household had food shortage over the last 12 months: (n=79)	
1-12 weeks	59 (74.7)
13-24 weeks	18 (22.8)
25-36 weeks	2 (2.5)
Mean ± SD	11.5 ± 6.7 11.5 ±
How did the household cope during these times?	
Found other sources (n=79)	39 (49.4)
Asked family/relatives/neighbours for help (money/food) (n=79)	1 (1.3)
Sold assets (n=79)	5 (6.3)
Worked for payment in kind (n=79)	4 (5.1)
Borrowed money or food (n=79)	10 (12.7)
Bought food to supplements farm produce (n=79)	17 (21.5)

Food security scoring using the CCHIP Household Hunger Scale (Wehler et al., 1992) and a final total score of zero indicates that a household is food secure; a score of 1-4 indicates that the household is at risk of hunger, and a score of ≥5 indicates that the household is going hungry

4.4.6 Association between nutritional status based on BMI and household food security

In Table 4.7, nutritional status classification, based on BMI, was cross-tabulated with food security classification and the individual indicators of food security according to the CCHIP index. Overall, nutritional status based on BMI, was not significantly associated with household food security classification.

Table 4.7: Cross-tabulation of nutritional status (BMI) and food security levels and indicators (N=159)

Item	**Underweight**	**Normal**	**Overweight**	**Obese**	
	n (%)	**n (%)**	**n (%)**	**n (%)**	**p-value**
CLASSIFICATION					
Food secure	6 (3.8)	61 (38.6)	7 (4.4)	4 (2.5)	0.455
At risk of hunger	9 (5.7)	53 (33.5)	7 (4.4)	0 (0.0)	
Experiencing hunger	1 (0.6)	10 (6.3)	0 (0.0)	0 (0.0)	
INDICATORS					
Did the household ever run out of money to buy food? (n=79)	9 (11.4)	63 (79.7)	7 (8.9)	0 (0.0)	0.0026*
Did the household ever rely on a limited number of foods to feed children? (n=20)	4 (20.0)	16 (80.0)	0 (0.0)	0 (0.0)	0.0090*
Did the household ever cut the size of meals or skip any because there is not enough food in house? (n=23)	3 (13.0)	20 (87.0)	0 (0.0)	0 (0.0)	0.0129*
Did the household ever eat less than they should because there is not enough money for food? (n=29)	3 (10.4)	25 (86.2)	1 (3.4)	0 (0.0)	0.0198*
Did the children in the household ever eat less than they feel they should, because there is not enough money for food? (n=13)	1 (7.7)	11 (84.6)	1 (7.7)	0 (0.0)	0.1024
Did the children in the household ever say they are hungry because there is not enough food? (n=10)	1(10.0)	8 (80.0)	1(10.0)	0 (0.0)	0.1234
Did the children in the household ever go to bed hungry because there is not enough money to buy food? (n=5)	1(20.0)	4 (80.0)	0(0.0)	0 (0.0)	0.1950
Has the household ever experienced periods of food shortage? (n=76)	10 (13.2)	59 (77.6)	7 (9.2)	0 (0.0)	0.1958
Duration of food shortages (n=78)					
1-12 weeks	8 (13.8)	47 (81.0)	3 (5.2)	0 (0.0)	2.921

13-24 weeks	2 (11.1)	12 (66.7)	4 (22.2)	0 (0.0)
25-36 weeks	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)

- Assessed by Fishers exact test; $p < 0.05$ considered statistically significant
- n is the total number of positive responses for the household, with each mother representing a household.
- Food security scoring using the CCHIP Household Hunger Scale (Wehler *et al*., 1992) and a final total score of zero indicates that a household is food secure; a score of 1-4 indicates that the household is at risk of hunger, and a score of ≥5 indicates that the household is going hungry

However, mothers were significantly more likely to be underweight or normal weight, than overweight or obese when the following indicators applied to them: their household ever ran out of money to buy food (p=0.0026); their household had relied on a limited number of foods to feed children (p=0.009); their household had cut the size of meals or skipped meals, because there is not enough food in the house (p=0.0129); and their household had eaten less than they should have, because there is not enough money for food (p=0.0198).

4.5 Discussion

This study explored the dietary patterns and intakes of nutrients that are relevant to ID and IDA, of mothers of young children in the Northern Region of Ghana with the purpose of designing a follow-up nutrition education programme (NEP). Anemia is known to be endemic in these communities in this region. Around 50% of the study population was found to be food insecure, more than 80% had probable inadequate intakes of iron (if bioavailability of 5% was assumed), and more than 90% had inadequate intakes of vitamin B12. A NEP based on the findings to educated the target community to make the best use of their available resources, may contribute to address ID and anemia in the area.

About half of households in the study were experiencing chronic hunger, or were at risk for hunger (indicating food insecurity), using the 12 months prior to data collection as the period of reference. This was higher than the 10 to 30% rates reported for the Northern Regions (Biederlack & Rivers, 2009:13). Similar to the findings of Quaye (2008) about half of the households interviewed reported food shortages lasting about three months per year, indicating that they were not able to produce enough to last throughout the year or were unable to store enough produce for home consumption throughout the year. Interestingly, most mothers defined 'eating enough' as having 'enough food for everyone until the nest harvest season'. During times of food shortages, households mostly coped by finding other food sources, and by buying the foods that they otherwise produced, from the marketplace, which also corroborates the findings of Quaye (2008).

Overall energy intakes among these mothers were very high, combined with high intakes of carbohydrates and fat. This was attributed to large portions of the staple foods that these women were observed to consume, in addition to daily consumption of shea nut oil and shea butter. Their mean BMI was, however, in the lower range of normal weight, probably due to high levels of activity, as these women reported spending a mean of around six hours per day working the land, in addition to manual household chores like grounding cereal and extracting shea oil. A third of the mothers had inadequate intakes of protein, which may contribute to malnutrition (Grover and Ee, 2009; Gibson, 2005). Mothers who were food insecure were also significantly more likely to be underweight or normal weight, rather than overweight or obese, suggesting the strain of food shortages on their nutritional status.

As maize was available all year round, homemade maize flour, produced in the households in small quantities according to their needs, was the staple used in Tuo-zaafi and other highly consumed dishes. In Ghana, vegetable oil and wheat flour are fortified under supervision of the Global Alliance for Improved Nutrition (GAIN) (GAIN, 2007: Online). Oils are fortified with vitamin A, and wheat flour with iron, vitamin B12 and folic acid, among others. In the current study population, however, only 10.5% reported daily consumption of bread made from the fortified wheat flour. Although most households in the current study consumed shea nut oil daily, it was mostly homemade (using a process, which is illustrated by Peace Corps Ghana (2015). The fortified product was commercially available, but expensive. Although fortification programmes have helped improve the nutritional status of vulnerable communities in many parts of the world (Leong & Lonnerdal, 2012; Sadighi *et al*., 2009), these rural communities were not benefitting from the national fortification program. Maize flour fortification at the factory level is feasible and effective for countries like South Africa (DoH/UNICEF, 2015); but may not be applicable in smallholder agrarian communities like these in northern Ghana. Venkatesh Mannar

(2006) suggested that in farming communities, the best approach might be micro-fortification coupled with nutrition education. However, though home fortification in pilot stages in selected districts seemed feasible, this approach also poses some challenges, including the need to mill maize in bulk, and the unavailability of fortificants in small packages. This implies that if a mother runs out of flour and need to prepare some for cooking as a matter of urgency, she may not get fortificant in small quantities to do so. Another challenge is the sustainability of the donor-dependent supply of fortificants to these communities (Lartey *et al*., 2011).

Although a high percentage of the households reared animals, heme iron sources were not consumed on a daily basis. Animals were rarely kept for household consumption, but rather represented a form of wealth index, used as collateral for borrowing money against, or as an emergency ‘fund to sell when having to pay hospital bills, funeral rites, or to buy foods in times of food shortage. Fish intake was low, because fish is rarely available in areas not close to the sea, rivers or streams. “Keta school boys” and anchovies, imported from southern Ghana, were available in the local markets, but were expensive due to the transportation costs involved. Therefore, dried anchovies were used more as a condiment, added as small quantities of dried powder to flavour other foods. Although these amounts were insignificant as a source of protein and iron, a benefit it may have contributed, was adding the MFP (meat, fish and poultry) factor to enhance absorption of non-heme iron from the rest of the diet.

On the other hand though, studies find the effects of meat, and other enhancers, on iron absorption, be negated by the simultaneous consumption of food components which are inhibit iron absorption (Beck *et al*., 2014) In this study population the absorption of non-heme iron was likely negated by the very high intakes of fibre and phytate from unprocessed cereals and legumes (dried beans and peas, and peanuts, which were the major source of non-heme iron among these women). The mean fibre intake was 47.8 ± 19.0 g/day, which is almost double the recommended level of intake for adults (26–29 g/day). Furthermore, most mothers also consumed tea on a daily basis with meals. A review by Temme & van Hoydonck (2002) concluded that, in populations with marginal iron status, a negative association exists between tea consumption and iron status. When assuming 5% or 10% bioavailability of iron in the current study, as suggested by the FAO/WHO for communities in developing countries (Gibson &

Ferguson, 2008; Allen *et al.*, 2006; WHO/FAO, 2004), 80.8% and 33.1% of these women probably had inadequate iron intakes despite a mean intake of around 20 mg/day from their diets. In addition, although about half of the mothers used iron supplements, the same inhibitory factors as for the diet, applies (Beck *et al*., 2014).

In this community, legumes was cultivated and, based on the FFQ, quite common consumed. Yet, only an around a third of these mothers reported having eaten legumes in the 24h prior to the interviews. Legumes are good sources protein and iron and some varieties have low levels of antinutritive factors (Bala *et al*, 2012; Messina, 1999, Hussain & Basahy, 1998). The combination of legumes and cereals like maize in a vegetarian diet, provides all the essential amino acids the human body requires (Messina, 1999). Legume crops also increased indigenous nitrogen production, improves soil fertility, and reduce pest and disease problems when used in rotation with non-leguminous crops (Das *et al*., 2012). The use of legumes should therefore be encouraged in communities like these.

At the time of data collection, at the start of the rainy season, vitamin C and folate intakes was adequate for all participants, and vitamin A intake adequate for most participants, as estimated from 3x24h recalls. The FFQ indicated that fruit and vegetable intake was mostly seasonal. The vegetation of the Northern Region does not allow for citrus fruits cultivation, hence, citrus fruits are imported from other regions in Ghana. During the dry season, transportation cost of oranges and other imported fruits are transferred to the consumer adding to the price. About a fifth of households have access to baobab trees. The fruit of the baobab (also called "monkey fruit") contains about ten times as much vitamin C as oranges (Stone *et al*., 2011). Baobab fruits, berries and other wild fruits which are also good sources of vitamin C are seasonal however, and the communities do not have the means to preserve these fruits for use during the off-season. The only fruit that the communities could preserve well was "dawadawa", which is a wild fruit and good source of beta-carotene (a precursor for vitamin A) (Gernah *et al*., 2007).   .

At the time of the interviews, most of the households were growing and consuming seasonal vegetable sources of vitamin C, beta-carotene (vitamin A) and folate. These included butternut and various green leafy vegetables, which are traditionally cooked and eaten as a relish together with the starchy staple food. During the dry season, intakes of these vegetables may be compromised, and particularly troublesome to the 10% of mothers who had inadequate vitamin A intakes at the time of the study. The communities may therefore benefit from irrigation projects (Stiener-Asiedu *et al.*, 2012; Abu *et al.*, 2010). Irrigation projects may also improve income (Abu *et al.*, unpublished) to empower households to purchase foods and other commodities that they do not have access from their own production.

According to Beck *et al*. (2014) even though vitamin C, is recognised as a powerful enhancer of iron absorption, the majority of studies in young women have not found any association between iron status and total daily vitamin C intake, or fruit and vegetable intakes. Furthermore, a recent biochemical analysis of amaranth, baobab and hibiscus (which was consumed in the study population according to the FFQ) in northern Côte d'Ivoire, which borders the Northern Region of Ghana to the west, found that these are good sources of iron, but in the presence of oxalates; which are known to inhibit iron bioavailability (Oulai *et al*., 2014).

Adequate intakes of both vitamin B12 and folate are needed to prevent megaloblastic anemia. In this study population almost 95% of this population had inadequate intakes of vitamin B12, as estimated from 3x24h-recalls. This may be explained by their relatively infrequent intakes of foods from animal sources, including meat, dairy and eggs, which are the only dietary sources of this nutrient. About half (46.6%) of the mothers also had inadequate intake of folate, predisposing to megaloblastic anemia. Though the food frequency indicated frequent intakes of green leafy vegetables, which are good sources of folate, the quantities consumed may have been rather low. At the beginning of the rainy season, when vegetation is just turning green, most vegetables become expensive to buy. Folate can also be lost during the harvest, preparation or storage of food. Folic acid, the synthetic form of folate, is used together with vitamin B12, to universally fortify wheat flour in Ghana (WHO/FAO, 2004). The communities in the current study only occasionally ate bread. The rest had adequate and even excessive folate intakes (12.4%), which, while preventing megaloblastic anemia in those mothers with inadequate vitamin B12 levels, may also mask the neurological damage caused by vitamin B12 deficiency (WHO/FAO, 2004).

4.6 Limitations

A major limitation of this study was the lack of biochemical data on the blood levels of the micronutrients to correlate with the nutrient intake levels and assess the presence of low iron stores in the population. This was not performed in the study due to logistical problems regarding the storing and transporting of blood samples across long distances and a poor road conditions to the nearest laboratory that could perform the tests; and due to lack of funding however, due to the high prevalence of anemia which has been previously reported it was very probale that most of the participants had ID.

4.7 Conclusions and recommendations

Despite subsistence farming, which should contribute to household food security, about half of this population of mothers of young children in Northern Ghana, where high levels of anemia also exist, were found to be at risk of hunger. Periods of food insecurity, high intakes of fibre, phytates and tea (with meals and iron supplements), combined with almost absent intakes of fortified foods, low intakes of heme sources, and seasonality of vitamins C-rich and A-rich fruits and vegetables, may however, exacerbate ID in this study population. In mothers already exposed to ID through menstruation, pregnancy, and lactation, these risk factors may contribute to the high anemia prevalence in the area. As the primary caregivers in charge of food, preparation in their households, their knowledge, attitudes and practices translates to the feeding practices of their young children, putting them at similar risk for ID and anemia, with even more detrimental health consequences. Due to their largely self-sufficient dietary practices, these communities are not benefitting from the national fortification strategies. Nutrition education on making the best use of available iron sources and improving the iron bioavailability from their diets may therefore be a viable option in these communities, and possibly other similar communities in developing countries, to address the global public health issue of ID and anemia. A successful NEP approach could reduce anemia within the community and decrease the need for more costly interventions like fortification and supplementation.

In the academic field, more research is needed in such agrarian communities, on the bioavailability of iron from mixed diets, and how to harness the indigenous knowledge to manage ID. Insufficient production to sustain the food supply throughout the dry seasons was the major cause of food insecurity in these communities, and ways to address these issues in the local context need to be further researched. Lastly, innovative ways to reach these vulnerable societies through sustainable fortification and supplementation programmes should be investigated.

4.8 References

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CHAPTER 5:

KNOWN DIETARY RISK FACTORS FOR IRON DEFICIENCY AMONG CHILDREN 6-59 MONTHS IN THE NORTHERN REGION OF GHANA

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5 KNOWN DIETARY RISK FACTORS FOR IRON DEFICIENCY AMONG CHILDREN 6-59 MONTHS IN THE NORTHERN REGION OF GHANA

5.1 Abstract

Background: In Ghana, the prevalence of anemia among children is 78%. Evidence indicates that at such high prevalence, iron deficiency (ID) may be assumed in the entire population. This study aimed to assess the known risk factors for ID among children 6-59 months in rural, low socio-economic subsistence farming communities in the Northern Region where anemia prevalence is 81%.

Methodology: Heights and weights were measured; birth weights assessed from birth cards; and a questionnaire, including socio-demography, breastfeeding and weaning practices, food frequencies, 3x24-hour recalls, and household food security (CHIPP index), were administered via structured interviews with the mothers. Anthropometry was analysed according to WHO Z-scores, using WHO Anthro Plus®. Dietary intakes were analysed with the Ghana Nutrient Database® (Version 6.02). Adequacy of iron intakes were evaluated by the probability method, and vitamins A, C, B12 and folate in relation to estimated average requirements (EAR) cut-points. Data was analysed with SAS® (Version 16.0).

Results: Of the 175 children (54.5% female), 90.9% were born at home and birth weights were not recorded; 30.4% were moderately, and 16.7% severely stunted. About 80% were exclusively breastfed for 4-6 months, and 82.3% were weaned on to the family foods. At the time of data collection, about 60% of the children were still breastfeeding. Most (73.7%) ate maize porridge ("koko"), made from unrefined, unfortified flour, daily. Meat intake was only occasional and vegetable and fruit intakes, seasonal. Legumes were the main source of non-heme iron. More than half drank tea frequently. Mean fibre intake was 19.8 ± 13.9 g/day. The probability of inadequate intake of iron was 67.3% at 5% bioavailability, and 32.6% at 10% bioavailability. Inadequate protein (17.7%), vitamin A (36.6%), folate (26.2%) and vitamin B12 (98.2%) intakes were reported. Of the 161 households, 43.8% were at risk for hunger and 6.9% were experiencing chronic hunger. Mean Z-scores for weight-for-age, height-for-age and weight-for-height were significantly directly associated with food security ($p<0.0001$).

Conclusion: Unfortified complementary foods, high intakes of fibre, phytate and tea, combined with low meat intakes, may exacerbate ID in this study population. Programmes to educate mothers regarding these factors, may reduce ID among children in this and other similar agrarian communities in developing countries.

Key word: iron deficiency, iron deficiency anemia, risk factors, children, Northern Ghana

5.2 Introduction

Global efforts to improve child health are targeted at interventions within the first thousand days post-conception, which include the foetal stage, as well as the first two years of life (Black *et al*., 2008). Anemia is also one of the major causes of death among children under the age of five years, in both developed and developing countries (Black *et al*., 2008; (Agarwal, 2010; MOST/USAID, 2004; ACC/SCN, 2000). Iron deficiency anemia (IDA) in infancy, has also been consistently associated with long lasting poor cognitive and behavioural performance, as well as growth retardation and impaired immune response (Domellöf *et al*., 2014).

IDA is caused by depletion of iron, which develops in several steps. Iron deficiency (ID) may exist without anemia, after which increased utilisation or loss of iron without replacement, progresses to IDA (Cook & Skikne, 1989; Cook *et al*., 1986). Children born premature, with a low birth weight (LBW), are particularly at risk of ID as seen in USA (Domellöf *et al*., 2014; Collard, 2009). At birth, infants born term with optimal iron stores may have 75 mg/kg iron stored, which is enough to cover the needs for the first five to six months (Ohls, 2000; Kivivuori *et al*., 1999). For infants below the age of four to six months, in the absence of supplementation and complementary feeding, only two sources of iron are available, namely birth stores and breast milk or formula. Although breast milk contains highly bioavailable iron, the iron content is not substantial, making birth stores of iron critical to prevent early ID (Burke *et al*., 2014). Young children are therefore vulnerable for ID due to increased needs for iron for growth and development. Similarly, their mothers, due to menstrual blood losses, pregnancy and lactation, are also at high risk for ID (Agarwal, 2010:2).

In developing countries, ID is usually seen among children older than six months, when complementary foods provide inadequate iron. Complementary feeds should contain increased sources of heme iron and at least one serving of vitamin C rich food to enhance the absorption of non-heme iron (Fitch *et al*., 2008). In complementary feeds adequate frequency and diversity of iron rich foods would therefore improve ID of children between six and 24 months.

Iron status in childhood is greatly affected by dietary factors. For children who are not breastfed at all, or those fed breast milk without supplementation, the risk of ID increases (Ohls, 2000). Substituting breastfeeding with unmodified cow's milk, instead of iron-fortified infant formula, puts children under the age of 12 months at risk of ID, as cow's milk protein induces colitis in the intestines, leading to occult bleeding (Hopkins *et al*., 2007; Ziegler *et al*., 1990). In toddlers, ID is associated with high intakes (>500 ml/day) of cow's milk, which replaces iron-sources from the diet (Maguire *et al.*, 2013). A study among two to three year olds in Mexican Americans indicated that bottle-feeding compared to cup feeding increased the risk of infant ID, and this was attributed to the intake of large amounts of cow's milk. The authors also cited the need for education intervention programs to educate caregivers regarding this risk for ID (Sutcliffe *et al*., 2006).

ID and anemia among children is also associated with low socioeconomic level (Brotanek *et al*., 2008; Cusick *et al*., 2007). Household food insecurity affects the intake of several nutrients, including iron. Where there is food insecurity, dietary quantity and quality is compromised. Several studies have observed that, to cope, primary caregivers in the household may reduce their own food quantities, forgo food for children, and resort to less expensive and sometimes low nutrient quality foods (Abu *et al*., 2010; Nyanteng & Asuming-Brepong, 2003). Other social factors, which have been associated with the prevalence of IDA in young children, include familysituation, rural location and sanitation (Burke *et al*., 2014).

In Ghana, the prevalence of anemia among children (six to 59 months) was 78% in 2008 nationally, and 81% in the Northern Region (Ghana Demographic and Health Survey (GDHS), 2008). The national prevalence of anemia was also higher among children in rural areas (84%) than urban areas (68%) and was negatively associated with mothers' levels of education (GDHS, 2008). Recognised causes of anemia in Ghana include dietary intake, malaria, and intestinal helminthes infection (GDHS, 2003). Although the GDHS only consider hemoglobin levels and not the causes of anemia, evidence suggest that, when the overall anemia prevalence in a population is above 40%, it may be assumed that the entire population suffers from some degree of ID (Maclean *et al*., 2007; Asobayire *et al*., 2001).

In Ghana, the Integrated Anemia Control Strategy aims to 'contribute to the health of women in the fertile age group and the growth and development of children by reducing morbidity and mortality due to anemia.' The five key components of the strategy are food-based approaches, food fortification and dietary diversification, iron-folate supplementation, malaria control, helminthes infection control, and information, education and communication (GHS/USAID/MOST, 2003). Of these approaches, nutrition education may be the most cost effective. This study aimed to identify known dietary risk factors for ID among children six to 59 months in two selected districts in the Northern Region of Ghana to address with a nutrition education programme (NEP) in these communities. Information gained from this survey, may also contribute to the understanding of dietary risk factors for ID and nutritional anemia in developing countries, to direct research, policy, and nutrition interventions in similar agrarian communities.

5.3 Methods

5.3.1 Study design and participants

In April 2012, a cross-sectional descriptive survey was conducted in the Northern Region of Ghana in Tolon-Kumbumgu district and Tamale metropolis. These two districts were randomly selected from the list of 20 districts in the region. From each district, one community was randomly selected, and in these two comparable communities, randomly selected households were approached. Not all mothers who had lived in the selected community for at least one year were pregnant, and had one or more children aged six to 59 months old (including twins, triplets and quadruplets) of whom they were the primary caregiver, were invited to participate in the study. The final sample included 161 mothers; 81 from Gbullung in the Tolon-Kumbumgu district and 80 from Tugu in the Tamale metropolis. Two communities of 80 households each was deemed cost-effective to later engage one community in a NEP on ID and anemia, based on the baseline findings, while using the other as a control.

The study was approved by the institutional review boards of Noguchi Memorial Institute of Medical Research (NMIMR), Ghana (NMIMR-IRB CPN 064/11-12) and the Ethics Committee of the Faculty of Health Sciences, University of the Free State, South Africa (ECUFS NR 24/2012). All rights of the participants were observed according to the Helsinki declaration on ethics in handling research participants (CIOMS, 1991). After the study procedures were explained to them, mothers, who wanted to volunteer to be part of the study, signed or thumb printed an informed consent form. Older children signed or thumb printed assent forms to indicate that they agreed to participate.

5.3.2 Data collection

In total, 175 children six to 59 months (the index children) were included in the study along with their own mothers (n=161). Data on socio-demography, child health, breast feeding practices, complementary feeding practices, dietary practices, household food security, and household food production, were collected using a questionnaire which the researchers designed based on an extensive literature survey regarding ID and IDA. The questionnaire was administered during structured interviews with the mothers. To encourage mothers to give truthful and accurate information, interviews were conducted in the privacy of each woman's own home, and they were assured of the confidentiality of data collected. Since mothers were not formally educated, the researcher and assistants read the questions to them in their home language and captured their responses in English.

Household food security was assessed using the validated 8-item Community Childhood Hunger Identification Project (CCHIP) Household Hunger Scale (Wehler *et al*., 1992)

The questionnaire included 24h-recalls for 3 non-consecutive days. These were administered according to a multiple-pass interview approach (Lee & Nieman, 2013) and each mother was facilitated to give a complete account of all foods and beverages that her index child (ren) had eaten, with details on the types, amounts and the modes of preparation. To assess the dietary patterns of the study population, a 75-item food frequency questionnaire (FFQ) was developed based on the FAO Dietary Diversity Questionnaire (Kennedy *et al*., 2011), and adapted to reflect foods commonly consumed in this population. The reference period of the recall was three months prior of the interview. The primary researcher trained two research assistants to estimate food portions sizes and to use probing questions to improve the accuracy of dietary data collected by the 24h-recalls. Calibrated food models and household measures obtained from inside the communities were used to help mothers describe portion sizes (Gibson & Ferguson, 2008:48).

Children's birth weights were collected from the child record card (CRC) or "weighing card", which is issued to all children at birth, and serves as a growth monitoring and immunisation record.Even those born at home have are later sent to the health centre for registration and a CRC card obtained. The researcher and two trained field workers measured the heights and weights of the women and index children. To ensure reliability, all standard methods and standard published procedures were observed. Weight was measured on an electronic scale according to standard procedures, and recorded to the nearest 0.1kg. The scale was calibrated every morning, using a known weight. Height was determined by means of a mobile tape (Microtoise) to the nearest 0.1cm.

All mothers and children were assessed for physical signs of chronic anemia, namely angular stomatitis, atrophic glossitis, and koilonychias. Pictures were used to train the assistants to recognise these signs.

The primary researcher also observed the local customs and recorded these in a field journal, in order to improve the understanding of the local situation and contextualise the findings.

5.3.3 Data analysis

Data were analysed using SAS/STAT software (Version 9.3 of the SAS system for Windows; Copyright © 2010 SAS Institute Inc.). Socio-demographic, food frequencies, and responses to questions related to breastfeeding practices and child health were summarised as frequencies and percentages for categorical data and medians, means and standard deviations (SD) for continuous data.

The intakes of energy, macronutrients and the micronutrients relevant to iron status, namely vitamins C, A, B12, folate and iron, were calculated from the 3x24h-recalls using the Ghana Nutrient Database (Version 6.02); and the averages of the three days' intakes were calculated with Microsoft Office Excel to express the final absolute intake values. The age-specific estimated average requirements (EAR) cut-points were used to evaluate the adequacy of intakes of energy and all the nutrients (except iron), according to the FAO/WHO (2004) vitamin and mineral requirements in human nutrition (Gibson & Ferguson, 2008). The probability method was used to assess the adequacy of iron intake at 5% and 10% bioavailability, according to the HarvestPlus methodology and recommendations for populations in developing areas (Gibson & Ferguson, 2008; Allen *et al*., 2006; WHO/FAO, 2004). The age-specific estimated average requirements (EAR) cut-points were used to evaluate the adequacy of intakes of energy and all the nutrients (except iron), according to the FAO/WHO (2004) vitamin and mineral requirements in human nutrition (Gibson & Ferguson, 2008).

A child was classified with a low birth weight (LBW) if birth weight was ≤2.5kg, as indicated on the CRC (Roche, 1994). The children's weight-for-age, height-for-age was also measured and the Z-scores evaluated. These measurements were used to evaluate stunting (low height-for-age), underweight (low weight-for-age), and wasting (low weight-for-height) (Gibson, 2005). The Z–scores were calculated using the WHO Anthro Plus software based on standards for children less than 60 months (Seal & Kerac, 2007; WHO, 2006). For the mothers, body mass index (BMI) (kg/m2) was calculated and interpreted according to the WHO guidelines (WHO, 2004). The paired t-test was used to compare variables, and Pearson correlations or 95% confidence intervals (CI) to assess associations between variables. A p-value <0.05 was considered statistically significant.

5.4 Results

5.4.1 Socio demographics

The final sample consisted of 161 households, with one mother representing a household, and 175 index children six to 59 months. Table 5.1 summarises the socio-demographic characteristics of these mothers and children.

Table 5.1: Socio-demography of mothers (n=161) and index children (n=175)

Variable	**n (%), mean ± SD**
Mothers' ages (yrs)	
Unknown	17 (10.6)
Mean ± SD	33.0 ± 8.3 SD
Median	30.0
Mothers' highest level of education	
None	148 (91.9)
Primary (1-6 yrs)	10 (6.2)
Junior Secondary School (7-10 yrs)	2 (1.2)
Senior Secondary School /Vocational school (11-14years)	1 (0.6)
Mothers' religion	
Christian	3 (1.9)
Muslim	158 (98.1)
Mothers' ethnicity	
Dagomba	155 (96.3)
Moshi	1 (0.6)

Hausa	1 (0.6)
Fulani	3 (1.9)
Ewe	1 (0.6)
Marital status of the mother	
Married	157 (97.5)
Single	3 (1.9)
Cohabiting	1 (0.6)
Age of the mother when she got married (n=151)	
Mean ± SD	20.8 ± 3.7 SD
Mothers' employment status	
Self employed	136 (84.5)
Unemployment	25 (15.5)
Number of people living in the household (n=160)	
Mean ± SD	13.1 ± 6.2
Minimum	4
Maximum	32
Number of children < 18yrs living in the household (n=160)	
Mean ± SD	6.6 ± 3.8
Minimum	18
Maximum	1
Index children's' ages (mo)	
6.00-12.00	28 (16.8)
12.01 -24.00	56 (33.5)
24.01 -36.00	38 (22.7)
36.01-48.00	33 (19.8)
49.01 -59.00	12 (7.2)
Unknown	8 (4.6)
Mean ± SD	25.7 ± 13.8
Median	23.6
Children's 'gender	
Male	80 (45.5)
Female	95 (54.5)
Care of the index child while the mother works (n=134)	
Mother takes child to work	50 (31.1)
Child goes to school	3 (1.9)
Child if left with other siblings	57 (35.4)
Child is left with other relations	10 (6.2)
Child is left with grandmother	14 (8.7)
Delivery of index child (n=174)	
At medical centre/hospital	15 (9.1)
Home delivery with or without assistance of traditional birth attendants	159 (90.1)
Fathers' involvement with the index child(ren)	
Not at all	3 (1.7)
Makes a financial contribution only	12 (6.9)
Helps to physically and financially take care of his children	160 (91.4)

There were slightly more female (54.5%) than male (45.5%) children. The mean age of the children was 25.7 ± 13.8 months, and about 56% of the children were between 12 and 36 months. Most children (90.1%) were born at home, and the ages of 4.5% were not known.

The mean age of the children's mothers was 33.0 ± 8.3 years. Most were married (97.5%), from the Dagomba ethnic group (96.3%), and practiced the Muslim religion (98.1%). Everyone lived in huts; mostly with thatched roofs (61.9%) and cement floors (98.8%) and one to 16 rooms (mean of 5.5 ± 2.9); 36.9% had piped water and had electricity (79.2%), but cooked on wood-fires (98.7%).

Most of the mothers (91.9%) had no formal education and none was formally employed. All were engaged in subsistence farming, spending an average of 6.1 hours per day away from the household in agricultural activities. Mothers carried their children with them to work (31.1%), or they left the young children in the care of other older siblings (35.4%), grandmothers (8.7%), or other relations (6.2%). Only about three (1.9%) of the sampled children were enrolled in pre-school.

Children were raised in polygamous households (97.5%) where in 62.1% cases the head of the household was the husband or partner; in 27.3% the grandparent; and only in 1.9% the mothers. Most fathers were involved with their children both physically and financially (91.4%). Mothers have a median of four of her own children (1-8), but households consisted of 4-32 (mean 13.1 ± 6.2) people.

5.4.2 Nutritional status of mothers and children

The nutritional status of the mothers and their children as expressed by anthropometry is summarised in Table 5.2. As most babies were delivered at home without any assistance from a health care professional, the birth weights of only 9.1% were known. Of these, about half had LBW. Of the children, 47.3% were moderately to severely stunted, 38.9% moderately to severely underweight, and 17.2% moderately to severely wasted. About 10% of the mothers were underweight, while another 11.3% were overweight or obese (class 1). No signs of angular stomatitis, atrophic glossitis, or koilonychias were observed in any of the children.

Table 5.2: Nutritional status of mothers and children

Variable	n (%)
BMI of mothers (kg/m^2) (n=159)	
Underweight (<18.5)	16(10.0)
Normal (18.50 - 24.49)	125(78.6)
Overweight (24.50 – 29.99)	14(8.8)
Obese class 1 (30.00 - 39.99)	4(2.5)
Mean weight (mothers) ± SD	55.2 ± 8.8
Mean height (mothers) ± SD	1.6 ± 0.1
Birth weight (n=175)	
Unknown (Home deliveries)	159 (90.9)
Low birth weight (LBW) ≤2.5kg	7 (4.0)
Normal birth weight >2.5kg	9 (5.1)
Z-score: weight-for-age (Underweight) (n=167)	
Over-nutrition (>2.01SD)	1 (0.6)
Normal (-2≥ and ≤2SD)	101 (60.5)
Moderate (-2.01 to -3SD)	47 (28.1)
Severe (>-3.01SD)	18 (10.8)
Z-score: weight-for-height (Wasting) (n=175)	
Over-nutrition(>2.01SD)	5 (2.9)
Normal (-2≥ and ≤2SD)	140 (80.0)
Moderate (-2.01 to -3SD)	19 (10.9)
Severe (>-3.01SD)	11 (6.3)
Z-score: height-for-age (Stunting) (n=167)	
Over-nutrition(>2.01SD)	1 (0.6)
Normal (-2≥ and ≤2SD)	87 (52.1)
Moderate stunting (-2.01 to -3SD)	51 (30.5)
Severe stunting(>-3.01SD)	28 (16.8)

5.4.3 Child health

About 63.4% of the mothers did not remember the last time their child had malaria, or said the child had never had malaria; the majority (74.2%) used prescribed drugs for the treatment of malaria. Apart from malaria, 30.7% of children had other forms of illnesses in the two weeks prior to the interview, including fever (80.8%), coughs (15.4%), and colds (13.2%). Overall, 51.1% of the children received iron drops.

5.4.4 Breastfeeding and complementary feeding

The breastfeeding practices are summarised in Table 5.3. Mothers indicated that 80% of their index children had been exclusively breastfed for four to six months; 16.7% for less than four months; and 4.1% for longer than six months.

Table 5.3: Breastfeeding history of index children (n=175)

Question	**n (%)**
How long was the index child was exclusively breastfed (n=174)	
Shorter than 2 months	9 (5.2)
3-4 months	20 (11.5)
4-6 months	139 (80.0)
Longer than 6 months	6 (3.5)
Never	1 (0.6)
If a child was never breastfed; why not? (n=175)	
'Mother's breast milk will not flow'	1 (0.6)
What was breastfeeding then replaced with? (n=175)	
Maize porridge	1 (0.6)
At what age was the index child first given water to drink? (n=173)	
At birth	7 (4.1)
Within the 1st month	2 (1.2)
Within the 2nd month	4 (2.3)
Within the 3rd month	10 (5.8)
Within the 4th month	8 (4.6)
Within the 5th month	15 (8.7)
Within the 6th month	115 (66.5)
Within the 7th month and above	12 (6.9)
Age at which the index child was introduced to fluids? (n-175)	
Younger than 2 months	3 (1.8)
3-4 months old	12 (7.2)
4-6 months old	91 (54.5)
7-8 months old	49 (29.3)
9-10 months old	11 (6.7)
Not yet	1 (0.6)
What is the index child eating? (n=158)	
Family foods	130 (82.3)
Cereals fortified by additions food components	20 (12.7)
Fortified infant formula	8 (5.0)

Only one child was never breastfed, because 'the mother's milk would not flow', and received maize porridge as replacement for milk. Mothers indicated that 13.4% were given water to drink before four months (4.1% at birth already), and 9% were introduced to liquid foods before four months. Asked to choose form a list of options, the mothers indicated that more than 80% of the index children (n=158; for the rest the mothers did not respond) were receiving the family food, 12.7% were given cereals mixed (fortified) with other foods, and 5% were receiving fortified formula.

5.4.5 Adequacy of the food intakes

The mean daily intakes of energy, macronutrients, and micronutrients relevant to anemia estimated from the average of three 24hr-recalls for non-consecutive days, as well as the analysis of the adequacy of these intakes, are summarised in Table 4.4. Based on the 3x24h recalls, 57.1% of the children consumed breast milk. To quantify breast milk intakes is, however, very difficult in children who are not exclusively breastfed, therefore the analysis is excluding any additional breast milk.

Table 5.4: Evaluation of the adequacy of nutrient intakes (excluding breast milk) of index children based on 3x24h-recalls (N=175)

Variable	Inadequate intake n (%)	Adequate intake n (%)	Excessive intake n (%)
Energy (kCal/day)	46 (33.3)	92 (66.7)	
Macronutrients			
Protein (g/day)	29 (17.7)	135 (83.3)	
Carbohydrate (g/day)	40 (24.4)	124 (75.6)	
Vitamins			
Vitamin C (mg/day)	35 (21.3)	129 (78.7)	
Vitamin A (µg RAE/day)	96 (58.5)	60 (36.6)	8 (4.9)
Vitamin B_{12} (µg)	161 (98.2)	3(1.8)	
Folate (µg)	43 (26.2)	67 (40.9)	54 (32.9)
Iron			

Percentage of population which probably have inadequate intakes of iron if 5% bioavailability of iron is assumed: 67.3%
Percentage of population which probably have inadequate intakes of iron if 10 % bioavailability of iron is assumed: 32.6%

Intakes of folate, vitamins A, B12, and C were evaluated against the estimated average requirement (EAR) and upper limit (UL) (WHO/FAO, 1988; 2002; 2004 guidelines).

A third (33.3%) of the children had inadequate energy intakes and almost a fifth (17.7%), had inadequate protein intakes. Regarding the micronutrients relevant to ID and IDA, 21.3% had inadequate intakes of vitamin C, 58.5% inadequate intakes of vitamin A, 98.2% inadequate intakes of vitamin B12, and 26.2% inadequate intakes of folate. On the other hand, 4.9% had excessive intake of vitamin A and 32.9% had excessive intakes of folate. The probability of inadequate iron intake was 32.6% at 10% bioavailability and 67.0% at 5% bioavailability. Mean fibre intake was 19.8 ± 13.9 g/day.

5.4.6 Dietary patterns of the children

The reports of the mothers regarding the usual dietary patterns of their index children, based on a FFQ, and compared to the 24h-recalls, are summarised in Table 5.5. Porridge in a form commonly called “koko’, was used as a weaning food for children in these communities. Most children ate maize porridge (73.5%) and Tuo-zaafi (TZ) (74.1%) (made from cooked fermented maize meal dough and cassava dough) daily, while about a third also ate millet porridge on a daily basis. About two thirds ate rice 3-4 times per week. Only about 10% of children ate white bread daily.

More than 70% of the children ate butternut and yams at least four times per week. Other yellow vegetables, like pumpkin and carrots, were rarely eaten. More than 90% of children did not eat dark green leafy vegetables on a daily basis. About half ate amaranth leaves 3-4 times a week, and about half ate baobab and hibiscus leaves at least once a week. Of the children, 42.3%, 40% and 77.4% ate tomatoes, green peppers, and onions daily. All these vegetables are however, seasonal and not available throughout the year. At the time of the interviews, at the start of the wet season, these vegetables were in season. This is reflected in the 24h-recall data, which indicted that many childrennow consume these vegetables in the 24 hours prior to the interviews. Most of the children did not consumed fruits daily, but mangoes, oranges, and berries were eaten on a weekly basis. Around 57% were reported to have consumed mangoes in the 24 hours prior to the study. Juice intake was low.

Table 5.5: Food frequency data for children (N=175)

Food	24h recalls	FFQ						
	24h prior to interviews	**Daily**	**3-4x/week**	**Weekly**	**2-3x/month**	**Monthly**	**Occasionally**	**Never**
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Cereals: Grains and starches								
Maize porridge	132 (78.1)	125 (73.5)	9 (5.1)	3 (1.8)	0 (0.0)	0 (0.0)	11 (6.5)	22 (12.9)
Sour porridge	28 (16.5)	18 (10.6)	14 (8.2)	19 (11.2)	1 (0.6)	0 (0.0)	69 (43.3)	49 (28.8)
Millet porridge	60 (34.3)	52 (30.8)	8 (4.7)	6 (3.6)	1 (0.6)	0 (0.0)	17 (10.1)	85 (50.3)
Tuo-zaafi (Tz) /Banku	132 (77.6)	126 (74.1)	8 (4.7)	1 (0.6)	0 (0.0)	0 (0.0)	5 (2.9)	30 (17.6)
White Bread	66 (38.8)	18 (10.6)	40 (23.5)	26 (15.3)	4 (2.4)	0 (0.0)	51 (30.0)	31 (18.2)
Brown bread	2 (1.2)	0 (0.0)	1 (0.6)	5 (3.0)	4 (2.4)	0 (0.0)	47 (27.8)	112 (66.3)
Pasta	30 (17.6)	2 (1.2)	29 (17.2)	17 (10.1)	2 (1.2)	1 (0.6)	85 (50.3)	33 (19.5)
Potatoes	4 (2.4)	24 (14.2)	53 (31.4)	19 (11.2)	0 (0.0)	0 (0.0)	4 (2.4)	69 (40.8)
Rice	106 (62.4)	9 (5.3)	104 (61.2)	21 (12.4)	1 (0.6)	0 (0.0)	7 (4.1)	28 (16.5)
Corn on cob	0 (0.0)	23 (13.6)	53 (31.4)	16 (9.5)	1 (0.6)	0 (0.0)	3 (1.8)	73 (43.2)
Popcorn	1 (0.6)	0 (0.0)	0 (0.0)	6 (3.5)	13 (7.6)	0 (0.0)	83 (48.8)	68 (40.0)
Tubers (yam)	94 (55.6)	67 (39.6)	56 (33.1)	7 (4.1)	9(5.3)	0 (0.0)	9 (5.3)	30 (17.8)
Yellow vegetables (vit A sources)								
Butternut	121 (72.0)	74 (43.8)	52 (30.8)	1 (0.6)	0 (0.0)	0 (0.0)	4 (2.3)	38 (22.5)
Pumpkin	2 (1.2)	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	165 (98.2)
Carrot	1 (0.6)	0 (0.0)	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	35 (20.8)	131 (78.0)
Sweet potato	2 (1.2)	18 (10.7)	56 (33.3)	19 (11.3)	0 (0.0)	0 (0.0)	3 (1.8)	72 (42.9)
Dark green leafy vegetables								
Amaranth leaves	114 (67.1)	6 (3.5)	98 (57.6)	22 (12.9)	1 (0.6)	0 (0.0)	11 (6.5)	32 (18.8)
Cassava leaves	15 (8.8)	2 (1.2)	35 (20.7)	56 (33.1)	5 (3.0)	0 (0.0)	33 (19.5)	38 (22.5)
“Spinach”/Nkontomire (cocoyam leaves)	5 (2.9)	1 (0.6)	6 (3.6)	7 (4.1)	6 (3.6)	0 (0.0)	78 (46.2)	71 (42.0)
Bean leaves	13 (7.6)	2 (1.2)	63 (37.3)	32 (18.9)	2 (1.2)	0 (0.0)	24 (14.2)	46 (27.2)
Pumpkin leaves	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	169 (100.0)
Mellon leaves	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	169 (100.0)
Bitor/Bra leaves (Hibiscus sabdariffa)	17 (10.0)	0 (0.0)	42 (24.9)	28 (16.6)	9 (5.3)	0 (0.0)	37 (21.9)	53 (31.4)
Wild leafy vegetables (Baobab leaves)	44 (25.9)	1 (0.6)	60 (35.3)	34 (20.0)	0 (0.0)	0 (0.0)	17 (10.0)	58 (34.1)
Mixed vegetable	0 (0.0)	0 (0.0)	4 (2.5)	2 (1.2)	0 (0.0)	0 (0.0)	33 (20.2)	124 (76.1)
Other vegetables								
Green/sweet pepper	69 (41.1)	67 (39.9)	4 (2.4)	0 (0.0)	0 (0.0)	0 (0.0)	11 (6.5)	86 (51.2)

Tomatoes	115 (68.5)	71 (42.3)	62 (36.9)	0 (0.0)	0 (0.0)	0 (0.0)	3 (1.8)	32 (19.0)
Onions	128 (76.2)	130 (77.4)	4 (2.4)	0 (0.0)	0 (0.0)	0 (0.0)	4 (2.4)	30 (17.9)
Eggplant	4 (2.4)	3 (1.8)	69 (41.8)	10 (6.1)	1 (0.6)	0 (0.0)	33 (20.0)	49 (29.7)
Food	**24h prior to interviews** n (%)	**Daily** n (%)	**3-4x/week** n (%)	**Weekly** n (%)	**2-3x/month** n (%)	**Monthly** n (%)	**Occasionally** n (%)	**Never** n (%)
Fruit								
Yellow/orange fruit (vit A sources)								
Mango	98 (57.6)	55 (31.4)	45 (26.6)	19 (11.2)	2 (1.2)	0 (0.0)	20 (11.8)	28 (16.6)
Papaya	2 (1.2)	1 (0.6)	11 (6.5)	4 (2.4)	5 (3.0)	0 (0.0)	97 (57.7)	50 (29.8)
100% Juice apricot/cantaloupe	3 (1.8)	0 (0.0)	7 (4.1)	1 (0.6)	0 (0.0)	0 (0.0)	28 (16.6)	133 (78.7)
Other fruits and juice (vit C sources)								
Orange	19 (11.2)	3 (1.8)	62 (36.7)	16 (9.5)	4 (2.4)	0 (0.0)	50 (29.6)	34 (20.1)
Orange juice	0 (0.0)	2 (1.2)	5 (3.0)	1 (0.6)	0 (0.0)	0 (0.0)	99 (58.6)	62 (36.7)
Berries	3 (1.8)	3 (1.7)	73 (43.7)	14 (8.4)	0 (0.0)	0 (0.0)	12 (7.2)	65 (38.9)
Vitamin C fortified juice	1 (0.6)	0 (0.0)	2 (1.2)	1 (0.6)	0 (0.0)	0 (0.0)	97 (57.7)	68 (40.5)
Other fruits/wild fruits/100% juices	4 (2.4)	0 (0.0)	1 (0.6)	3 (1.8)	2 (1.2)	0 (0.0)	93 (56.4)	66 (40.0)
Meat (Heme sources)								
Organ meat								
Liver	14 (8.3)	0 (0.0)	5 (3.0)	7 (4.2)	6 (3.6)	1 (0.6)	106 (63.1)	43 (25.6)
Kidney	9 (5.4)	0 (0.0)	2 (1.2)	5 (3.0)	6 (3.6)	0 (0.0)	107 (64.1)	47 (28.1)
Heart (n-167)	1 (0.6)	0 (0.0)	1 (0.6)	1 (0.6)	5 (3.0)	1 (0.6)	102 (61.1)	57 (34.1)
Blood based	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	44 (24.3)	122 (73.1)
Flesh meat								
Beef	21 (12.5)	1 (0.6)	16 (9.5)	29 (17.3)	10 (6.0)	0 (0.0)	71 (42.3)	41 (24.4)
Pork	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	8 (4.8)	158 (94.6)
Lamb	7 (4.2)	0 (0.0)	15 (8.9)	12 (7.1)	8 (4.8)	0 (0.0)	93 (55.4)	40 (23.8)
Goat meat	4 (2.4)	0 (0.0)	7 (4.2)	9 (5.4)	5 (3.0)	0 (0.0)	108 (64.3)	39 (23.2)
Game	1 (0.6)	0 (0.0)	26 (15.5)	16 (9.5)	4 (2.4)	0 (0.0)	79 (47.0)	43 (25.6)
Chicken	7 (4.0)	0 (0.0)	11 (6.6)	6 (3.6)	6 (3.6)	0 (0.0)	98 (58.7)	46 (27.5)
Worms/insects	0 (0.0)	0 (0.0)	19 (11.6)	7 (4.3)	2 (1.2)	0 (0.0)	70 (42.7)	66 (40.2)
Duck	0 (0.0)	0 (0.0)	1 (0.6)	2 (1.2)	2 (1.2)	0 (0.0)	91 (54.2)	72 (42.9)
Fish and other seafood								
Fish (anchovies)	128 (75.3)	128 (75.3)	5 (2.9)	2 (1.2)	0 (0.0)	0 (0.0)	7 (4.1)	28 (16.5)
Eggs	33 (19.5)	2 (1.2)	18 (10.6)	9 (5.0)	6 (3.5)	0 (0.0)	99 (58.2)	36 (21.2)
Legumes, nuts and seeds,								
Dry beans	57 (33.5)	1 (0.6)	70 (41.2)	49 (28.8)	2 (1.2)	0 (0.0)	17 (10.0)	31 (18.2)

Food	24h prior to interviews n (%)	Daily n (%)	3-4x/week n (%)	Weekly n (%)	2-3x/month n (%)	Monthly n (%)	Occasionally n (%)	Never n (%)
Dry peas	51 (30.0)	6 (3.4)	67 (39.4)	42 (24.7)	3 (1.8)	0 (0.0)	17 (10.0)	35 (20.6)
Nuts	108 (64.3)	80 (47.6)	45 (26.8)	1 (0.6)	0 (0.0)	0 (0.0)	6 (3.6)	36 (21.4)
Peanuts	57 (33.5)	29 (17.2)	33 (19.5)	1 (0.6)	0 (0.0)	0 (0.0)	3 (1.7)	103 (60.9)
Melon seeds	1 (0.6)	0 (0.0)	1 (0.6)	2 (1.2)	0 (0.0)	0 (0.0)	5 (3 .0)	160 (95.2)
Milk and milk products,								
Cow's milk	15 (8.9)	2 (1.2)	3 (1.8)	4 (2.4)	1 (0.6)	0 (0.0)	92 (54.4)	67 (39.6)
Yoghurt	3 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	76 (45.0)	92 (54.4)
Goat's milk	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	170 (100.0)
Breast milk	96 (57.1)	96 (69.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	10 (7.2)	32 (23.2)
Food	**24h prior to interviews** n (%)	**Daily** n (%)	**3-4x/week** n (%)	**Weekly** n (%)	**2-3x/month** n (%)	**Monthly** n (%)	**Occasionally** n (%)	**Never** n (%)
Fats & Oils								
Added to food/used for cooking	124 (73.8)	70 (41.7)	60 (35.7)	2 (1.2)	0 (0.0)	0 (0.0)	5 (3.0)	31 (18.5)
Sweets/ Sugar	141 (82.9)	114 (67.1)	24 (14.1)	2 (1.2)	0 (0.0)	0 (0.0)	8 (4.7)	22 (12.9)
Beverages, alcohol								
Coffee	2 (1.2)	1 (0.6)	2 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)	11 (6.5)	154 (91.7)
Tea	93 (55.0)	32 (19.0)	72 (42.9)	8 (4.8)	3 (1.8)	1 (0.6)	24 (14.3)	28 (16.7)
Chocolate drink	1 (0.6)	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	5 (3.0)	162 (96.4)
Milo	51 (30.2)	20 (11.8)	46 (27.2)	10 (5.9)	8 (4.7)	0 (0.0)	57 (33.7)	28 (16.6)
Alcohol	2 (1.2)	2 (1.2)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	165 (98.2)
Locally brewed beer	1(0.6)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	167(99.4)
Spices, condiments								
Green tea	2 (1.2)	1 (0.6)	3 (1.8)	1 (0.6)	0 (0.0)	0 (0.0)	2 (1.2)	161 (95.8)
Soft drinks	13 (7.4)	6 (3.6)	5 (3.0)	1 (0.6)	1 (0.6)	0 (0.0)	105 (62.5)	50 (29.8)
Soy products	7 (4.1)	0 (0.0)	12 (7.1)	4 (2.4)	0 (0.0)	0 (0.0)	60 (35.7)	92 (54.8)
Dawadawa (condiment)	129 (75.9)	127 (74.7)	5 (2.9)	1 (0.6)	0 (0.0)	0 (0.0)	7 (4.0)	30 (17.6)
Black pepper	83 (49.1)	76 (45.2)	10 (6.0)	4 (2.4)	1 (0.6)	0 (0.0)	20 (11.9)	57 (33.9)

Whole or processed-maize meal (144 whole; 2 processed)

TZ/Bank (cooked fermented maize meal dough and cassava dough)

Legumes, nuts and seeds, whole -130 (99.2%) and processed 1 (10.8%)

These children had very low intakes of heme-sources. Only about 17% were eating beef weekly, and other meats were consumed very rarely. The mothers did indicate that 75.2% of the children ate anchovies daily, dried anchovies were pounded into a powder and incorporated in very small amounts into food as a type of condiment.

Eggs were consumed between one and four times per week by 13.8%, whereas the rest ate eggs only occasionally or never. In the 24 hours prior to the interviews, 19.5% of the children had eaten eggs.

Legumes, nuts, and seeds were mostly used in the whole, unprocessed form. Around 70% of the children consumed dried beans and peas between one and four times per week. Most children (74.4%) ate nuts between one and four times per week. About a fifth of the children ate peanuts (raw, roasted, or in a soup) daily, and another fifth 3-4 times per week. In the 24 hours prior to the interviews, 64.5% had consumed nuts and 33.5% had consumed peanuts. However, 21.4% and 60.9% never ate nuts and peanuts, respectively.

Overall, 69.6% of the children were being breastfed on a daily basis at the time of data collection. Cow's milk and yoghurt were only very rarely consumed and goat's milk was not given to the children at all. In the 24h recalls however, 8.9% were reported to have consumed cow's milk.

Shea butter/oil was the main source of fat, mostly used for cooking. It was consumed on a daily basis by 41.7% of the children, and 3-4 times per week by 35.7%. In the 24 hours prior to the interviews, 73.8% of mothers reported consuming it.

Overall, 67.1% reported adding granular sugar to their tea and their breakfast porridge on a daily basis, with another 14.1% doing so 3-4 times per week. In the 24 hours prior to the interviews, almost 82.9% reported having consumed sugar.

Most children never consumed coffee or green tea. Overall, 19.0% and 42.9% consumed black tea daily and 3-4 times per week, respectively. In the 24 hours prior to the interviews, 55% of the children had consumed black tea. About a third consumed Milo (made with water) at least once per week (11.8% daily, 27.2% 3-4 times per week, and 5.9% once a week). In the 24 hours prior to the interviews, 30.2% had consumed Milo. About 94% of the mothers only occasionally consumed soft drinks (usually carbonated). Only one mother reported using any alcohol. Most (92.3%) consumed soft drinks only occasionally or never. Surprisingly, three mothers indicated that their child drank alcohol daily.

Dawadawa, a seasonal wild fruit that is dried and processed into a powder, was the most commonly used condiment (added to 74.7% of the children's food daily).

The researcher observed that both mothers and children rarely washed hands with soap, after going to the toilet or before handling food.

5.4.7 Association between the nutrient intakes of the mothers and their index children

The mother's nutrient intakes were assessed in the same way as that of the children (reported in Table 5.4), and published elsewhere (Abu, 2015:121-56). Table 5.6 summarises the association between the nutrient intakes of mothers and their index children. Energy, macronutrient and micronutrient intakes (except for vitamin B12), were statistically significantly correlated.This was a direct relationship.

Table 5.6: Correlations between the nutrient intakes of mothers and their index children

Nutrient	R	p-value
Energy	0.33	0.0001
Macronutrients		
Protein	0.36	0.0001
Carbohydrate	0.35	0.0001
Dietary fibre	0.34	0.0001
Minerals		
Iron (mg)	0.41	0.0001
Vitamins		
Vitamin C (mg)	0.5	0.0001
Vitamin A (µg RAE)	0.4	0.0001
Vitamin B_{12} (µg)	0.09	0.2729
Folate (µg)	0.5	0.0001

r refers to Pearson's correlation coefficient, $p<0.05$ was considered significant

5.4.8 Household food security

Household food security in this study population is summarized in Table 5.7. Overall 49.4% of the households in this study population were food secure, 43.8% was at risk for hunger and

6.9% were hungry. About half of the households indicated that they run out of food/money to buy food in the year prior to the study. In these 12 months before the study, 12.4% reported that they had relied on a limited number of foods to feed children; 6.3% that children had complained that they were hungry while there was no food for them; 6.7% that the size of children's food was reduced or that children skipped meals because there was not enough money for food; and 3.1% that children had gone to bed hungry, because there was not enough food. Overall, 79 (49.4%) of households reported experiencing periods of food shortages lasting a mean of 11.5 ± 6.7 weeks. About a quarter (25.3%) of these households reported shortages lasting more than 12 weeks at a stretch.

Table 5.7: Household food security (N=161 households)

HOUSEHOLD FOOD SECURITY CLASSIFICATION	**n (%)**
Food secure	79 (49.4)
At risk of hunger	70 (43.8)
Experiencing hunger	11 (6.9)
RESPONSES TO QUESTIONS IN THE CCHIP QUESTIONNAIRE **In last 12 months:**	**Yes answers** **n (%)**
Did the household ever run out of money to buy food?	80 (49.7)
Did the household ever rely on a limited number of foods to feed children?	20 (12.4)
Did the household ever cut the size of meals or skip any, because there is not enough food in the house?	23 (14.3)
Did the household ever eat less than they should because there is not enough money for food?	29 (18.0)
Did children in the household ever eat less than they feel they should, because there is not enough money for food?	13 (8.1)
Did children in the household ever say they are hungry, because there is not enough food in the house?	10 (6.3)
Did the household ever cut the size of the children's meals, or do they ever skip meals, because there is not enough money to buy food?	10 (6.7)
Did children in the household ever go to bed hungry, because there is not enough money to buy food?	5 (3.1)

Assessed by Fishers exact test; $p < 0.05$ considered statistically significant

n is the total number of positive responses for the household, with each mother representing a household.

Food security scoring using the CCHIP Household Hunger Scale (Wehler *et al*., 1992) and a final total score of zero indicates that a household is food secure; a score of 1-4 indicates that the household is at risk of hunger, and a score of ≥5 indicates that the household is going hungry.

Table 5.8 summarises the association between the nutritional status of the children based on the mean Z-scores, and food security classification according to the CHIPP index. WHZ, HAZ and WAZ were statistically significantly associated directly with food security across the 'food secure' and the 'at risk for hunger' categories. In the 'hungry' category, food security was only significantly associated with WAZ (95% CI for mean [-3.26; -0.23]), which is indicative of underweight or acute malnutrition, but not with WHZ, indicative of wasting, and HAZ, indicative of stunting or chronic malnutrition.

Table 5.8: Cross-tabulation of nutritional status (mean Z-scores) and food security

Food Security level (CHIPP Index)	n	Variable	Mean ± SD	95% CI for means
Food secure	87	WHZ	-0.93 ± 1.39	[-1.22; -0.63]
		HAZ	-1.97 ±1.46	[-2.29; -1.65]
		WAZ	-1.76 ±1.252	[-2.03; -1.49]
At risk for hunger	76	WHZ	-0.75 ±1.491	[-1.09; -0.41]
		HAZ	-1.67 ±1.327	[-1.98; -1.36]
		WAZ	-1.48 ± 1.344	[-1.79; -1.16]
Hungry	12	WHZ	-0.80 ± 1.412	[-1.70; 0.10]
		HAZ	-2.08± 3.342	[-4.20; 0.04]
		WAZ	-1.74 ± 2.378	[-3.26; -0.23]

Abbreviations: WHZ = weight for height Z-Score; HAZ = height for age Z-Score; WAZ = weight for age Z-score.

5.5 Discussion

This study explored the dietary patterns and intakes of nutrients, which are relevant to ID and IDA, of children six to 59 months in the Tolon-Kumbumgu district and Tamale metropolis of the Northern Region of Ghana. In this area, the prevalence of anemia is above 80% in this age group (GHDS, 2008). At the time of the study, 47.3% of the children were moderately to severely stunted, 38.9% moderately to severely underweight, and 17.2% moderately to severely wasted. This indicates high levels of both acute and chronic malnutrition, which were significantly associated with food security levels. Though breast feeding practices were generally in line with recommendations, some concerns were raised regarding weaning practices and the types of foods children were fed. Overall, 67.3% had probable inadequate intakes of iron if bioavailability of 5% was assumed, and 98.2% had inadequate intakes of vitamin B12. A follow-up NEP based on the findings, aimed at educating the mothers in this study population to best utilise available resources to feed their young children, may contribute to address ID and anemia in the area.

The children in this study population were being raised in extended households, headed by a father with a number of wives. Living conditions entailed that extended families lived together in mud huts, with electricity, but mostly without piped water. The mothers were mostly uneducated and in many cases illiterate. In Ghana, children of mothers with little or no formal education are at the highest risk for anemia (Abu *et al*., 2010; GDHS 2008; MICS, 2006:19).

In our study population, 47.3% of the children were moderately to severely stunted, 38.9% moderately to severely underweight, and 17.2% moderately to severely wasted. According to the GHDS (2008) the national averages in this age group was 28% stunting, 14% underweight, and 9% wasting. There is thus a very high prevalence of chronic malnutrition among these children. In Ghana, children of mothers with little or no formal education are most at risk of stunting and wasting (Colecraft *et al*., 2011). IDA in infancy has also associated growth retardation and impaired immune response (Domellöf *et al*., 2014). About a third of the children had been sick (fever, colds and coughs) in the two weeks prior to the data collections. Fever and infections may also contribute to anemia (Zaritsky, 2009) Based on the 3x24h recalls, a third of the children had inadequate energy intakes and around a fifth had inadequate protein intakes (breastfeeding, still practiced by 57.1% of the children, was not included in the analysis).

More than 90% of children in this study population were born at home, with or without the assistance of traditional birth attendants (TBA). In the Tolon district 76.2% of all deliveries in the district in 2010, were assisted by TBA (GHS, 2012a). In the Tamale district, the 2011 Annual Report (GHS, 2012b) indicated that the district had 205 trained TBA and 570 untrained TBA. According to a recent Cochrane review (McDonald, 2013), the timing of the clamping of the umbilical cord is an important determinant of iron stores in the new-born, as blood is transfused from the placenta to the new-born during the first three minutes after delivery. Delayed cord clamping allows approximately 30% more blood to be transferred to the infant, and this has been shown to protect against ID in infants (Burke *et al*., 2014).

LBW infants have lower total body iron at birth and a more rapid relative growth rate, leading to high iron requirements even before the age of six months (Collard 2009). LBW infants also grow rapidly, to realise catch-up growth, and have increased iron needs, and thus enhanced risk of ID (Burke *et al*., 2014). Most children in this study, born at home, did not have their birth weights captured, and thus the prevalence of LBW in this population is not known. A recent systematic review and meta-analyses concluded that short-statured women have higher unadjusted risks of LBW (Han *et al*., 2012). As our study population included many women with likely ID (GDHS, 2008; Asobayire *et al*., 2001) a high prevalence of LBW may be suspected. Furthermore, nutrient analysis of the mothers' diets published elsewhere (Abu, 2015:121-156) indicated that 46.6% had inadequate folate intakes, which may also predispose to LBW, among other detrimental effects on the foetus (Grieger & Clifton, 2015).

This study population was from an agrarian society, living of subsistence farming, and so mothers worked the land and spent on average 6.1 hours per day at work, away from their households. Overall, fathers were both financially and physically involved in the raising of the children. Whereas some mothers left the young children in the care of other older siblings or relatives, mothers would carry younger children with them to work (31.1%). This makes on-demand breastfeeding easier. For infants below the age of four to six months exclusive breast feeding is the ideal for overall health and normal growth and development. Although the iron content is not high, iron in breast milk is highly bioavailable and plays a vital role to prevent early ID (Burke *et al*., 2014). In this population, 80% of the children had been exclusively breastfed for four to six months. For almost a fifth of the children, however, breastfeeding before four months of age was not exclusive; 13.4% were given water to drink before four months (4.1% at birth already), and 9% were introduced to liquid foods before four months. Similarly, the GDHS reported that though 65% of children were exclusive breastfeeding rates at 2-3months but reduced as to only 14.3% at 6-7months in 2003. In 2008, only 63% of the children under 6months were exclusively breastfed (GDHS, 2008; 2003). This indicates, that although exclusive breastfeeding practices were generally in line with recommendations, some room for education still exists.

At the age of 4–6 months, the need for iron starts to outpace iron intake, and stores are rapidly depleted, increasing the risk for ID and IDA. Commonly used complementary foods, especially in developing countries, may be low in iron (Burke *et al*., 2014). To prevent this, iron-fortified formula, meat products, iron fortification of follow-on formula and complementary foods, avoidance of cow's milk, and use of iron-fortified milks, are recommended (Domellöf *et al*., 2014). According to Stoltzfus (2011), countries should focus on infant and young child nutrition through appropriate complementary feeding, and on healthy family members through fortification initiatives. Thus, a lifecycle approach is more comprehensive and complementary.

In our study population, only 5% of the index children were receiving fortified formula; 12.7% were given cereals mixed (fortified) with other foods and more than 80% were receiving the family food. Tuo-zaafi and maize porridge, made from unrefined maize flour that the households produced in small quantities according to their needs, was the staple. Only about 10% of the children consumed white bread daily. The children in this study population therefore were not benefitting from the national fortification programme in Ghana that fortifies wheat flour with iron, folate, and vitamins A and B12 (GAIN, 2007: Online). Overall, the children had very low intakes of animal milk, which contribute to ID, but equally low intakes of meat products, which enhance iron status. Legumes, nuts, and seeds, in the whole, unprocessed form, were the main sources of protein and non-heme iron in the children's diets. The mean fibre intake was 19.8 ± 13.9 g/day, compared to the daily recommendation of 5g plus age (WHO/FAO, 2004). In combination with high phytate intakes from unprocessed maize, the absorption of iron from their diets may have been low (Beck *et al*., 2014). Furthermore, the children frequently consumed Ceylon tea, which has been shown in populations with marginal iron status, to be negatively associated with iron status (Temme & van Hoydonck, 2002). When assuming 5% or 10% bioavailability of iron in the current study, as suggested by the FAO/WHO for communities in developing countries (Gibson & Ferguson, 2008; Allen *et al*., 2006; WHO/FAO, 2004), 67.3% and 32.6%, of these children, respectively, probably had inadequate iron intakes.

At the time of the study, at the start of the wet season, most children (>70%) had frequent intakes (at least 3-4x/week) of butternut and yams and about half ate amaranth leaves 3-4 times a week, and baobab and hibiscus leaves at least once a week. Of the children, 42.3%, 40% and 77.4% ate tomatoes, green peppers, and onions daily. Nevertheless, inadequate intakes of vitamin C, vitamin A, and folate were found in 21.3% and 58.5% and 26.6% of the children. All these vegetables are however, seasonal and not available throughout the year. Almost the entire population of index children had inadequate intakes of vitamin B12 which may put them at risk of neurological impairment, particularly those who were consuming adequate levels of folate.

We found that a child's intakes of energy, macronutrients, iron, vitamins C and A, and folate, was significantly correlated with that of the mother. According to the CCHIP index, 49.4% of this study population was food secure, 43.8% was at risk for hunger and 6.9% were experiencing chronic hunger. This high level of food insecurity was related to times of food shortages of around three months a year that the households experienced in the dry season. To cope, mothers were found to, in this and other studies reduce portion sizes, turn to the use of low nutritious and/or less varied diets (Abu *et al*., 2010: Hoddinott, 1999) and skipped meals to feed the children. Even so, around 6-10% of mothers reported that in the 12 months prior to the study, that there had been not enough food to satisfy hungry children. Periods of food shortages may negatively affect growth and development, as well as contribute to micronutrient deficiencies, ID, and anemia. We found that underweight, wasting, and stunting were all statistically significantly associated with food security in this study population (Table 5.8).

In communities like these, reported food security may not translate to nutrition security, since children are eating less varied diets (Steiner-Asiedu *et al.*, 2012; Abu *et al*., 2010). Large household sizes may contribute to there not being enough for everyone in proportion to the amount of food harvested. The large household sizes may also lead to inadequate quality foods when children begin to eat with the household. Although mothers had a mean number of four children, the polygamous settings mean that a man has to provide for multiple wives within the same household, increasing the burden on the entire household. Males in similar communities should therefore, ideally be involved in the discussion of food security and nutrient requirements.

In a study conducted in Ghana by Nti & Lartey (2008), they found that a mother's feeding behaviour and her active involvement in feeding her child (responsiveness to feeding) influences the feeding behaviour and nutritional status of her children. Therefore, a child's feeding practices are largely dependent on the mother and her level of education on health behaviour and nutrition. A mother's hand washing (Bartlett *et al,* 1992) and other hygiene practices (Ahmed *et al*., 1992) have also been shown to affect morbidity rates of her children, especially in relation to diarrhoea incidence. In this population, hand washing and sanitary practices were observed to be sub-optimum.

Just more than half of the children were receiving iron drops. Although iron supplementation in young children contributes to a better iron status, they frequently cause gastrointestinal side effects and create the potential for overdose (Burke *et al*., 2014). Furthermore, in malaria endemic areas like these, there are some concerns that iron supplementation may increase morbidity and mortality as reported in several studies (Spottiswoode *et al*., 2012), despite a Cochrane review which concluded that there is no excess risk in settings with regular malaria surveillance and control (Ojukwu *et al*., 2009).

5.6 Limitations

Biochemical analysis was not included in this study due to logistical problems regarding the storing and transporting of blood samples across long distances and a poor road conditions to the nearest laboratory that could perform the tests; and due to lack of funding. Correlation between the nutrient intakes and blood levels of the micronutrients would have added to the interpretation of the data. Although blood analysis could have confirmed the prevalence of ID and anemia in these children, this is an area where 80% of children are anemic (GHDS, 2008) and ID is suspected among the whole population (Asobayire *et al*., 2001).

5.7 Conclusion and recommendations

In this population of children six to 59 months, in a low socio economic agrarian society, the following dietary risk factors for ID were prevalent; low frequency of meat intake (heme iron); sub-optimal and seasonal intakes of non-heme iron sources, including green leafy vegetables, vitamin C-rich fruit, and eggs; and high fibre, phytate and tea intake, which interfere with iron absorption. Low intakes of animal products may be reflected in the low inadequate intakes vitamin B12 among almost the entire population. Maize porridge (koko) as the main weaning food may be a source of phytates, which coupled with low intake of fruits and fleshy meat, may exacerbate risk for ID among children in northern Ghana. Mothers who are the primary caregivers, need to be trained to identify these risk factors of ID and anemia, and empowered to use the food that are available to the best effect in order to curb ID in themselves and their young children. Ideally, the fathers, as heads of the household, need to be involved in education and discussion on food security issues. Education on risk factors and processing methods among small holder farmers will improve access to food nutrients and ID status.

5.8 References

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CHAPTER 6

KNOWLEDGE, ATTITUDES AND PRACTICES REGARDING IRON DEFICIENCY AND ITS ASSOCIATED RISK AMONG MOTHERS IN AN ANEMIA ENDEMIC POPULATION IN NORTHERN GHANA.

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6 KNOWLEDGE, ATTITUDES AND PRACTICES REGARDING IRON DEFICIENCY AND ITS ASSOCIATED RISK AMONG MOTHERS IN AN ANEMIA ENDEMIC POPULATION IN NORTHERN GHANA

6.1 Abstract

Objectives: Prior assessment of knowledge, attitude and practices (KAP) is important to determine the goals of nutrition interventions. This study assessed the KAP regarding the known risk factors for iron deficiency (ID) of mothers with children six to 59 months old, in an anemia endemic area.

Design: Cross-sectional descriptive survey.

Setting: Two randomly selected communities the Northern Region of Ghana.

Subjects and methods: A questionnaire on socio-demographics and KAP regarding known risk factors for ID, was designed and administered in structured interviews to rural mothers (n=161) with low income and have children six to 59 months old, during April 2012. Responses to statements testing KAP were scored, and manual content analysis was performed on open ended questions. SAS® software was used to analyse data.

Results: In response to nine test statements on measures to prevent ID and iron deficiency anemia (IDA), the knowledge score of the mothers appeared to be poor, with a mode and median of four (out of nine) correct responses. In response to ten test statements assessing attitudes, most mothers had moderate scores (four to seven with a median of seven). From a list of practices which prevents ID, regarding tea and milk intake, use of mosquito nets, use of iron supplements and deworming, the median score was three out of five. A significant inverse association was found between the mothers' total score on knowledge regarding risk factors, and her education level (p=0.006); and having ever been diagnosed with anemia

(p=0.009). Overall, 63.3% of the mothers could not identify the communities most vulnerable to anemia; 16.4% chose adult men, adolescent boys or post-menopausal women.

Conclusions: Most of the mothers scored moderately to poorly on KAP regarding ID. Many half-truths and totally inaccurate information about ID and anemia were identified. These should be addressed through targeted education.

Key words: iron deficiency, pica, practices, mothers and children, Northern Ghana

6.2 Introduction

According to a recent systematic analysis of the global anemia burden from 1990 to 2010 (Kassebaum *et al*., 2014), one third of the global population suffered from anemia in 2010, causing 68 million years lived with disability (YLD). The greatest coverage for all three most affected communities, namely preschool children, pregnant women and non-pregnant women of reproductive age (WRA) were in Asia and Africa. Globally, Central, East and West sub-Saharan Africa fared the worst, with YLD almost doubling from 1990 to 2010 and the rate of decrease in anemia lagging behind other low- and middle income regions (Kalassebaum *et al*., 2014).

The 2008 Ghana Demographic and Health Survey (GDHS) reported the prevalence of anemia among WRA in the Upper East, Upper West and Northern Regions of the country, at 48.8%, 66.9% and 59.5% (GDHS, 2008); and among children six to 59 months in the same areas, even higher at 89%, 88% and 81%. This, according to the World Health Organization (WHO), constitutes a severe public health problem (anemia prevalence ≥40%) (WHO, 2008). The main causes of anemia in Ghana have been identified as inadequate dietary intake of bioavailable iron, malaria, hookworm infestation and infections (GDHS, 2008; Abu *et al*., 2010; MICS, 2006; GDHS, 2003; Ronald *et al*., 2006; Koram *et al*., 2003). Most anemia surveys, including the GDHS, only consider hemoglobin levels and not the causes of anemia. Based on an analysis of the NHANES 1976–80 data, however, it was suggested that, if the overall anemia prevalence in a population is above 40%, as is the case in these regions of

Ghana, it may be assumed that the entire population suffers from some degree of iron deficiency (ID) (Maclean *et al.,* 2007; Asobayire *et al*., 2001).

Globally, efforts to improve ID include supplementation, fortification and bio-fortification; efforts to increase dietary diversity; and nutrition education programs (NEPs). In Ghana, wheat flour and oils are universally fortified with micronutrients, including iron (GAIN, 2010: online), and iron supplements are given to women who attend antenatal care (Fiedler *et al*., 2014; GDHS, 2008). Among these approaches, NEPs which specifically address preventive measures towards risk factors of ID, are considered a cost-effective to sustainably address ID and reduce the need for more costly interventions (Thompson, 2007; Balachander, 1991). Theories on behaviour change suggest that an increase in knowledge precedes changes in attitudes and practices, although change is more complicated than just knowledge translating to behaviour change (Lytle, 2005). As dietary habits and patterns are highly dependent on cultural beliefs and practices (Savage *et al*., 2007; Birch, 1999), prior assessment of the knowledge, attitudes and practices (KAP) of a community regarding a nutrition-related problem like ID, is vital to address the etiology of anemia and determine the goals of a planned NEP (NCP, 2014a; NCP, 2014b; Stoltzfus & Dreyfuss, 1998).

This study aimed to evaluate the KAP of mothers with children six to 59 months old, with regard to anemia and the known risk factors for ID, in an area of Ghana where anemia is a severe public health problem. The study also assessed the BMI of mothers. The results contribute to the understanding of the root causes of the persistent high anemia prevalence in this setting, and may be used to inform the design of NEPs to combat ID and IDA among mothers and young children in this area.

6.3 Methods

6.3.1 Study design, population and sampling

A quantitative, descriptive survey was conducted in April 2012, in the northern and largest region of Ghana, in two randomly selected districts, namely Tolon-Kumbumgu district and Tamale metropolis. One community was randomly selected from within each of these two districts. In these two communities, randomly selected households were approached and all mothers who had lived in the selected community for at least 12 months, were not pregnant, and had children aged six to 59 months, were invited to participate in the study. Mothers who volunteered, signed an informed consent form after the study procedures were explained to them. The final sample included 161 mothers; 81 from the Tolon-Kumbumgu district and 80 from Tamale metropolis. Sampling was based on the prospect of later engaging mothers of one community in a NEP regarding ID and anemia, based on the baseline findings, with the other community serving as control. It was felt that two communities of approximately 80 households would be the limit in terms of cost-effectiveness for this study and effective engagement in the later NEP, while still allowing for some attrition during follow-up.

The study was approved by the institutional review boards of Noguchi Memorial Institute of Medical Research (NMIMR), Ghana (NMIMR-IRB CPN 064/11-12) and the Ethics Committee of the Faculty of Health Sciences, University of the Free State, South Africa (ECUFS NR 24/2012).

6.3.2 Data collection

Data were collected with the use of a questionnaire, based on an intensive literature review of the known risk factors and characteristics of ID and IDA. The questionnaire was administered during structured interviews with the mothers, by the primary researcher and four trained assistants.

The questionnaire assessed socio-demographic information and medical backgrounds of the mothers with regard to practices and/or conditions that may pose risks for ID, including age, education level, menstrual history, the use and type of contraception, age at marriage and first pregnancy, spacing of pregnancies, number of live births, miscarriages and still births, as well as the gestational ages and birth weights of the children six to 59 months. The mothers' history of anemia and malaria were recorded. The use of treated mosquito nets, use of iron supplements, and recent history of malaria and worm infections were also assessed as potential causes of anemia. Further questions were related to food totems and taboos (foods that are forbidden for consumptions due to cultural reasons) of mothers and children, and cooking methods.

Body mass index (BMI) of mothers was assessed as a measure of nutritional status. All standard protocols for anthropometry were observed (Gibson, 2005). Based on BMI, the women were categorized according to WHO recommendations, as underweight (<18.5 kg/m2), normal (18.5–24.9 kg/m2), overweight (25.0–29.9 kg/m2), and obese class 1 (30.0–34.9 kg/m2) (WHO 2004).

Knowledge regarding measures that prevent ID, knowledge of risk factors for ID, and symptoms associated with anemia, as well as the mothers' attitudes (defined for the purpose of the study as approval of certain behaviours associated with poor iron status); and practices regarding the use of iron supplements and mosquito nets, drinking tea or milk with meals, and deworming, were assessed with multiple choice questions, sets of test statements, and questions to which the mothers could answer "yes/no", "agree/don't agree", or "I don't know". Knowledge of food sources of iron and enhancers of iron absorption were assessed with sets of paired foods from which the better source had to be selected. The responses to these questions were scored as described below. Open-ended questions were also included to allow mothers to share their own ideas about ID and anemia. Additional questions (not scored) assessed the mothers' perceptions on the availability of food sources of iron, cooking methods, as well as where the mothers had learned what they knew about anemia.

6.3.3 Data analysis

The data was analyses with SAS/STAT software, version 9.3 of the SAS system for Windows (Copyright © 2010 SAS Institute Inc). Categorical data was summarised as frequencies and percentages and continuous variables were expressed as means and standard deviations.

To assess knowledge, a score of one was allocated if the mother could identify a measure which prevents ID, or an incorrect test statement regarding ID and associated risk factors; a zero score was allocated if she chose an incorrect answer or the "do not know option". The same method was used to evaluate knowledge regarding food sources of iron and iron absorption enhancers, and risk factors and symptoms of ID. To assess attitudes regarding ID and risk factors, a score of zero were allocated for each high risk behaviour, or each “do not know option” that she chose. To assess practices regarding ID and risk factors, a score of one was allocated for each positive preventive measure a mother reported practicing and each negative practice that she reported to abstain from. A zero score was allocated for each risk behaviour that she admitted to. Manual content analysis was done on open ended questions by categorising responses into themes. Chi-square and t-test analysis were used to test associations between KAP and age at first menstruation, the age of mothers at marriage, age at first pregnancy, number of live births, ever having been diagnosed with anemia by a doctor and level of education which were direct factors that could influence ID state or the mothers exposure to information of ID/anemia. The p-value was considered significant at $p<0.05$.

6.4 Results

6.4.1 Socio-demographic characteristics

The mean age of the 161 mothers in the sample was 33.0 ± 8.3 years (Table 6.1). Most were married (97.5%); almost a third before the age of 19 years; and all were in polygamist marriages, which was the norm in this setting. Most (96.3%) were from the Dagomba ethnic community; and all but three practiced the Muslim religion (98.1%). In 62.1% of cases the husband or partner was head of the household; in 27.3% the grandparent was the head; mothers headed only 1.9% of the households.

The mothers had a median of 4 children (live births); 147 (91.3%) had only one child between six and 59 months, and the rest 14 (8.7%) had two children in this age bracket (total of 175 index children). The date of birth of eight of the children could not be determined; for the remaining 167 children, the median age was 23 months, with an inter-quartile range (IQR) of 13–36 months. The median age at first pregnancy was 20 years. Most mothers (67.1%) had been pregnant one to five times (median of four times). About a tenth (11.8%) of mothers reported that they had had a miscarriage. Most mothers delivered the index children at home (90.9%); hence the children’s birth weights were mostly not known.

Most of the mothers (91.9%) had no formal education and none were formally employed, but engaged in subsistence farming. Most of the mothers (84.5%) reported earning a living through petty trading and sale of food crops or livestock (spending an average of 6.1 hours per day at work); the remaining 15.5% perceived themselves as unemployed. Most lived in huts with thatched roofs (61.9%) and cement floors (98.8%), and had electricity (79.2%), but cooked on wood-fires (98.7%). Only 36.9% had piped water; 58.1% drew water from a river/pond, 3.1% from a borehole, and 1.9% from a well.

Table 6.1: Socio-demographic, medical history and BMI of mothers in the study

	n (%) / Mean ± SD / Median
Age (yrs) (n=146)	
≤ 19	2 (1.2)
20–29	38 (23.6)
30–39	70 (43.5)
40–49	28 (17.4)
>50	6 (3.7)
Did not know	17 (10.6)
Mean ± SD	33.0 ± 8.3
Highest level of education (n=161)	
None	148 (91.9)
Primary (1–6 yrs)	10 (6.2)
JSS level (7–10 yrs)#	2 (1.2)
SSS/Vocational school (11–14 yrs) #	1 (0.6)
Religion (n=161)	
Christian	3 (1.9)
Muslim	158 (98.1)
Ethnicity (n=161)	
Dagomba	155 (96.3)
Moshi	1 (0.6)
Hausa	1 (0.6)
Fulani	3 (1.9)
Ewe	1 (0.6)
Employment status (n=161)	
Self employed	136 (84.5)
Unemployment	25 (15.5)
Marital status (n=161)	
Married	157 (97.5)
Single	3 (1.9)
Cohabiting	1 (0.6)
Age at menarche (n=129)	
Mean ± SD	14.2 ± 2.6
Median	14.0
Age at getting married (yrs) (n=152)	
≤19	46 (30.5)
20-29	99 (65.5)
30-39	5 (4.0)

40-49	1 (0.7)
Mean ± SD	20.8 ± 3.7
Median	20.0
Use of contraception (n=161)	
Yes	1 (0.6)
No	160 (99.4)
Age at first pregnancy (yrs) (n=159)	
≤19	40 (24.8)
20–30	115 (71.4)
31–40	3 (1.9)
>40	1 (0.6)
Unknown	2 (1.3)
Mean ± SD	21.2 ± 3.9
Median	20.0
Delivery of the index child[§] (n=174)	
Delivery at a health care centre	15 (90.9)
Delivery at home	159 (9.1)
Number of pregnancies (n=161)	
Minimum	1
Maximum	10
Median	44
Number of miscarriages (n=161)	
Minimum	0
Maximum	3
Median	0
Number of still births (n=161)	
Minimum	0
Maximum	6
Median	0
Number of live births (n=161)	
Minimum	1
Maximum	10
Median	44
Total number of live children (n=161)	
Minimum	1
Maximum	8
Median	4
Ever been diagnosed with anemia by a health professional (n=149)	
Yes	41 (27.5)
No	108 (72.5)
Last episode of malaria infection (n=161)	
Less than a week ago	3 (1.9)
Longer than 2 weeks ago	2 (1.2)
Longer than a month	12 (7.5)
Longer than two months ago	5 (3.1)
Longer than three months	29 (18.0)
Do not remember	39 (24.2)
Never	71 (44.1)
How the malaria episode was treated it (n=49)	
Used OTC medicine	20 (40.8)
Used prescribed drugs	27 (55.1)
Used a herbal treatment	2 (4.1)

Had been sick in the two weeks prior to the study (n=161)	
Yes	34 (21.1)
No	127 (78.9)
Symptoms experienced (n=32)	
Fever	13 (39.4)
Headache	5 (3.1)
Gastro-intestinal symptom	9 (28.1)
Hypertension	1 (0.6)
Chest pains	1 (0.6)
Body pains	1 (0.6)
Boils	1 (0.6)
Cold	1 (0.6)
BMI (kg/m^2) ¥ (n=159)	
Underweight (<18.5)	16 (10.0)
Normal (18.5-24.99)	125 (78.6)
Overweight (25.0 – 29.99)	14 (8.8)
Obese Class 1 (30.0-39.99)	4 (2.5)
Mean BMI ± SD	21.8 ± 3.0
Mean height (m) ± SD	1.6 ± 0.1
Mean weight (kg) ± SD	55.1 ± 8.8

#JSS= Junior secondary school, SSS=Senior secondary school,

§Index child (ren) refers to child (ren) included in this study

¥BMI= Body mass index.

6.4.2 Medical and menstrual histories

The mean age of menarche was 14 years; although a fifth of the mothers could not remember (Table 6.1). More than a quarter (26.9%) of the women reported that they had been previously diagnosed with anemia by a medical doctor. Sixty percent of the mothers were lactating at the time of the interview, and had not had a menstrual period since their last delivery; another 31.7% of the mothers had their last menstruation two to three weeks prior to the day of the interview. The women reported changing their pads a mean of twice per day and only 9% reported changing it during the night. Most mothers (76.8%) indicated that they used five or fewer pads per menstrual period. About half (46.9%) reported passing blood clots; 6.3% reported clots of up to 1 cm radius and 0.6% reported bigger clots. Most (79.8%) reported that menstruation lasted four to seven days, and 5.1% longer than seven days.

6.4.3 BMI

Based on BMI, most mothers (78.6%) were normal weight. Around 10% were underweight and 11.3% were overweight or obese (class 1) (Table 6.1).

6.4.4 KAP scores

Regarding knowledge on measures to prevent ID/IDA, the mothers scored a median of four out of nine; regarding knowledge on sources of iron and enhancers of iron absorption, they scored a median of three out of seven; regarding knowledge on risk factors for ID they scored a median of five out of nine; and regarding knowledge of symptoms of anemia, they scored a median of four out of seven (Table 6.2). The added individual scores and the distributions thereof are illustrated in Figure 6.1. In response to ten statements assessing attitudes, the median score was seven. Overall, 7.5% of the mothers either chose only attitudes that promote ID, or did not know how they felt about the list of actions. The distribution of the total attitude scores is illustrated in Figure 6.1. From the list of five practices which prevents ID, about one third of the mothers reported that they practiced only one or two of the listed positive actions (Figure 6.1). Only 3% of the mothers reported practicing all five preventive actions. The median score was three out of five. Total scores on knowledge regarding risk factors for ID was significantly, and inversely, association with the mothers' level of education (p=0.006); as well as the mother ever being diagnosed with anemia by a doctor (p=0.009). No significant associations were found between KAP scores and the ages at menarche, marriage, or first pregnancy; or number of live births.

Table 6.2: Knowledge, attitudes and practices regarding ID/anemia (N=161)

Item[#]			Selected the correct / protective answer: n (%)
Knowledge on measures to prevent ID[§]:			
Do the following actions help to prevent ID/anemia?(Identifying protective actions)			
De-worming			147 (91.3)
Taking iron supplements			154 (95.7)
Drinking fruit juice with food			152 (94.4)
Regular weighing (growth monitoring) of a child			13 (8.1)
Circumcising a baby boy			48 (29.8)
Shaving of a baby's hair			40 (24.8)
Drinking tea with meals			20 (12.4)
Eating eggs			117 (72.7)
Drinking a lot of milk			35 (21.7)
Knowledge of good iron sources and enhancers of iron absorption			
Which food is better choice to prevent anaemia in each pair?			
Meat	Versus	*Vegetables*	15 (9.3)
Orange	Versus	*Mango*	100 (62.1)

Spinach	Versus	*Okra*	6 (3.7)
Maize	Versus	Meat	84 (52.2)
Red meat	Versus	*Chicken*	91 (56.5)
Meat	Versus	*Milk*	43 (26.7)
Liver	Versus	*Bread*	111 (68.9)
Knowledge of risk factors of ID			
Does the following increase the risk of / cause ID/anemia?			
Standing for long hours			16 (9.9)
Poor nutrition			136 (84.5)
Bleeding			141 (87.6)
Pregnancy			142 (88.2)
Multiple pregnancies			138 (85.7)
Age at pregnancy			134 (83.2)
Spacing of pregnancies			41 (25.5)
The use of an intra-uterine device (IUD)			14 (8.7)
Being an adolescent girl			32 (19.9)
Knowledge of symptoms ID			
Are the following symptoms of anemia?			
Tiredness			104 (64.6)
Obesity			53 (32.9)
Rashes			88 (54.7)
General weakness			118 (73.3)
Dizziness			130 (80.7)
Hair loss			62 (38.5)
Headaches			75 (46.6)
Attitudes towards behaviour related to ID			**Selected the protective attitude: n (%)**
Does the mother approve of the following?			
Taking iron supplements			146 (90.7)
Getting married young (before 16 years old)			122 (75.8)
Having many babies			77 (47.8)
Having babies before 20 years old			112 (69.6)
Using an IUD			103 (64.0)
Drinking tea with meals			59 (36.6)
Taking supplements with milk and tea			145 (90.1)
Taking supplements after eating			144 (89.4)
Giving birth every year			103 (64.0)
Practices of ID preventive measures			**Selected a protective practice: n (%)**
Is the mother practicing any of the following?			
Drinks milk with meals or within an hour before or after meals			36 (22.4)
Drinks tea during meals			94 (58.4)
Has and is using a mosquito net			113(70.2)
Has been de-wormed within the last three months prior to the survey			61(37.9)
Currently uses an iron supplement			76 (47.2)

Incorrect or risk statements are shown in italics

§Some missing values occurred were this section was skipped in 12 of the questionnaires.

6.4.5 Self-reported ideas regarding cause, signs and symptoms and prevention of anemia

Asked to relate any additional knowledge regarding cause, signs and symptoms and prevention of anemia (Table 6.3), the mothers revealed a variety of misconceptions and half-truths. About half of the mothers indicated that they learned what they knew about anemia from health professionals, family, community or radio/TV; while the rest indicated that they just ‘knew’ it by themselves. Further self-reported ideas on anemia included that anemia was caused by stress, a dirty environment, hard work, and the will of God.

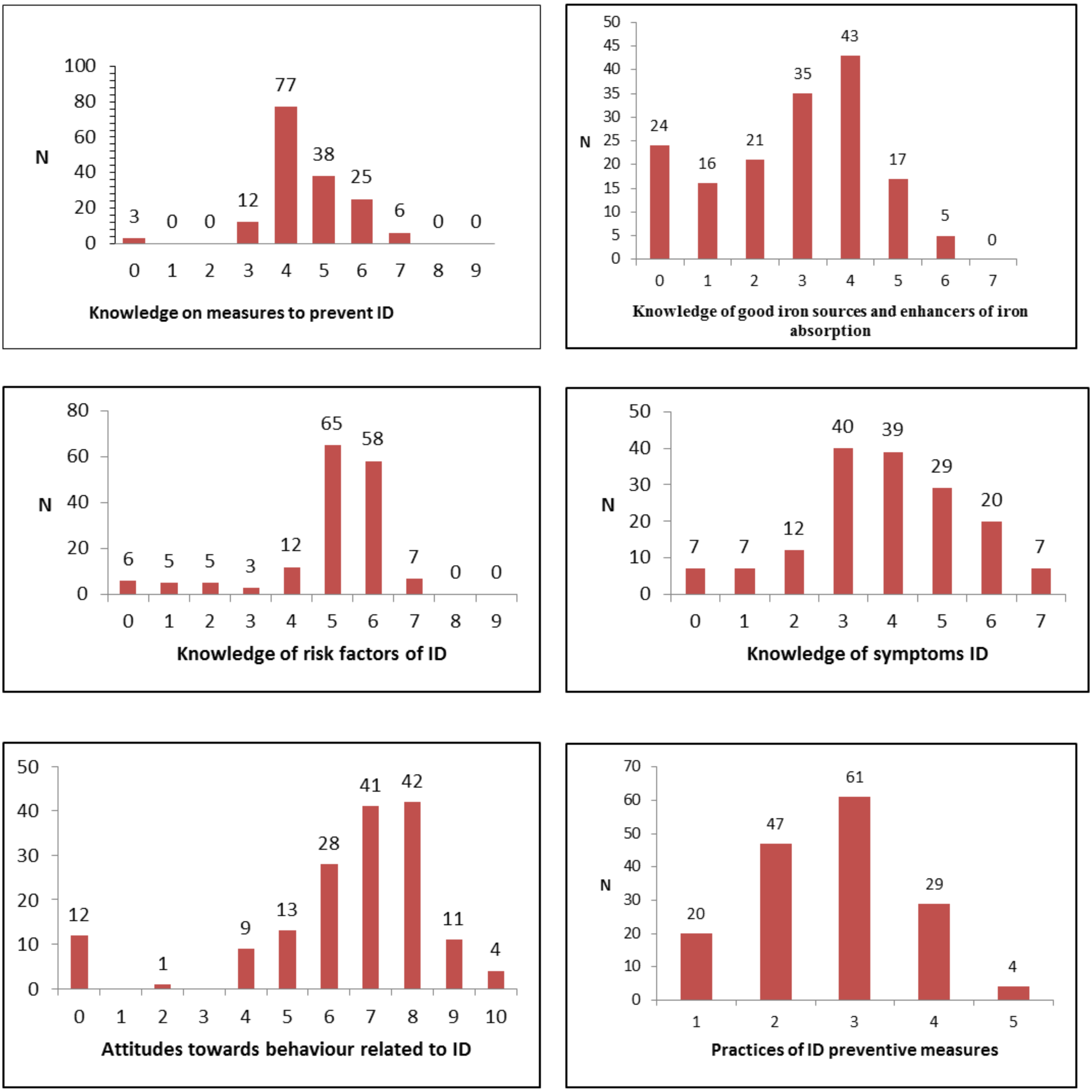

Figure 6.1: Scores for knowledge, attitudes and practices regarding ID, anemia and associated risk factors (the horizontal scale point indicates the number of items for each section, and represents the maximum possible score)

Table 6.3: Statements of mothers in response to open ended questions regarding cause, signs and symptoms and prevention of anemia. (n=148)

"What else do you know about anemia that was not mentioned in the questionnaire?"	**Response n (%)**
I know nothing else about anaemia (other than what was mentioned in the questionnaire)	83 (51.6)
Causes of Anaemia	
"When people do not eat enough iron rich foods they can get anaemia"	27 (18.2)
"Cuts/injury can cause anaemia"	2 (1.4)
"Pregnant/lactating mothers are vulnerable to anaemia"	2 (1.4)
"Hard work can cause anaemia"	2 (1.4)
"Stress causes anaemia"	3 (2.0)
"Sickness (fever) causes anaemia"	1 (0.7)
"Standing in the sun for long hours can cause anaemia"	2 (1.4)
"Regular visit to the clinic will help reduce anaemia"	2 (1.3)
"Anaemia is God's will"	1 (0.7)
Signs and Symptoms	
"One of the signs of anaemia is paleness"	2 (1.4)
"One of the signs of anaemia is dizziness"	8 (5.4)
"One of the signs of anaemia is tiredness"	3 (2.0)
"Keeping the environment clean can prevent anaemia"	1 (0.7)
"One can die due to anaemia"	2 (1.4)
"Oedema is a sign of anaemia"	1 (0.7)
"Itching body is a sign of anaemia"	1 (0.7)
Prevention	
"Green leafy vegetables prevent anaemia"	1 (0.7)
"Transfusion in the hospital helps anaemia patients"	1 (0.7)
"When someone gets malaria, he/she can get anaemia"	2 (1.4)
"A mixture of Malta (a non-alcoholic drink made from malt) and milk prevents anaemia"	1 (0.7)
#Where did you learn what you know about anemia?	
I know it myself	83 (51.6)
Health professional	76 (47.2)
Family member	11 (6.8)
Radio	3 (1.9)
TV	2 (1.2)

Note: Statements in italics are half-truths or inaccurate perceptions

Question was a multi-choice and the percentage of each response was calculated from the total (N=161); thus total percentages for question will be above 100%.

6.4.6 Additional KAP related to anemia/ID

Asked who they thought were vulnerable to anemia (Table 6.4); 5.7 % chose adult men, 2.5% adolescent boys, 8.2% menopausal women, and 20.3% adolescent girls, while the rest (63.3%) chose 'I don't know'. To an open ended question probing the reason for their choices, statements included that adult men were vulnerable to anemia because they 'sit in one place', or that they 'walk in the sun for long hours', while adolescence boys 'work hard' which make them vulnerable to anemia.

Only seven mothers indicated food totems for children, these being pork (forbidden for religious reasons), fish and eggs (both believed to cause a child to become a thief), cowpea (believed to cause malaria), and cashew nuts (made the children sick). For mothers, dog meat and pork were forbidden for religious reasons.

Of the mothers 25.3% thought that red meat, 53.3% that fish, and 36.0% that chicken was too expensive to buy; and 46.7% thought that vegetables, and 38.6% that fruits were too expensive. The main cooking utensil was an iron cooking pot, used by 98.8% of the mothers and the major cooking method was boiling (89.9%). Vegetables were mostly washed and boiled or par-boiled. Fish was usually smoked to preserve it. Local beer, typically brewed in iron pots, contributes to iron intake, but were not prepared or consumed in these Muslim communities.

One in four mothers (25.5%) and one in three children (31.6%) did not have treated mosquito nets; while 14.4% of the mothers and 18.5% of the children who did have treated mosquito nets, did not sleep in them. Reasons given for non-use included 'there are no mosquitoes', 'the weather was warm' or that their mosquito nets were torn.

Table 6.4 Statements of mothers in response to additional multiple choice and open-ended questions related to ID/anemia

Questions and response statements	n (%)[#]
Who is vulnerable to anemia? (n=161)	
Adult men	9 (5.6)
Adolescent boys	4 (2.5)
Women who have stopped menses	13 (8.1)
Adolescent girls	32 (19.9)
Don't know	100 (62.1)
***Why*?**	
Women give birth	4 (2.5)
Girls menstruate	1 (0.6)
Menopausal women, because they are old	6 (3.7)
Adult men walk in the sun for long	2 (1.2)
Adult men usually sit at one place	1 (0.6)
Adult men stress themselves	2 (1.2)
Adolescent boys work hard	3 (1.9)
Sickness	5 (3.1)

Poor nutrition	2 (1.2)
Don't know	33 (20.5)
Do you drink tea during meals?(n=161)	
Yes	65 (40.4)
When do mothers usually drink tea?	
Early mornings	60 (37.3)
When she has money	6 (3.7)
Occasionally	1 (0.6)
When the mother delivers	2 (1.2)
Do you drink milk?	
Yes	120 (77.0)
When do you usually drink milk?	
During meals	24 (14.9)
Within an hour before/after meals	48 (29.8)
More than an hour before and after meals	36 (22.4)
Occasionally	6 (3.7)
When she has money	6 (3.7)
In the morning	2 (1.2)
Do you have a mosquito net?(n=161)	
Yes	120 (74.5)
If you have it, do you use it?(n=120)	
Yes	113 (94.2)
If you do not use it, why not?	
There are no mosquitoes	1 (0.8)
The weather is too warm	3 (2.7)
The net is torn	3 (2.7)
Does your child(ren), 6-59 months, have mosquito net(s) (n=175)	
Yes	119 (68.0)
If he/she/they have it, do they use it?(n=119)	
Yes	114 (95.7)
If he/she/they does not use net, why not?	
There are no mosquitoes	3 (2.6)
The weather is warm	2 (1.8)
The net is torn	2 (1.8)
What types of cooking utensils do you use for cooking?	
Stainless steel pots	2 (1.2)
Iron pots	159 (98.7)
What cooking method do you mostly use?	
Boiling	143 (88.8)
Smoking	2 (1.2)
Frying	13 (8.1)
Drying on the floor	1 (0.6)
Do you drink home brewed beer?	
No	159 (98.7)

6.5 Discussion

Even though the sample size of 161 was relatively small, this was the first study to explore the knowledge, attitudes and practices which may contribute to ID in Ghana. This study among mothers with children six to 59 months, in an area of Northern Ghana where anemia is a serious public health problem, identified several socio-demographic risk factors, knowledge deficits and various attitudes, practices, and misperceptions which may contribute to the burden of ID and anemia in this area, and which may be addressed by NEPs.

Millennium Development Goal (MDG) 1 aims to eradicate extreme hunger and poverty (ICF Macro, 2010). Good health and increased productivity are required for economic development to take place (Kalassebaum *et al*., 2014). Since anemia negatively affects productivity and income levels (Bunn, 2011; Lozoff *et al*., 2006), this MDG will not be achieved while anemia rates remain high, as is the case in the rural Northern regions of Ghana where this study was conducted. Anemia, if not addressed, may also contribute to increased mortality rates, which is an important indicator of the MDG 5 aimed at improving maternal health. Thus, improving maternal health by addressing anemia may contribute to the previously set goal of reducing maternal mortality by three quarters, between 1990 and 2015 (ICF Macro, 2010).

The socio-demographic characteristics of these mothers in rural Northern Ghana are typical of mothers in many rural farming communities in Africa and other developing countries (Heubach *et al*., 2011; Kamanga *et al*., 2009). The main source of income and food in this setting was subsistent farming from crops, which is seasonal in this area, and livestock; so that household income is not stable all year round. Inadequate incomes were reflected in the mothers' responses that the good iron sources such as meat, fish and vegetables, as well as fruits as sources of vitamin C, which enhances iron absorption (Hurrell & Egli, 2010; Fairweather-Tait, 2004), was too expensive for them.

Nine out of ten mothers in this study population had no formal education. In Ghana, children of mothers with little or no formal education (Abu *et al*., 2010; GDHS, 2008), and mothers who suffer from anemia were found to be most at risk for anemia (GDHS, 2003). A significant inverse association was also found between the mothers' level of education and their knowledge score on the risk factors for ID, but not their knowledge on the symptoms or preventive measures.

The rural mothers in this study reported having experienced menarche at a mean age of 14, which is higher than in developed countries (Thomas *et al*., 2001; Garnier *et al*., 2005). This was also seen in a longitudinal study in Senegal among rural adolescent girls, where menarche was seen to occur at a median age of 15.9 years. While later menarche is related to genetic and environmental factors, including poor nutrition, delayed growth and development (Karapanou & Papadimitriou, 2010) and increased energy expenditure (Thomas *et al*., 2001), it also delays the onset of menstrual blood and related iron losses.

Most women were married and had their first child in their late teens to early twenties, used no contraception, and had a median of four pregnancies; all factors associated with increased risk for ID and IDA (Agarwal, 2010). Pregnancy at an early age, and a high number of pregnancies pose increased nutrient requirements on mothers when development may still not be complete (Black *et al*., 2008). Contraceptives which manipulate the menstrual cycle stop or reduce menstrual flow in order to reduce iron losses (Herceberg *et al*., 2001; Milman *et al*., 1993). Some brands of oral contraceptive pills are also used to supplement iron, such as the Leostrin 24 Fe and Minastrin 24 Fe; in these the pills to be taken for the last seven days of the 28 menstrual cycles (usually brown in colour and called the "reminder pills") contain iron. Almost 50% of mothers reported the discharge of blood clots during menstruation and 9% reported having to change sanitary pads during the night. These are signs of heavy bleeding which require adequate iron repletion (Black *et al*., 2008).

Anemia may result in miscarriages, preterm deliveries and still births (Allen, 2000). In this study, the mean gestational age of 36 ± 0.8 months indicates that many mothers may be having preterm deliveries. Even though the median number of both miscarriages and still births was zero, maximums of three and six cases respectively were reported, thus indicating high risk and a possible consequence of anemia/ID. Most of these mothers delivered the index children at home (Table 6.1), without access to skilled medical assistance (doctor, nurse, community health personnel, midwife or auxiliary midwife) to address possible complications. The development of IDA is in stages, and persistent inadequate intake of iron with concomitant iron loss may cause progression from ID without anemia to the stage of IDA. A quarter of the mothers reported having been previously diagnosed with anemia, indicating that even more mothers may be suffering from different levels of ID states (GDHS, 2008; Maclean *et al*., 2007: Asobayire *et al*., 2001). Taken together, these factors may reduce chances of achieving the second indicator used to monitor progress for millennium development goal (MDG) 5, namely improving maternal health which is measured by the number of mothers with access to reproductive health by 2015 (ICF Macro, 2010).

In this study population, the mothers achieved relatively poor knowledge scores regarding preventive measures and risk factors for symptoms of ID and anemia, as well as food sources of iron and iron absorption enhancers; and showed only middle-range scores for having positive attitudes, as well as practices that may protect against ID/anemia. Scores on practices of ID preventive actions were also moderate; these included sleeping in mosquito treated nets, and avoiding drinking tea and milk with meals which may lower iron absorption. Peoples' food choices and preferences are influenced by biologically determined behavioural predispositions, experience with food, personal factors and environmental factors (Contento, 2008; Birch, 1999). The health belief model holds the existence of sufficient motivation for change to occur; thus one needs to be convinced that one is susceptible or vulnerable to a serious illness, and that a change in health behaviour in accordance to recommendations will be beneficial, albeit at a reasonable cost (Becker & Rosenstock, 1987). This therefore implies that the mothers should be aware of the risk factors and preventive measures to enable them to take actions to prevent ID. The mostly average or below average scores achieved for attitudes and practices in the current study, indicate that the mothers did not know that they were themselves vulnerable to ID.

Because behaviour in individuals occurs in the society in which they live, it is important to consider the setting of the target community in order to influence change in behaviour (Snetselaar, 2008). In this study population, many half-truths, misperceptions and myths about anemia were reported in open-ended questions. About half indicated that their primary source of knowledge on anemia was health care workers, while the rest ‘just knew it’ or learned about anemia from family and the community. Mothers may have misunderstood information given by health professionals. Though health workers are trained in providing health care, studies show that they may not always have adequate and accurate knowledge regarding nutrition (van den Berg *et al*., 2012). The main contacts of these mothers are with community health nurses who, among other services, impacts on child health (Pence *et al*., 2007). The workload and the broad nature of the health needs of communities, may affect the quality of care, including nutrition education which they deliver. Typically contact times with community health nurses are characterised by community education, with little allowance for individualized contact (Lehmann & Sanders, 2007). It would have been expected that at least those mothers who previously had been diagnosed with ID/anemia by the health care system, would have been educated on the risk and preventive measures which should have translated to improved practices. Though the information on previous diagnosis was self-reported in this study population, and the time since diagnoses was not known, it may indicate that patient counselling was neglected by treating doctors, forgotten or not well understood by the mothers.

The scientific method postulates that one’s mental processes are influenced by one’s environment and social interactions (Contento, 2008). The influences of one’s culture, the family, partner or colleagues are important and should be considered when advocating for social change (Snetselaar, 2008). In this study, reported food totems included meat, fish, eggs and cowpea, all of which are excellent sources of iron and cashew a good source of vitamin C, which is an iron absorption enhancer. Consistent inadequate intake due to these beliefs could significantly contribute to the prevalence of ID and anemia in the community. Furthermore, typical eating habits among these mothers included drinking tea and milk with meals or within an hour of meals, which may significantly reduce the bioavailability of iron from the meal (Ogilvie, 2010; WHO, 2001). Test statements regarding their attitudes on these aspects, indicated gaps that may be addressed through NEPs.

Environmental factors are very important in promoting healthy eating habits, and decision makers should increase the availability and affordability of healthy food options (Contento, 2008; Snetselaar, 2008: Institute of Medicine, 2002). The lack of safe drinking water in the community could promote gastrointestinal infections, and contamination with parasites and other disease-causing pathogens which may contribute to anemia prevalence. It was observed that water was not treated before drinking; even for young children who are most vulnerable to infections. Indeed, one in five mothers reported having experienced some symptoms of ill health in the two weeks prior to data-collection, mostly fever, and gastro-intestinal symptoms. Studies have shown that periodic deworming reduced anemia and contribute to improved growth and increased absorption of vitamin A (Alderman & Horton, 2007). Despite the known benefits of deworming, only about 40% of mothers in this community were dewormed within the three months prior to the study. Deworming with anti-helminthic for at least twice a year is recommended as part of the ongoing national program by the Ghana Health Service (GHS, USAID & MOST, 2003). One out of ten mothers however, did not know that deworming was a preventive action against ID/anemia (Table 2). The inadequate knowledge regarding the importance of deworming may be the reason most mothers were not being dewormed even though the deworming medication was observed to be sold in the communities at three to five cedis which is equivalent to one to two USD, an amount which is affordable within the community.

Malaria is another environmental factor that may lead to ID due to increased intravascular hemolysis of the red blood cells; as well as the effects of malaria symptoms, including vomiting, general weakness and loss of appetite that may lead to reduced food intake (WHO, 2006; Lew *et al.*, 2003). In addition, the cost of treatment further reduces household income which could have been used to improve household food security (McIntyre *et al.*, 2006; Mutabingwa, 2005). A multi-dimensional approach to reduce breeding of mosquitoes through sanitation programs, and prevent contact between mosquitoes and people by the use of mosquito nets, reduces malaria episodes and improves general health (Lindsay *et al.*, 2004). Treated nets are distributed by non-governmental organizations working to reduce malaria. In the study area, though a third of the mothers in this study population reported previous episodes of malaria, a quarter of the mothers and a third of the index children, did not have treated nets. Also, about 5% of the mothers who reported that they possessed a treated net were not using it because they did not think there were mosquitos, the weather was too hot, or that the nets were torn. Studies have reported that people targeted by anti-malaria programs often refuse to replace torn nets with their own money (Baume & Franca-Koh, 2011; Pulford *et al*., 2011; Birch, 1999).

Research indicates that targeted education which addresses the specific health needs of the community needs to be incorporated into the current health delivery system (Contento, 2008; Sahyoun *et al*., 2004).

6.6 Limitations

A quantitative approach was used in this study to lay the foundation for follow up evaluation of the effect of a NEP; however qualitative methods may have helped to gain a deeper understanding of the feelings and sentiments regarding ID/anemia. Recall bias may have been introduced in some instances, particularly on questions that depended on memory.

6.7 Conclusions and recommendations

This study was conducted among mothers of children six to 59 months, in a region with low socio-economic security and low levels of education, where anemia and ID has been identified as a serious public health problem. The findings indicate that, although the mothers had some knowledge regarding the prevention, causes, signs and symptoms of ID; many half-truths, myths and totally inaccurate information, mostly associated with the intake of milk, eggs, tea and birth control, and risk factors for ID, was apparent. The frequencies of inaccurate answers or “do not know” answers were high. Various attitudes and practices that may further put WRA and young children at risk for ID and anemia were also identified. The Tamil Nadu Integrated Nutrition Project in India indicated that an emphasis on NEPs is likely to influence nutrition-related KAP to such an extent that the need for intervention can be significantly reduced (WHO, 2006; Balachander, 1991). Education targeting the gaps identified in this baseline study may therefore empower mothers with more accurate information on the causes and prevention of anemia/ID, which may influence knowledge and attitudes to an extent that practices may change. If successful, such a NEP may be used to reduce the need for more costly intervention and treatment of IDA in similar high risk areas.

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CHAPTER 7

PICA PRACTICES AMONG WOMEN AND THEIR CHILDREN 6-59 MONTHS IN NORTHERN GHANA.

This section of the research was presented at **the Maternal and Infant Nutrition and Nurture (MAINN) Conference,** June, 2012; Grange over Sands, United Kingdom.

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7 PICA PRACTICES AMONG WOMEN AND THEIR CHILDREN 6-59 MONTHS IN NORTHERN GHANA.

7.1 Abstract

Background: Pica, an increased appetite/craving for food or non-food substances like clay, and chalk, is strongly associated with iron deficiency (ID) anemia. This study assessed pica practices among non-pregnant mothers and their children, six to 59 months, in an anaemia endemic population.

Subjects and methods: A cross-sectional quantitative descriptive survey conducted in two randomly selected districts in the Northern Region of Ghana was performed. Semi-structured questionnaires developed by the researchers with components on pica practice and experiences, were administered via structured interviews with mothers (N=161) of children aged 6-59 months (N=175), in April 2012. Data was analysed using SAS/STAT software, Version 9.3 of the SAS system for Windows (Copyright © 2010 SAS Institute Inc).

Results: Mothers spontaneously reported that pica (for food and/or non-food substances) was practised at the time of the interview by 4% while in 27 (16.8%) pica was confirmed after further probing. Pica practice among children was reported by their mothers in 9% at the time of the interview in the form of ingesting clay 4 (28.6%), soil 9 (64.3%), dust 2 (14.3), paper 1 (7.1%) and chalk 1 (7.1%). Pica was reported to have been practised by expecting mothers during 51 (30%) of the pregnancies of the children involved in the study, and was mostly for clay/soil 32 (65.3) and kola nut 8 (16.3%) and in some instances uncooked rice and bambara beans. A child's pica practice was significantly associated (p=0.005) with his/her mother's pica practice when she was expecting him/her. Many myths were associated with the practice of pica.

Conclusions: The observed pica practices among mothers and their children were lower than what has been observed in other studies; however knowedge and perceptions regarding pica

were mostly inaccurate. Education on pica and associated dangers of its practices should be included in nutrition interventions in communities with known high anemia prevalence.

Key words: Iron deficiency, pica practices, mothers, children, Northern Ghana

7.2 Introduction

Pica is defined as the craving for, and compulsive intake of non-food substances, and sometimes an enhanced craving for, or ingestion of, food substances (Louw *et al*., 2007). Globally, pica has been reported in many countries, among men, children, pregnant and non-pregnant women alike (Young, 2010). In Africa, the common occurrence of pica has been documented, amongst others, in Tanzania (Kawai *et al*., 2009; Antelman *et al*., 2000), Kenya (Luoba *et al.*, 2004), South Africa (Louw *et al.*, 2007), Botswana (Ekosse & Anyangwe, 2012) and Namibia (Thomson, 1997). In addition to being commonly associated with pregnancy, pica also occurs with certain mental and psychiatric conditions (Williams & McAdam, 2012; Mensah *et al*., 2010), as well as in both adults and children with iron deficiency anemia (IDA).

IDA is the most common cause of anemia, particularly among women and children. While contributing to more than 50% of the global burden of anemia (WHO, 2001), it disproportionately affects Africa and Asia (Kassebaum *et al*., 2010). In the northern region of Ghana, anemia occurs among more than 80% of children, six to 59 months, and among almost 60% of women of reproductive age (WRA) (GDHS, 2008). Since studies have suggested that, when the overall anemia prevalence in a population exceeds 40%, various degrees of iron deficiency (ID) may be assumed among the entire population (Maclean *et al*., 2007; Asobayire *et al*., 2001), high prevalence of ID and IDA may be assumed in these parts of Ghana.

IDA is preceded by a period of depletion of the iron stores which only manifests as anemia with clinical symptoms when iron stores can no longer support adequate red blood cell production (Janz & Hamilton, 2014). The absence of obvious symptoms during the earlier phases of ID therefore earns it the name "hidden hunger" (Kennedy *et al*., 2003). Subjects who suffer from ID often have an increased appetite for food or non-food substances like clay, paste, ice, paint and chalk, even though these substances may not contain iron at all, and so may not remedy their ID. The mechanisms responsible for linking pica and ID are not clear, but the strong association (Miao *et al*., 2015; Barton, 2010; Adam *et al*., 2005; Antelman *et al*., 2000) nevertheless suggests that pica may be used as a marker for ID. Particularly in regions with poor access to quality healthcare, pica could be useful as an early warning sign of possible ID (Louw *et al*., 2007), thus increasing the surveillance, identification and treatment of ID in underdeveloped areas in countries with high anaemia risk.

The only study reporting on pica in the general population in Ghana was performed over 40 years ago among the Ewe ethnic group. This study reported geophagia, which refers to pica for clay, sand and soil, among 14% of men, 46% of non- pregnant women, and 63% of pregnant women (Vermeer, 1971). Most studies to date in Ghana reported on the association between pica and pregnancy (Mensah *et al*., 2010). Processed white clay is commonly used as a pica substance by 25% (Mensah *et al*., 2010) to 28% (Tayie & Lartey, 1999) of pregnant women in Ghana. This form of geophagia may not be entirely safe, as Coliform bacteria, Staphylococcus species, and yeasts have been isolated from the external surfaces of white clay in Ghana (Tano-Debrah & Bruce-Baiden, 2010). Furthermore, geophagia has also been associated with complications such as lead and mercury poisoning, dental injury, hyperkalemia, hypokalemia and abdominal problems which may require surgery (Federman *et al*., 1997).

Very little is currently known about pica practices among non-pregnant women and young children in Ghana, or other developing countries. Given the high prevalence of anemia among these communities in Northern Ghana (GDHS, 2008); the possibly associated high prevalence of ID (Asobayire *et al*., 2001); and the strong relationship between ID and pica practice; the current study sought to explore pica practices among children, six to 59 months, and their mothers in this area. The study focussed on recording current practices among the mothers and children; the history of pica among the mothers during pregnancy with the index child (ren); as well as the perceptions of the mothers, and that of their community, regarding pica practices and the people who practise it. We believe that the findings of this study may provide indicators of ID for public health workers in the area, as well as baseline information from which education programs and antenatal care (ANC) messages may be developed.

7.3 Methods

7.3.1 Study design, population and sampling

A quantitative descriptive survey was conducted in April 2012, in the northern and largest region of Ghana, in two randomly selected districts, namely Tolon-Kumbumgu district and Tamale metropolis. One community was randomly selected from within each of these two districts. In these two communities, randomly selected households were approached and all mothers who had lived in the selected community for at least 12 months; were not pregnant; and had one or more children aged six to 59 months (henceforth referred to as the index child(ren), were invited to participate in the study. Mothers who voluntarily agreed to participate signed an informed consent form, after the study procedures had been explained to them. The final sample included 161 mothers; 81 from the Tolon-Kumbumgu district and 80 from Tamale metropolis. A sample of 161 was chosen in order to effectively engage mothers in a longitudinal study on NEP program regarding ID and anemia. It was approximated that two communities of households, of 80 each, would be the limit in terms of cost-effectiveness for the study and intervention, while still allowing for some attrition during follow-up.

The study was approved by the institutional review boards of Noguchi Memorial Institute of Medical Research (NMIMR), Ghana (NMIMR-IRB CPN 064/11-12) and the Ethics Committee of the Faculty of Health Sciences, University of the Free State, South Africa (ECUFS NR 24/2012). To confirm voluntary participation, mothers signed an informed consent form. Children (six to 59 months) were only subjected to the study procedures if they were willing to comply, thereby implicating assent.

7.3.2 Data collection

The researchers developed a questionnaire based on an in-depth review of the literature on pica practices and ID/IDA. This questionnaire was administered during structured interviews with the mothers. Data on socio-demographic characteristics of the mothers and the index child(ren), including age, gender, ethnicity, level of education, marital and employment status; and childcare, access to electricity and cooling facilities were collected. Weight and height/length of the mothers and index child (ren) were measured to assess levels of body fatness in the mothers and growth status in the children. Weight was determined with an electronic scale according to the standard procedures, and recorded to the nearest 0.1kg. Height was determined by means of a mobile tape (Microtoise) to the nearest 0.1 cm. Body mass index (BMI) in kg/m^2 of the mothers were calculated using weight (kg)/height (m^2) (Gibson, 2005).

Mothers and the index children were assessed for angular stomatitis, atrophic glossitis and koilonychias, as possible physical signs of IDA.

Current pica practices of the mother and her index child (ren), as well as of the mother during the pregnancy with the index child (ren), were assessed by asking the mother if there were any uncommon food or non-food substances that she and/or the index child (ren) ate or craved. After noting her spontaneous responses, the mothers were further probed using a list of substances known from the literature to be associated with pica. For mothers and children who were practicing pica, the frequency and quantities of consumption of the relevant substances, as well as the symptoms and/or emotions that the mothers associated with these cravings in her and the index children, were also recorded using a combination of open-ended and multiple choice questions. The perceptions of the mothers regarding the causes and treatment options for pica, as well as how she thought the community viewed pica, and the people who practise it, were also explored with open-ended questions.

7.3.3 Data analysis

Content analysis was done on open-ended questions. Responses were categorized into themes and then further analysed into frequencies. Anthropometry was expressed as body mass index (BMI) for the mothers and Z-scores for weight-for-age, height-for-age and weight-for-height for the index children; and categorized according to WHO guidelines (WHO, 1995; Gibson, 2005; WHO, 2006). The data was analysed using SAS/STAT software, Version 9.3 of the SAS system for Windows (Copyright © 2010 SAS Institute Inc). Categorical data was expressed as frequencies and percentages and continuous data as medians, means and standard deviations. Fisher exact tests were used to test for associations between variables and $p<0.05$ was considered significant.

7.4 Results

7.4.1 Socio-demographic characteristics (Table 7.1)

Of the 161 mothers in the survey, 147 (91.3%) had only one child between six and 59 months, and 14 (8.7%) had two children in this age bracket (total of 175 index children) (Table 7.1). Of the index children, 54.5 were female. The date of birth of eight of the children could not be determined; for the remaining 167 children, the median age was 23.6 months. The median age for the mothers was 30.0 years; most (43.5%) were between 30-39 years, but 17 (10.6%) did not know their ages. Most mothers (96.3%) were from the Dagomba ethnic group and practised the Muslim religion (98.1%). Most were married (97.5%); polygamy was the norm in the community with a husband having a number of wives (between one to four wives)

Most mothers (91.9%) had never been to school. Overall, 84.5% reported earning a living through sale of food crops or livestock, and petty trading; while the remaining 15.5% perceived themselves as unemployed. Many households had access to electricity (79.2%) however only 3.7% had access to cooling facilities. Most lived in huts with thatch roofs (61.9%); iron sheeted roofs (3.8%) or a combination of both roofing types (33.7%). The huts mostly had cement floors (98.8%), while very few had tiled floors (1.2%) or mud floors (0.6%). The entire study population cooked on open fires using wood (98.7%) or charcoal (1.3%). Only 36.9% had piped water; 58.1% drew water from a river/pond; 3.1% from a borehole; and 1.9% from a well.

With regard to childcare care practices, the mothers spent an average of 6.1 hours per day away from home with work related to their subsistence farming; about a third reported leaving the index child (ren) with older siblings, and 31.1% took the child(ren) to work. More than half (61.1%) of households were headed by husbands.

Table 7.1: Socio-demography of the mothers (n=161) and their index children (six to 59 months (N=175)

Variable	**n (%)**
Mothers' ages (yrs)#	
≤ 19	2 (1.2)
20-29	38 (23.6)
30-39	70 (43.5)
40-49	28 (17.4)
>50	6 (3.7)
Unknown	17 (10.6)
Mean	33.0 ± 8.3 SD
Medium	30.0
Children's ages (mo)§	
6.00-12.00	28 (16.8)
12.01 -24.00	56 (33.5)
24.01 -36.00	38 (22.7)
36.01-48.00	33 (19.8)
49.01 -59.00	12 (7.2)
Unknown	8 (4.6)
Mean	25.7 ± 13.8 SD
Median	23.6
Children's gender	
Male	80 (45.5)
Female	95 (54.5)
Mothers' highest level of education	
None	148 (91.9)
Primary (1-6 yrs)	10 (6.2)
Junior Secondary School (7-10 yrs)	2 (1.2)
Senior Secondary School /Vocational school (11-14years)	1 (0.6)
Mothers' religion	
Christian	3 (1.9)
Muslim	158 (98.1)
Mothers' ethnicity	
Dagomba	155 (96.3)
Moshi	1 (0.6)
Hausa	1 (0.6)
Fulani	3 (1.9)
Ewe	1 (0.6)

Mothers' employment status	
Self employed	136 (84.5)
Unemployment	25 (15.5)
Household have electricity	
Yes	122 (79.2)
No	32 (20.8)
Household possess cooling facilities (n=151)	
Refrigerator / Freezer	5 (3.7)
Clay pots	125 (77.6)
Veronica container	4 (2.5)
Do not have	19 (11.8)
Care of the index child while the mother works (n=134)	
Mother takes child to work	50 (31.1)
Child goes to school	3 (1.9)
Child if left with other siblings	57 (35.4)
Child is left with other relations	10 (6.2)
Child is left with grandmother	14 (8.7)
Marital status of the mother	
Married	157 (97.5)
Single	3 (1.9)
Cohabiting	1 (0.6)
Age of the mother when she got married (yrs) (n=151)	
≤19	46 (30.5)
20-29	99 (65.5)
30-39	5 (4.0)
40-49	1 (0.7)
Mean	20.8 ± 3.7 SD
Health professional assisted delivery of study child (n=174)	
Assisted delivery	15 (9.1)
Home delivery	159 (90.1)

#yrs. = years; §mo = months

7.4.2 Anthropometry and physical signs of chronic IDA

The nutritional status based on anthropometry, of mothers and index children, are illustrated in Table 7.2. About 10% of the mothers were underweight, while another 11.3% were overweight or obese (class 1). Of the children, 47.3% were moderately to severely stunted, 38.0% moderately to severely underweight, and 17.2% moderately to severely waste. No mother or child was observed to exhibit any signs of angular stomatitis, atrophic glossitis or koilonychias.

Table 7.2: Anthropometry of mothers and their index children (six to 59 months)

Variable	n (%)
MOTHERS:	
BMI# (kg/m^{-2}) (n=159)	
Underweight (<18.5)	16 (10.0)
Normal (18.5-24.49)	125 (78.6)
Overweight (24.5 – 29.99)	14 (8.8)
Obese Class 1 (30-39.99)	4 (2.5)
INDEX CHILDREN:	
Z-score height-for-age (Stunting) (n=167)	
Over-nutrition (>2.01 SD)	1 (0.6)
Normal (-2≥ and ≤2 SD)	87 (52.1)
Moderately stunted (-2.01-3 SD)	51 (30.5)
Severely stunted (>-3.01 SD)	28 (16.8)
Z-score weight-for-age (Underweight) (n=167)	
Over-nutrition (>2. 01SD)	1 (0.6)
Normal (-2≥ and ≤ 2SD)	101 (60.5)
Moderately underweight (-2.01-3 SD)	47 (28.1)
Severely underweight (>-3.01 SD)	18 (10.8)
Z-score weight-for-height (Wasting) (n=175)	
Over-nutrition (>2.01SD)	5 (2.9)
Normal (-2≥ and ≤2SD)	140 (80.0)
Moderately wasted (-2.01-3 SD)	19 (10.9)
Severely wasted (>-3.01 SD)	11 (6.3)
Birth weight (n=175)	
Unknown (Home deliveries)	159 (90.9)
<2.5	3 (1.7)
2.5	4 (2.3)
>2.5	9 (5.1)

#BMI: Body mass index

7.4.3 Pica practices and pica history

These findings are summarised in Tables 7.3 to 7.5.

7.4.3.1 Mothers (Table 7.3)

When asked if there were any substances that they craved, only eight mothers spontaneously admitted craving kola nuts (which is a bitter caffeine-containing chestnut-sized seed of a kola tree used especially as a masticatory and in beverages) (n=5; 3.1%), clay and soil (n=3; 1.9%). Upon probing mothers further, using a list of foods commonly associated with pica, 27 mothers admitted to cravings for various non-food substances, mostly clay (n=14), soil (n=4) and dust (n=1) which is indicative of geophagia; as well as ice (n=3), uncooked rice (n=3), and uncooked corn starch (n=3). Substances that were consumed most frequently (three to seven times/week) were mostly the geophagia-related substances; mostly less than a handful at a time. A total of 16 mothers responded to an open-ended question as to what she does when she experienced these cravings and 11 indicated that they act on it by finding and eating the relevant substance.

Table 7.3: Pica practices among the mothers (n=161) at the time of data collection

SUBSTANCES CRAVED:	n (%)
Excessive appetite/ cravings (n=161) for substances spontaneously mentioned:	
Non-food substances:	
No	157 (98.1)
Yes	3 (1.9)
Substances craved *(n=3)*	
Clay	2 (66.7)
Soil	1 (33.3)
Uncommon food substances:	
No	156 (96.9)
Yes	5 (3.1)
Substances craved *(n=5)*	
Kola nut	5 (100)
Excessive appetite/ craving for items from a list of substances mentioned upon further probing (n=27)	
Ice	3 (11.1)
Dust	1 (3.7)
Soil	4 (14.8)
Clay	14 (51.9)
Uncooked corn starch	1 (3.7)
Uncooked rice	3 (11.1)
Tomatoes	1 (3.7)
REACTION TO CRAVING:	**n (%)**
What do you do when you experience cravings for these substances (n=16)	
I do not know	4 (25.0)
I look for the food and cook it	3 (18.8)
I looks for the foods substance and eat it	8 (50.0)
I do nothing about it	1 (6.3)

Note that two mothers had poly-pica.

7.4.3.2 Index children (Table 7.4)

No pica for uncommon food substances was reported for the index children, but 14 (8%) had been observed by their mothers to eat non-food substances, mostly soil and clay, followed by dust, paper and chalk. Poly-pica for more than one substance was identified in only one child. Most of these substances, particularly soil, were consumed daily.

Table 7.4: Pica practices among the index children (n=175) at the time of data collection

SUBSTANCES CRAVED	n (%)
Excessive appetite/craving for substances spontaneously mentioned by the mothers:	
Do not know	1 (0.6)
No	160 (91.6)
Yes	14 (8.0)
Types of non-food substances mothers have seen them eat (n=14)	
Soil	9 (64.3)
Clay	4 (28.6)
Dust	2 (14.3)
Paper	1 (7.1)
Chalk	1 (7.1)

* One child had poly-pica

7.4.3.3 Pica in mother during the pregnancy with the index child(ren) (Table 7.5)

Overall, 51 (29.3%) of the mothers recalled experiencing pica practice during their pregnancies with the index children. Five reported having craved uncommon foods, in the form of kola nut and uncooked rice; 46 reported geophagia ranging from occasional to daily consumption of handfuls of soil and/or clay; and 2 reported craving fairly large amounts (three deep ladles 1-2/week) of bambara beans, which is a highly nutritious legume or ground nut. Two mothers reported having experienced polypica during the pregnancy. The reported onset of pica was equally distributed over the three trimesters among these women, and 78.2% of the affected mothers indicated that pica ceased after delivery.

Table 7.5: Pica practices among the mothers (n=161) while pregnant with the index child

SUBSTANCES CRAVED	n (%)
Did the mother practise pica while pregnant with the index child (n=174)?	
No	123 (70.7)
Yes	51 (29.3)
Onset of pica during pregnancy (n=50)	
First trimester	18 (36.0)
Second Trimester	18 (36.0)
Third Trimester	14 (28.0)
Non-food substances she had craved ** (n=46)	
Clay	35 (68.6)
Soil	10 (19.6)
Sand	1 (2.0)
Uncommon food substances she had craved (n=5)	
Kola nut	4 (7.8)
Bambara beans	2 (3.9)
Uncooked rice	1 (2.0)
Substances she actually ate (n=49)	
Kola nut	8 (16.3)
Bambara beans	1 (2.0)
Uncooked rice	1 (2.0)
Clay	32 (65.3)
Soil	7 (12.2)
Sand	1 (2.0)
Did pica stop after delivery? (n=50)	
Yes	39 (78.0)
No	11 (22.0)

Cross tabulation of pica practicing in mothers and children (Table 7.6), revealed no statistically significant association between whether the mother practised pica at the time of the study, and whether the index children were practicing pica or not at the time of the study. A strong statistically significant positive association (p=0.005) was, however, found between whether or not the mothers practised pica while pregnant with the index child, and whether the index children were practicing pica or not. There was also no association between the stage of onset of pica during pregnancy, and whether the index child practised pica or not.

Table 7.6: Association between pica in the mothers while pregnant with the index child, and pica in the index children at the time of the study

# Child practicing pica	§Mothers practicing pica during pregnancy with the index child		p-value
	Yes (n=51)	No (n=122)	
Yes (n=13)	8 (15.7)	5 (1.6)	0.005*
No (n=158)	42 (82.3)	116 (95.1)	
Do not know (n=1)	0 (0.0)	1 (0.8)	

*P value is statistically significant at P<0.05

Three values are missing for child pica practice

§ Two missing values for pica history during index child pregnancy.

7.4.3.4 Reported experiences of symptoms/emotions associations with pica practices

Symptoms associated with cravings which the mothers described, and which they said went away after eating the substances, were headaches, inability to work, and teary eyes. Among children, some were reported to cry or become irritable if they did not eat the non-food substance, but were seen to be calm or played about when they were allowed to eat it.

7.4.3.5 Mothers' perceptions on the causes and treatment of pica and how their community views people that practise pica (Table 7.7)

The mothers' responses to open-ended questions to assess how well pica practice is understood and accepted among the study population and in their communities are summarised in Table 7.7. One fivth of mothers (21.0%) did not know the causes of pica; another fifth attributed pica to pregnancy (10.8 %) and hormonal changes (10.8 %). Most (56.1%) mothers, however, attributed pica to one's own personal desire, thus is merely due to a persons want to eat non-food substances.

Probing the mothers about the way the community views pica, a third (31.5%) said that they did not know. Only 2.7% thought that the community perceives pica as normal. The rest reported that the community saw pica as abnormal (3.4%), as a bad practice (1.3%), and as a sickness (7.4%) which is probably untreatable (53%). When asked what they thought the community thinks about the person who practises pica, two thirds (63.6%) said that they did not know, but the rest reported similarly negative views. When asked what they thought should be done about mothers in the community who practise pica, almost a quarter (23.3%) said that they did not know, while the rest (76.6%) indicated that steps/actions should be taken to get her to stop. Similarly, a quarter (25.4%) did not know what should be done about children in the community who practise pica, while the rest (74.6%) indicated that steps/actions should be taken to make the child stop. When asked how pica could be treated among mothers and children in the study communities, 65.8% insisted that pica cannot be treated in mothers, while a fifth (22.6%) thought that mothers can be treated by educating them about pica. Overall, 96% insisted that there was no treatment for children with pica in the community, mostly because "there is no treatment for pica" (10.5%) / "pica cannot be treated" (65.8%).

Table 7.7: Mothers' perceptions on the causes and treatment of pica and how their community views people that practice pica

RESPONSES TO OPEN ENDED QUESTIONS	n (%)
What do <u>you</u> think causes pica? (n = 148)	
I do not know	31(21.0)
Pregnancy	16(10.8)
It is due to one's own desires	83(56.1)
Hormonal changes	16(10.8)
It is due to headaches	1(0.7)
It is a form of sickness	1(0.7)
What do people in <u>your community</u> think about pica practice? (n=149)	
I do not know	47 (31.5)
They see pica as a normal practice	4 (2.7)
They see pica as an abnormal practice	5 (3.4)
They see pica as a sickness that should be sent to the hospital	11 (7.4)
They see pica as a sickness that cannot be treated	79 (53.0)
They see pica as a bad practice and would advise people who practise pica to stop	2 (1.3)
They think that children practice pica they should be caned to stop	1 (0.7)
What do people in <u>your community</u> think of the people who practise pica?(n=151)	
I do not know	96 (63.6)
Community think people who practise pica are normal	5 (3.3)
Community think it is their own personal business	9 (6.0)
Community think that pica practice is not good for people who practise it	13 (8.6)
Community people think people who practise pica are sick	25 (16.6)

Community people think people who practise pica are foolish	1 (0.7)
Community people think pica practice can kill people who practise it.	2 (1.3)
What do <u>you</u> think should be done about someone who craves non-food substances (n=53)	
Mothers	
I do not know	31 (23.3)
Tell her to limit it	4 (3.0)
She should ignore the craving	55 (42.4)
She should do away with the food / non-food substance	3 (2.3)
She should entirely	18 (13.5)
She should nothing	3 (2.3)
She should be educated	5 (3.8)
She should get a substitute/ chewing stick	2 (2.3)
She should not start all	11 (8.3)
Children	
I do not know what should be done	32 (25.4)
Beat /scare the child to stop	62 (49.2)
Train the child to stop	26 (20.6)
Give them something else edible	5 (4.0)
Children will stop when they grow	1 (0.8)
How do <u>you</u> think pica should be treated in mothers in your community? (n=146)	
I do not know	44 (30.1)
Send them to hospital	13 (8.9)
There is no treatment for pica	54 (37.0)
Educate them	33 (22.6)
It will stop after delivery	1 (0.7)
Through self-control	1 (0.7)
Are there any treatments available for children who practise pica in your community? (n=149)	
Yes	4 (2.7)
No	143 (96.0)
I do not know	2 (1.3)
If yes, explain which? (n=67)	
Do not know	8 (12.0)
There are no treatments available	7 (10.5)
It cannot be treated	44 (65.8)
Train them to stop	2 (3.0)
Send them to hospital	5 (7.5)
Through health education	1 (1.5)

n = sample that responded to questions

7.5 Discussion

This study, among a population in rural Northern Ghana, where anemia affects almost 60% of WRA, and more than 80% of pre-school children, six to 59 months old (GDHS, 2008), and high levels of ID may be assumed (Maclean *et al.*, 2007; Asobayire *et al.*, 2001), identified moderate pica practices among children in this age bracket (referred to as the index children), as well as among their mothers. Ignorance and various misperceptions regarding the causes and treatment of pica, which may be addressed by education in this area, were also documented.

Pica associated with pregnancy has been recorded in many research settings (Young, 2010), and is suspected to be particularly prevalent among populations in Africa (Nyaruhucha, 2009; Ngozi, 2008). In the current study population, almost a third (29.3%) of the mothers recalled practicing pica while being pregnant with the index child(ren). This is lower than previous studies which reported pica practices among 57.3% and 48% of pregnant women visiting antenatal clinics in Accra (Koryo-Dabrah *et al.,* 2012; Tayie & Lartey, 1999) and 47% of pregnant women in Kumasi in the south of Ghana (Mensah *et al.,* 2010). It is possible that pica practices were underreported in the current study as women often seemed reluctant to spontaneously recall non-food substances that they craved, and most only admitted to pica after being probed. The mothers were of the opinion that their communities have a very negative view of pica and the people who practise it. As an individual's behaviour is influenced by the environment in which they find themselves (Contento, 2008); they may not have been completely open about pica to avoid being viewed as 'abnormal', 'sick' with an 'untreatable' disease, and 'in need of hospitalisation'.

No current information is available on the prevalence of pica practices among non-pregnant women and young children in Ghana. In the current study, almost 17% of the non-pregnant mothers admitted after probing, that they practised pica; while 4% reported having observed their index children practices pica, mostly on a daily basis. As discussed above, mothers may have underreported these practices.

Overall, 10% of the mothers in the current study population were underweight, and 47.3% of the children suffered from moderate to severe stunting, indicating chronic malnutrition. Almost a third of children were underweight and 17.2% were wasted. Although the presence of ID/IDA was not biochemically confirmed in this study, and no physical signs of chronic IDA were observed in the participants, chronic malnutrition is strongly associated with micronutrient deficiencies, such as ID (Lawn *et al.,* 2006). During childhood, especially if the window of opportunity (the first 1000 days of life post-conception) is not harnessed, a child with ID may also grow up with ID, thus leading to chronic malnutrition and presenting clinically as stunting (Cesar *et al.,* 2008; Grantham-McGregor *et al.,* 2007). Children with low birth weights are also at increased risk of being born with ID (Collard, 2009). In the current study, however, most children (90.9%) were born at home and their birth weights were not recorded, so that this association could not be investigated.

In the current study, whether or not the index child practised pica, was significantly associated with whether or not his/her mother practised pica while pregnant with him/her. One possible explanation may be that the mother practised pica during pregnancy because she suffered from ID/anemia, since an association between pica and ID/anemia in pregnant women have been previously reported (Adam *et al.,* 2005: Antelman *et al.,* 2000). After she delivered the child, however, if the food security situation in the household did not change (Rainville, 1998), the child grows up facing the same environmental risk factors for ID, and may develop ID/IDA which may present as pica.

An additional explanation is that pica is culturally driven. The cultural component of pica has been described in various studies in different settings (Bhatia & Jaswinder, 2014; Young, 2010). Morgan (1984) described case studies involving three sisters from a community in Ghana where pica was widely practised, who, upon migrating to the United Kingdom with their parents, continued to practise pica spontaneously and independent of each other, with no pressure from their mother, even though she herself practised pica during the pregnancies with all three children; and in spite of normal blood chemistry and no developmental challenges. Clay is also used in some cultures for medicinal purposes. In South Africa clay was reported by patients to be used to “cure tiredness” (Louw *et al.,* 2007) and in Nigeria to “cure diarrhoea” (Vermeer & Ferrell, 1985). It was noted that clay was sold in shops in the various markets that the mothers in the current study access. The very high prevalence of anemia (GDHS, 2008) and assumed ID in the area where the current study population was situated (Asobayire *et al.,* 2001), however, suggest that the observed pica may be more than a culturally ‘handed down’ or medicinal practice.

Geophagia is a very prevalent form of pica among individuals with ID (Barton *et al.,* 2010). It was also the most common form of pica practised in the current study population. This concurs with previous surveys conducted in Accra, Ghana, which found clay eating among 17% (Twenefour, 1999) and 28% (Tayie & Lartey, 1995) of pregnant women. More recently, Mensah *et al*. (2010) reported that processed white clay was consumed by 25% of pregnant women in the Kumasi metropolis of Ghana. Studies do however suggest that pagophagia (pica for ice) may be even more common than geophagia among individuals with IDA (Mensah *et al.,* 2010). In a study among patients with IDA in central South Africa, Louw *et al*. (2007) observed that pagophagia was the most common form of pica among white participants, while geophagia was more common among black participants. Mokhobo (1986) similarly reported predominant geophagia among blacks with IDA in Botswana. This ethnic difference could be attributable to culture and socio-economics, while access to pica substances may also play a role (Young *et al.,* 2010). Coetzee (2011) for example, observed that people with IDA who craved ice, but did not have access to it, instead drank the coldest water available to them. In the current study population, most households drew water from rivers/ponds/boreholes/wells where clay is readily available, while only 5 (3.1%) households owned a fridge, limiting their access to ice.

The ingestion of non-food substances may not be entirely safe. Coliform bacteria, Staphylococcus species, and yeasts have been isolated from the external surfaces of white clay in Ghana (Tano-Debrah & Bruce-Baiden, 2010). In South Africa, pupils who ate soil from termite mounds were more infected with Ascaris Lumbricoides, than those that did not practise geophagia (Saathoff *et al.*, 2002). Since parasites, like hookworms, cause bleeding in the intestinal walls of the host, infestation negatively affects iron status and may cause or worsen ID and IDA. Therefore, deworming with anti-helminthics every three months is recommended as prevention and treatment (Alderman & Horton, 2007) especially in endemic communities. Although the soil or clay eaten may contain some amounts of iron and other mineral nutrients (Tayie *et al.,* 2013), these nutrients are not very bioavailable (Hooda et al. 2004; 2002) and thus do not compensate for the iron losses incurred by the parasite infestation. Geophagia have also been associated with complications such as lead and mercury poisoning, dental injury, hyperkalemia, hypokalemia and abdominal obstruction which may require surgery. Pica for ice may also cause dental injury (Federman *et al.*, 1997). Similar risk may be associated with the other pica substances reported in this study, including soil, dust and uncooked starch (causing abdominal obstruction) or rice (which may be infested with weevils) (Young *et al.*, 2010).

No mother or child was observed to exhibit any signs of chronic iron deficiency anemia, in the form of angular stomatitis, atrophic glossitis or koilonychias. This may be due to seasonal effects since the data collection was done in April at the beginning of the wet season when food security may be better compared to the dry season when harvest would have been depleated.

Some mothers reported headache and anxiety when they did not satisfy their cravings and a feeling of relief when they did. Similar observations were made for the children. Kola nuts, another pica substance reported in the current study population, contain caffeine and theobromines (Burdock *et al.*, 2009) which may reduce headaches, but are also addictive (Persad, 2011). Although the anxiety and inability to work, which some women who practise pica in the current population reported, may have been signs of IDA (Bunn, 2011), it may also have been evidence of addiction.

One in five mothers (21.0%) reported that they did not know what causes pica, while most (56.1%), attributed pica to "personal desire"; in other words a choice each person makes. The mother's responses to open ended questions clearly indicated that their communities frown upon pica and those who practise it. Thus, although most did not believe that pica is treatable, around 75% of the mothers indicated that women and children, who practise pica, should be made to stop. One of the more radical approaches suggested, was beating children to make them stop, which poses the danger of abuse. Around a fifth of the mothers, however, raised the possibility of education. Because the behaviour of individuals is greatly influenced by culture, family, and the whole of the society in which they live, it is important to consider the context when trying to bring about behaviour change (Snetselaar, 2008). Therefore, educating mothers and her immediate community, to recognize pica as a condition related to ID will help improve early identification of the practice and consequently ID and anemia.

Though pica among children may be difficult to identify, as they tend to put any items they find in their mouths, mothers in this study population observed the consistent intake of non-food substances among 9% of the children. This may be a warning sign of micronutrient malnutrition. Child pica has been previously documented among 1-3year olds in India (Tamer *et al.*, 1986). In a more recent study in Iraq among 10-36 month olds from low socio-economic background, pica was recorded among 11.6% of the study population, and was observed to be associated with IDA, rickets and worm infestations (Al-sawaf, 2004).

7.6 Limitations

Since the study required the mothers to recall practices, there is the possibility of recall bias. The association found between a child's pica practice and his/her mother's practice of pica during pregnancy need further investigation with a larger sample size. Biochemical testing would have helped make inferences with strength of association. Pregnancy poses additional nutrient demands on the mother (Dewey & Cohen, 2007) thus multiparous women may be at higher risk of ID than primiparous women if not replenished. If these nutrients used during pregnancy are not replenished, the mother may have an increased risk of ID and other nutrient deficiencies during the next pregnancy. However, the role of birth order in child pica practice was not assessed. Since the topic is a sensitive one, mothers may not totally be honest in their answers.

7.7 Conclusion and recommendations for future research

This study identified some inaccurate iknowledge negative attitudes and regading pica practicein the community studied and there is clearly a need to educate mothers and their communities with regards to the causes and dangers of pica. Future research should focus on the etiology, risks to mother and child, as well as the management, of pica. The strength of the relationship between pica and IDA, as well as the potential use of pica as a risk marker for ID in anemia endemic communities with poor access to fully furnished health facilities, should also be explored. A better understanding of knowledge, attitudes and practices regarding pica in these communities is needed to design interventions targeted at individual and social behaviour change.

7.8 References

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PHASE II – INTERVENTION DESIGN

CHAPTER 8:

NUTRITION INTERVENTIONS: DESIGN AND IMPLEMENTATION

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Abu BAZ, Louw VJ, Raubenheimer JE & van den Berg VL. Designing interventions for resource poor communities with low literacy: An example of an iron deficiency (ID) education program in Ghana. Available at: http://micronutrientforum.org/wp-content/uploads/2014/12/0358.pdf

8 NUTRITION INTERVENTIONS: DESIGN AND IMPLEMENTATION

8.1 Introduction

This chapter discusses various nutrition interventions targeted at ID, with specific reference to the application of these interventions in Ghana. Among the interventions, nutrition education is discussed in more detail. The theoretical models/frameworks for nutrition education are explored, and applied to the design of the NEP for the current study.

Anemia is estimated to prevent 40 – 60% of the populations in developing countries from reaching their full potential (Venkatesh Mannar, 2007:14). At The World Summit for Children, 1990, 71 heads of states pledged to decrease IDA among pregnant women in their countries by a third from their 1990 levels, by 2000. This goal has since not been achieved by many of these countries, and it is unlikely to be met unless sustainable interventions are innovatively explored (Venkatesh Mannar, 2007:14).

The International Nutritional Anemia Consultative Group (INACG) is one such group with their central role to guide activities to eliminate anemia in the world (UNICEF, 2002:7). Project Iron Deficiency Elimination Action (IDEA) of the International Life Sciences Institute (ILSI) Micronutrient Deficiencies Program, is yet another effort to eliminate IDA through country-specific fortification programmes. It is currently working with several countries in Africa, Asia and elsewhere to achieve this. The Global Alliance for Improved Nutrition (GAIN) is also working with various countries, including Ghana, on fortification of most commonly consumed foods with iron and other nutrients to eliminate vitamin and mineral deficiencies (UNICEF, 2002:7). The Copenhagen Consensus Paper 2004, identified investment in preventing micronutrient deficiency, including anemia, as second only to fighting HIV/AIDS on the list of 17 proposed development investments (McLean *et al.*, 2007:3). The United Nations Agencies, such as UNICEF and WHO, also have IDA eradication as a focus of their health agenda. Several non-governmental organisations

(NGOs) in Ghana and the rest of the world are also involved with implementations of programmes to improve health as well as reduce malnutrition and anemia. Despite these efforts, anemia still persists. The WHO defines a prevalence of any form of anemia above 5% in a group, as a public health problem (WHO, 2001:17).

8.2 Interventions to prevent ID and IDA

The benefit-cost ratio for anemia is estimated at 200:1; which indicates that the benefit of preventing and treating anemia is 200 times higher than the cost of living with anemia. Moreover, according to Horton and Ross (2003) successful treatment of anemia in an adult as improves productivity by 5% in light manual work and 17% in heavy manual work; whereas there are also cognitive benefits and associated schooling improvements of 4% in all other work. Various types of interventions, which are commonly used to prevent ID, include supplementation, fortification, food-based approaches and nutrition education.

8.2.1 Supplementation

Traditionally iron supplementation was only given in the form of powders, tablets, and syrups. A meta-analysis of intervention studies found that the use of micronutrient powders positively impacted on iron status, but not growth (Dewey & Adu-Afarwuah, 2008). A newer form of supplementation includes micronutrient sachets (for example Sprinkles) that can be added to food after preparation at home (Adu-Afarwuah *et al.,* 2008). Some brands of oral contraceptives, such as Leostrin 24 Fe and Minastrin 24 Fe; incorporate iron into the pills to be used during menstruation, in order to protect WRA against ID and IDA. Some oral and injectable contraceptive also reduce or stop menstrual flow, thus reducing iron losses (Herceberg *et al.,* 2001; Milman *et al.,* 1993). Saaka *et al*. (2009) found that a combined iron and zinc supplement in the ratio 1:1, significantly improved ferritin and hemoglobin levels among pregnant women in the Upper West region of Ghana compared to the control communities. He therefore suggested that the iron-zinc supplementation was more beneficial compared to iron supplementation only.

The effectiveness of these supplemental interventions depend on the delivery channels used, since including supplementation in existing health systems are not always effective (Lutter, 2008). Venkatesh Mannar (2007) suggested that the successful approach used for the vitamin A supplementation campaign for pre-school children, who incorporated it into systems like the child immunisation days, could be applied to iron supplementation.

Coverage of many vulnerable populations remains problematic (Low *et al.*, 2013). Limitations of iron supplementation include supply issues and low access to health services. Previously, interventions provided iron and folic acid supplements to pregnant women. Limitations to this form of supplementation included non-compliance of women, side effects, poor supervision, and logistic problems during scaling up (Galloway *et al.*, 2002).

Iron and folic acid supplementation work well in controlled experiments where there is no worm infestation or malaria. A large-scale trial in a population with high rates of malaria study, however, found that iron supplementation was associated with increased hospitalisation and increased mortality among non-iron deficient children. This was probably due to increased risk of malaria which causes the red blood cells hemolysis (Osei & Harmer, 2008). The authors (Sazawal *et al.,* 2006) therefore recommended that iron supplementation in areas with high rates of malaria only be given to children who have been confirmed to be iron deficient. Based on these findings, international guidelines were changed (Stoltzfus, 2007), and now recommends that iron supplementation of pregnant women and iron-deficient children should still be a priority, but universal iron supplementation (with tablets, syrups or Sprinkles) should be avoided for young children who have a high risk of contracting malaria. Testing for ID, of course, increases cost (Dewey & Adu-Afarwuah, 2008).

Food and diet contain combinations of micronutrients; therefore evidence of a deficiency of one micronutrient usually implies that other micronutrients are also inadequate. Therefore, supplementation has shifted from single micronutrients to multiple micronutrients (de Pee *et al.,* 2011:256).

A recent meta-analysis concluded that iron supplementation is well-tolerated, and safely improves hematologic outcomes among primary-school-aged children in low- or middle-income settings (Low *et al.,* 2103). Iron supplementation has also been associated with reduction in anemia in young children and pregnant mothers (Alderman & Horton, 2007:20) and with positive effects on cognitive development in children. The effect on growth, though, was generally insignificant (Dewey & Adu-Afarwuah, 2008).

Iron supplementation seems to be most effective in small doses over the long term, rather than in larger doses over the short term. This still leaves the problem of distribution, lack of adherence to recommended doses, and monitoring.

Several trials in Ghana have assessed the efficacy of curbing anemia through fortification. A study by Assibey-Berko *et al*. (2007) proposed that a dual fortification of salt with iron and iodine could improve iron status, and reduce ID in rural Ghana, but this was not found to have significantly positive effects on ID levels.

Overall, supplementation is estimated to be five times more expensive than fortification in terms of DALYs (Baltussen, 2004: 2681).

8.2.2 Fortification

An alternative to supplementation is fortification of food sources with iron. Greater coverage of the at-risk population is achieved through fortification than through supplementation. Globally, there are several success stories for fortification as a means of improving health status. In Ghana, universal fortification of salt with iodine has reduced the incidence of iodine deficiency disorders (IDD). The fortification of vegetable oil with vitamin A and wheat flour with iron, zinc, vitamin A, folic acid (B9), thiamine (B1), riboflavin (B2), niacin (B3) and cobalamin (B12) (GAIN, 2007: online), have also been implemented. Though no impact studies have been done since 2007, surveys indicate that the percentage of people who used the fortified vegetable oil is 20.6% and that of fortified wheat flour, 46.9% (GAIN, 2010: online).

Studies indicate that it is difficult for children between six and 12 months of age to achieve adequate iron intake from unfortified local foods. Given the cost of iron-rich foods (such as meat), fortification is the most feasible option in most circumstances (Dewey & Adu-

Afarwuah, 2008). Iron fortification is not without problems the effectiveness depends on the prevalence of other micronutrient deficiencies, the presence of inhibitors and enhancers in the food that is fortified, as well as the characteristics of the added fortificant. The WHO recommends the use of ferrous sulphate for food fortification due to its relative bioavailability value (RBV) of 100% (Leong & Lonnerdal, 2012:92). This compound is, however, water-soluble and can cause sensory changes, limiting its suitability to food with a short shelf life. Other compounds used in fortification include elemental iron (electrolyte ion), ferric pyrophosphate, and NaFeEDTA. Though elemental iron and ferric pyrophosphate do not cause sensory changes, these compounds have low RBV, and therefore very high dosages have to be added. NaFeEDTA has the highest RBV - about two to three times that of ferrous sulphate – and is therefore used in food such as some cereals, with very high phytate content (which inhibit bioavailability of dietary iron) (Leong & Lonnerdal, 2012:92). It is however, too expensive to use on a large scale (Hurrel, 2002).

Challenges to the potential of fortification to eradicate ID, include cost, availability of centralised foods, and access to these foods. Fortification programmes in developing countries have not always been successful in achieving the intended goals. In Iran for example, evaluation of a programme to fortify flour, showed that though the coverage was above 90%, it did not have the expected impact on lowering IDA (Sidighi *et al.,* 2009:798). Causes speculated on, included low bioavailability of the iron compound, low consumption of the fortified bread, as well as low consumption of other iron-rich foods (Sidighi *et al.,* 2009:798).

Data on the success of fortification to decrease ID in iron deficient communities are limited. Positive effects have been shown with trials using iron-fortified water to improve iron status of preschool children (Arcanjo *et al.,* 2010); with micronutrient fortified milk (Sazawal *et al.,* 2010); as well as with the use of fortified complementary food for children in nursery schools (Rim *et al.,* 2008). According to Adu-Afarwuah *et al*. (2008), in Ghana, home fortification/supplementation with for example Sprinkles, may have a potential to improve iron status among children. Other newer approaches used in Ghana include using vehicles, such as micronutrient fortified fat-based spreads and fortified cereal-based complementary foods (Lutter *et al.,* 2008; Rivera *et al*., 2004). Some have proved to be beneficial to improving anemia and other health-related conditions.

Zlotkin *et al*. (2003) studied home fortification of weaning foods with Sprinkles containing iron and zinc (80mg; 10mg). They found that both improved hemoglobin levels, but that the rate of recovery from anemia was faster with iron alone, compared to the dual fortification. The group that received the iron-zinc combination, however, decreased in height-for age Z score compared to the group that received iron alone. The authors concluded that home-fortification with iron and zinc or iron alone in controlled settings, reduced anemia, probably due to nutrient interactions. Adom & Asiedu (2010) studied the use of iron-fortified cowpea and maize mix as complementary feed for children, and found that the fortified mix was well accepted at the community level, improved growth and hemoglobin status.

8.2.3 The food-based approach

Fortification and supplementation often fail in field settings due to challenges of non-compliance, supervision, and inference with high levels of malaria and worm infestation (Venkatesh Mannar, 2007:14). There is clearly still a need for more creative means of improving iron content in diets and enhancing its absorption.

Studies found that in the northern part of Ghana, only 26.6% of the study participants met their RDA for energy, and also failed to meet the recommended intakes of calcium, vitamin A, C and pro-vitamin A (Takyi, 1999). Overall, 90% of the study population did meet the RDA for iron and protein, but bioavailability of iron was not assessed. This could have implications for growth of children in instances where the anti-nutritive factors in the diets are high. In order to reduce the phytate content of complementary foods, for example, Amagloh *et al* (2012) proposed that complementary foods could be prepared from a sweet potato, which is also high in beta-carotene compared to the predominantly cereal-based foods. Aflatoxin B (1)-lysine adducts (AF-ALB) which is usually found in staples, especially cereals, was found to independently increase women’s risk of anemia. This association was even stronger when malaria infections were present (Shuaib *et al.,* 2010). A follow-up study by Osei-Boadi *et al*. (2012) found that vegetarian children need supplementation of vitamin

B12 when compared to controls. Generally, there was however lack of variety in the Ghanaian children's diet. Anemia prevalence was not significantly different.

Food-based approaches therefore offer another avenue to improve iron status. Food-based approaches focus of modifying diet through increase in the productivity, availability and access to food, increasing the consumption of food rich in micronutrients, and by increasing the bioavailability of iron from diets. Researchers have, for example, tried to include iron supplements in food to help reduce the side-effects of that contribute to non-compliance (Conwey *et al*., 2006). In Ethiopia, phytase have been added to bread flour to break down the phytate content and improve the bioavailability of iron. Though highly consumed and of high iron content, this bread, called teff, proved to have similar challenges as other non-heme sources of iron (Bokhari *et al*., 2012:99).

In a different approach, an intervention in rural central Burkina Faso (Sanou *et al.,* 2010) successfully reduced anemia and ID among young orphaned and vulnerable children living in foster homes, by integrating meal planning and hygiene practices. The meal planning included improving the bioavailability of iron by adding meat in their food, vitamin C and also iron rich condiments. Hygiene practices included hand washing and the use of individual plates.

Another food-based approach, which has potential in terms of cost and sustainability, is increased diversity through home gardening. This approach may improve the nutrient quality in diet of beneficiary households, but is hampered by poor bioavailability of non-heme iron in plant-based diets. Food-based approaches however, have great potential in reducing ID, especially when used alongside a NEP as community-based interventions (Talukder *et al.,* 2014).

Biotechnology entails improving the nutrient composition of staple crops through plant breeding technologies; testing of the nutritional efficacy of these crops; and promoting their cultivation among farmers (Venkatesh Mannar, 2008). Harvest Plus has a ten-year plan to increase the concentrations of certain nutrients in crops and their bioavailability. This is achieved by reducing inhibitors of absorption and increasing the effectiveness of promoters of iron absorption (Ruel & Levin, 2000:2-3). There is ongoing research on bio-fortification of cassava with vitamin A, maize with iron and zinc among other commonly consumed foods (HarvestPlus, 2006:1-2). Data on the contribution to reducing anemia is limited (Bouis, 2002:494S).

According to Stoltzfus, 2011 (757S), in all the interventions on global health, no focused initiative has been slated for iron on its own though interventions have a broader benefit to health and development. She therefore suggested interventions for anemia in four initiatives: Firstly making pregnancy safer through iron and folic acid fortification, secondly to maintain healthy new-borns born with enough iron stores through improving maternal anemia status and delayed clamping of the cord during delivery. Thirdly the focus is on infant and young child nutrition through appropriate complementary feeding, and fourthly on healthy family members through fortification initiatives. Thus, a lifecycle approach is more comprehensive and complementary.

8.2.4 Addressing other factors that affect iron status

Efforts to eradicate ID also need to focus on other factors, besides diet, that impact on iron status.

8.2.4.1 Infections and intestinal parasites

An interrelationship exists between iron status and infections as discussed in chapter 2. Worm infestations affect iron status by causing bleeding in the intestinal walls of the host. While deworming with anti-helminthes every three months is recommended to help prevent and treat worm infestations, this also reduces anemia, improves growth and increase the absorption of vitamin A (Alderman & Horton, 2007:27-31). Studies show that deworming is safe and positively affects productivity. In Kenya, for example, deworming among schoolchildren was associated with increased school participation (Miguel & Kremer, 2004), whereas in Indonesia, periodic deworming among adults decreased anemia and had a positive effect on income generation (Thomas *et al.,* 2004). Other non-dietary factors that affect iron status and need to be addressed in NEPs, include malaria and the use of oral contraception.

8.2.4.2 Pica

Pica is another factor, which needs to be addressed along with ID. Pica is prevalent among pregnant women, as well as among children with developmental/disability challenges, which has made practitioners describe pica as a behavioural condition rather than a nutritional condition. In Ghana, a recent study found that 67% of pregnant women had food cravings and 42% actually practices pica in the time of pregnancy (Koryo-Dabrah *et al.*, 2012:360). As discussed in chapter 2, pica also occurs among non-pregnant women, children and even men. This type of pica has been called "cultural pica" because in many countries it is a common and acceptable practice (Morgan, 1984:1054) A strong association has however been found between pica and IDA (Miao *et al.*, 2015).

Interventions have been described to change pica behaviour in children with autism and other developmental disabilities, using behavioural approaches (Williams & McAdams, 2012; Williams *et al.*, 2009; McAdams *et al.*, 2004). Kern *et al.* (2006) successfully reduced pica for non-edible substances in two developmentally challenged boys by using an intervention of exchanging inedible pica material for edible food items (Kern *et al.*, 2006). Ferreri *et al.* (2006) used food aversion to significantly decrease pica in a child with autism. Other interventions that have been tried included using an alternative response of discarding objects during attempted or actual pica (Ricciardi *et al.*, 2003). From the pathological perspective, interventions to treat pica with vitamin A (Pace & Toyer, 2000) and zinc (Lofts *et al.*, 1990) supplements reduced the practice significantly. However, no interventions specifically using nutrition and dietary approaches to address pica have been published.

8.2.5 Nutrition education

Among nutrition interventions, nutrition education is considered vital for the prevention and management of ID because of the potential to change behaviour. At the International Conference on Nutrition (ICN) in 1992 (ICN, 1992), nutrition education was recommended as a priority. The Tamil Nadu Integrated Nutrition Project in India indicated that an emphasis on nutrition education is likely to influence nutrition KAP to such an extent that the need for more costly intervention can be significantly reduced (Balachander, 1991).

8.2.5.1 Theoretical models for nutrition education

A meta-analysis of over 300 studies established that nutrition education is more likely to be successful when it focuses on the behaviour and systematically links relevant theory, research and practice (Contento, 2008: 177).

8.2.5.2 Nutrition education and interventions: definition and purpose

The Society for Nutrition Education and Behaviour defines nutrition education as "any combination of educational strategies, accompanied by environmental supports", which are designed to help people to "voluntarily adoption food choices and food- and nutrition-related behaviours which promote health and well-being" (Contento, 2008:xv; Adrien, 1994:1). According to the FAO (1997):

"to attain good nutritional status and health, people need sufficient knowledge and skills to grow, purchase, process, prepare, eat and feed to their families a variety of foods, in the right quantities and combinations. This requires a basic knowledge of what constitutes a nutritious diet and how people can best meet their nutritional needs from available resources. Undesirable food habits and nutrition-related practices, which are often based on insufficient knowledge, traditions and taboos or poor understanding of the relationship between diet and health, can adversely affect nutritional status. However, people can adopt healthier diets and improve their nutritional well-being by changing their food and nutrition attitudes, knowledge, and practices, if sufficient motivation is provided to do so"

The process of nutrition education usually entails a source of information, and a receiver of the information, but may take a variety of formats. Different methods of nutrition education may include direct methods where individuals or a small community are faced and directly addressed; whereas distance methods make use of the media, for example television, films or print material (Contento, 2008:176).

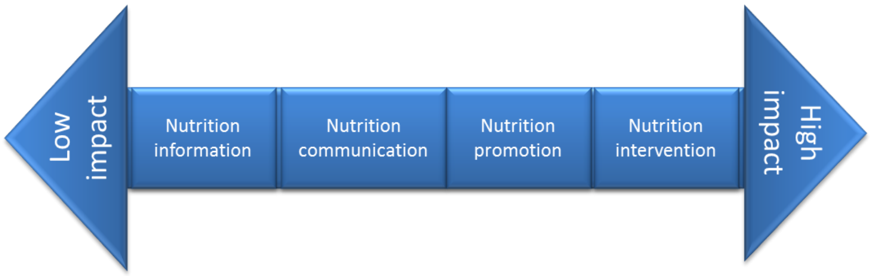

Figure 8.1: The impact of nutrition education opportunities on nutrition knowledge. (Adapted from ADA, 1996)

The American Dietetic Association (ADA, 1996) distinguishes four levels of nutrition education (Figure 8.1). On the one extreme is general nutrition information, which is usually delivered through the media, but has the least impact on nutrition knowledge. The next level is supported and underpinned nutrition communication. This is followed by nutrition promotion, which refers to the translation of science-based nutrition information to improve appropriate eating behaviour, into consumer-orientated messages. Lastly, on the other extreme, is nutrition intervention, which has the highest impact to empower individuals and communities to change their eating behaviour.

8.2.5.3 Consideration of the setting in nutrition education design

According to the model by Contendo (2008:177), illustrated in Figure 8.3, people's food preferences and the food choices they make are influenced by biologically determined behavioural predisposition, past experiences with food, as well as personal, and environmental factors. Food-related factors are clearly only one category that influences diet-related behaviour or practices (Contento, 2008:174; Birch, 1999).

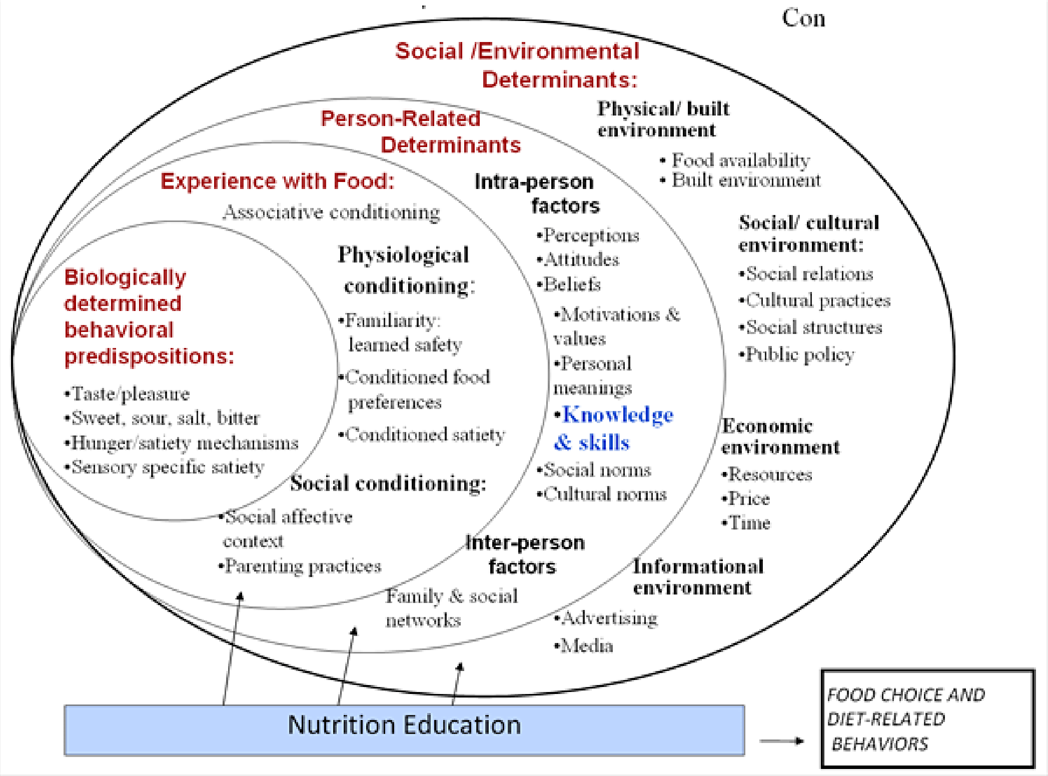

Figure 8.2: Influences on food choices (adapted from Cotendo, 2008)

Nutrition education therefore needs to address not just food preferences and sensory affective factors, but also factors such as perceptions, attitudes, social norms, and environmental factors (Contento, 2008:176) as summarised in Figure 8.2 (Contendo, 2008:178). Because behaviour in individuals occurs in the context of the society in which they live in, it is important to consider the setting when attempting to influence behaviour change. Culture, family, partners or colleagues have great influence on behaviour and should be considered when advocating for social change (Snetselaar, 2008; 491). Facilitators of nutrition education interventions must be aware of their own beliefs, and accept differences that may exist between themselves and the group of people they are targeting with nutrition education. Multicultural communication include language, but also requires being sensitive and mindful regarding postures, gestures, the role of the individual within a group, and the setting (Satia-About a *et al.*, 2005). The terminologies, assumptions, and norms of health professionals are different from those of group members. Studies have shown that clients only understand around 60% of what they are told by health professionals, and in some setting this is even lower (Ulrey & Amason, 2001). Ineffective communication could lead to incorrect diagnosis and ineffective implementation of interventions (Patterson 2004; Van Wieringen *et al.*, 2002). According to Patterson (2004), to be effective, facilitators and health professionals must be respectful of their target group and their ability to make changes; be genuine; have empathic understanding; effectively communicate this understanding to them; and structure the nutrition education well by defining his/her role and the proposed programme well.

Health education needs to reach the most vulnerable in the society. The challenge is that the most affected are usually the less educated and poor people within a society. In Pakistan a successful education programme to improve the knowledge of illiterate women on drug safety used pictorial 'story cards' issued to the mothers on how to handle drugs (Nisa *et al.,* 2008).

Another study among illiterate children, successfully made use of a focus group participatory learning approach. The study also found that the health knowledge of children corresponded with that of the parents, and therefore further suggested that the child-to-child education approach could improve the behaviour of both adults and children (Mahr *et al.,* 2005).

Warnock (2007) evaluated an education intervention on food safety practices in rural communities (Lao, PDR) using key messages targeted towards food safety. This approach was found to be effective, but the authors recommended a component on cultural practices should be included, and stressed the importance of a collaborative approach between the key associations in the intervention group and the programmes implementers. They also suggested securing some financial support; and to allow time for behaviour to change

8.2.5.4 Theories of health behaviour

There are two main schools of thought on health behaviour. These are defined as theories regarding knowledge, attitude, and behaviour (KAB), and social cognitive theories (SCT). The KAB theories hold that increase in knowledge leads to change in attitudes and practices. When the KAB models were tested against the scientific method, change was found to be more complicated than just knowledge translating to behaviour change, since mind processes are influenced by environment and social interactions. This led to the birth of the SCT (Lytle, 2005:90), which goes beyond knowledge and considers confidence in self to change (self-efficacy), and the context in which behaviour change is advocated for (Lytle, 2005:91).

8.2.5.4.1 Health Locus of Control Model (HLCM)

The Health Locus of Control model (HLCM) measures an individual's regard of their health as being controllable by them, versus regarding it as being under the control of other people more powerful than them (Wallston & Wallston, 1982:69). It also involves the thought that if people do indeed change behaviour, the channels of communication that they require to effect changes are important. These regards or beliefs can come from internal sources or external sources. It is however difficult to differentiate between internal and external motivations. For instance going to a doctor for a check-up could qualify as an external motivation because the client believes his/her health is in the hands of a higher power person (doctor). It could also come from an internal source being that client is taking his health into his own hands and therefore going to the hospital. Inaccurate perceptions of risk and unrealistic optimism may be one of the reasons people do not change from their unhealthy behaviours (Weinstein, 1984). The best method for facilitating behaviour change is by re-establishing self-efficacy, self-esteem and building on the internal locus of control of health (Katz, 2001:303). Self-efficacy is the clients' belief that he/she can make healthy behaviour changes. The belief in the possibility of change is an important motivator (Snetselaar, 2008:490).

8.2.5.4.2 Health Belief Model (HBM)

As people try to change behaviour or live healthier lives, they are confronted with several factors affecting their success in behaviour change and sustaining it (Parliamentary Office of Science and Technology, 2007:1). Giving information on the bad effects or the cause of an illness make people take precautions towards making healthier choices. For instance, knowledge about breast cancer is seen to relate to having regular mammograms (Reimer *et al.,* 1991) and knowledge about cervical cancer to having regular pap smears tests (O'Brien & Lee, 1990). However, some studies found a high relationship between healthy behaviour and perceived seriousness as seen in cases of inoculations against meningitis (Janz & Becker, 1984). Factors found to motivate healthy behaviour was cost versus benefit and the perceived seriousness (Becker & Rosenstock, 1984) whilst other studies found it to be perceived barriers and perceived susceptibility to illness (Janz & Becker, 1984).

The HBM has been criticised for only focusing on the individual and ignoring social and economic factors. The individual's outcome expectancy and their self-efficacy, thus their belief that they could carry out preventive behaviour, could also predict health behaviour (Schwarzer, 1992; Seydel *et al.*, 1990). In view of these arguments, Becker & Rosenstock (1987), define the HBM to consist of the existence of sufficient motivation, the belief that one is susceptible or vulnerable to a serious illness and the belief that their change in health behaviour in accordance to recommendations can be beneficial to them at a reasonable cost.

8.2.5.4.3 Health Action Process Approach (HAPA)

The HAPA aims at understanding the beliefs and behaviour of clients. It also emphasizes the importance of self-efficacy and distinguishes the difference in the three stages of change (decision making, motivational and action maintenance). Its main components are self-efficacy, outcome-expectancies, and threat appraisals (individuals' perception of vulnerability and beliefs of severity of an illness) (Schwarzer, 1992). Critics of the HAPA postulate that it is too rational while neglecting emotion, that the direct influence of the environment and society are not considered. They also question the existence of the cognitive theories (Schwarzer, 1992).

8.2.5.4.4 The Social Cognitive Theory

The Social Cognitive Theory, by Bandura (1989), postulates that there is an interaction between an individual and his/her environment. Past experiences therefore influence a person's current behaviour as well as the likelihood that he/she will continue or discontinue that particular behaviour (Bandura, 2001:4). When an individual has expectations, coupled with value, placed on the outcome of a change in behaviour, it may influence their success at changing that behaviour. The SCT also emphasises self-efficacy, thus the individual's confidence in whether or not they can successfully make a particular behaviour change. A person's self-efficacy can also be influenced by environmental factors, be it positive or negative (Boekaerts & Cascallar, 2006; Bandura, 2001:10; Bandura, 1999). The major limitation of this theory is its focus on the environment with little consideration of the biological factors that may influence behaviour, such as hormones. This model has been applied to the understanding of learning processes for students in the classroom setting (Boekaerts & Cascallar, 2006; Bandura, 2001:20).

8.2.5.4.5 Integrated approaches

Studies show that more sustainable results are achieved with nutrition education interventions if the various theories/models are integrated (Actherberg & Miller, 2004). According to Chapman-Nocakofski (2012) "key to changing nutrition behaviour is the person's awareness that change is needed and the motivation to change". Contento (2008) suggest such an integrated approach (figure 8.3). The first phase of a nutritional intervention is therefore the motivational phase when an increase in awareness is created, thus answering the question as to "why the audiences need to change behaviour". This stage is followed by the action phase when the focus becomes to help the audience make changes by answering "how it can be done". The last phase is working towards creating an environment, which may help sustain change. Herein for example, decision makers play an important role to create a supportive environment to promote healthy eating habits, and increase availability and affordability of healthy food choices (Contento, 2008:177; Institute of Medicine, 2002).

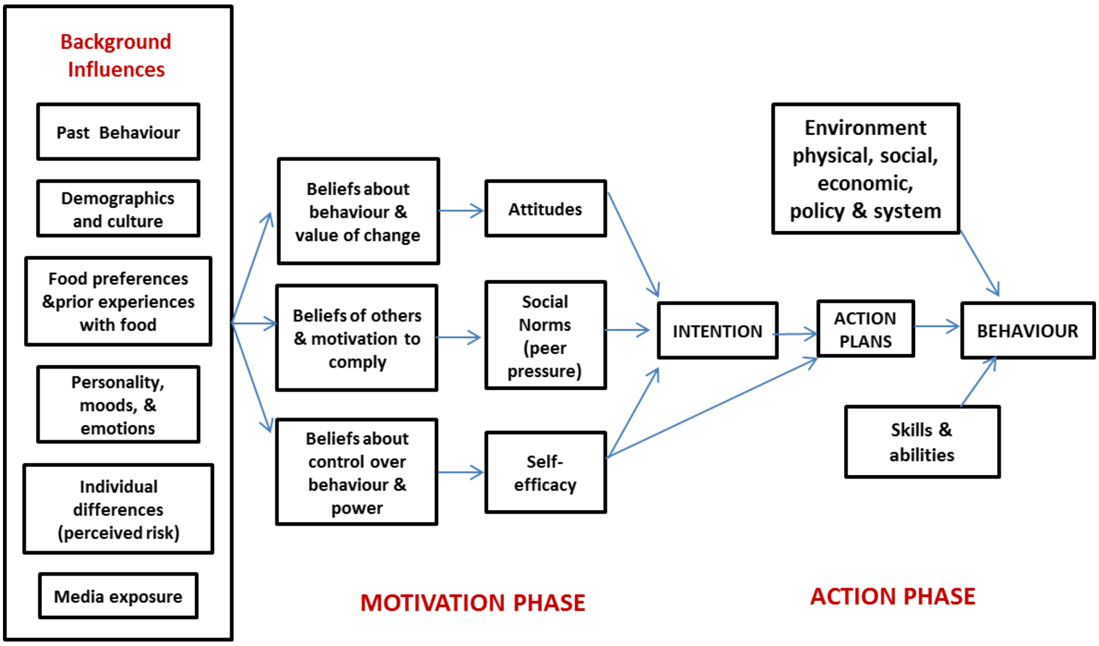

Figure 8.3: An integrative model of mediators of health behaviour change (adapted from Contendo, 2008:178)

8.2.5.5 Principles of adult learning

Adults have a different approach to learning compared to children. According to Lieb (1991), part of being an effective educator involves understanding how adults learn best. Andragogy is a theory that holds a set of assumptions about the adult learning process. The six most widely held principles of andragogy, which are applied across various disciplines, and thus may be relevant to nutrition education, are (adapted from Queensland Occupational Therapy Fieldwork Collaborative, 2007; Klatt, 1999:87; Lieb, 1991):

- Adults are self-directed and internally motivated; therefore they resist learning when they feel others are imposing information, ideas or actions on them;
- Adults are experienced, and apply their experience in the learning process, Adults bring their own life experiences and knowledge to the learning experience; making them active participants with contributions to training sessions.;

- Adults are oriented towards goals and "they experience a need to learn it in order to cope more satisfyingly with real-life tasks or problems";
- Adults are relevancy oriented and want to know how what they are learning is relevant to what they want to achieve;
- Adults are practical and need to experience practically how what they are learning applies to life and the work context; and
- Adult learners need to be respected.

Adult learners therefore need interventions to be more practical and goal-oriented to solving real life problems and questions, rather than theoretical situations (Klatt, 1999:87). Hence, the planners and facilitators of nutrition education intervention programmes targeted at adults, need to:

- Create a safe haven for learning by valuing their experiences;
- Create a comfortable environment;
- Encourage participation by seeking contributions from participants; and
- Facilitate more than lectures (Kennedy, 2003:1-4).

8.2.5.5.1 Leaning Styles

A series of theories on learning styles suggest that individuals differ in how they learn. Sensory preferences influence the ways in which people learn and the three learning modalities adapted are the:

- Visualising style (learning from what they see);
- Auditory style (learning from what they do); and
- Tactile (Kinaesthetic) style (learning by what they practically do, touch, feel) (Barbe & Milone Jr., 1981).

8.3 Application of the theory to design the NEP in the current study

The current study design integrated the various theories/models/frameworks discussed in 8.2, while taking the existing programmes in developing countries, and specifically in Ghana (discussed in 8.2 and 8.3) in to consideration.

8.3.1 The triple A cycle approach to nutrition interventions

To design sustainable solutions to nutrition problems, UNICEF proposes the triple A cycle approach which is illustrated in Figure 8.4. According to this framework, the current situation in a community should be assessed, the causes of the problem should be analysed, appropriate actions should be planned based on the analysis and taking the available resources in the community into account, the planned action should be implemented, and the effect of the implemented actions should be evaluated (UNICEF, 1992).

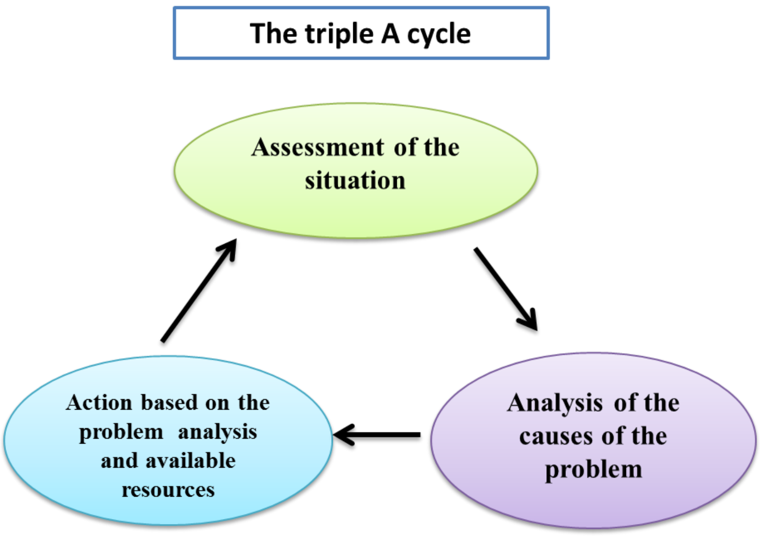

Figure 8.4: The triple A cycle approach to nutrition problems in communities (UNICEF, 1992)

The conceptual framework of the current study (illustrated in chapter 1, Figure 1.1) was based on UNICEFs triple A approach as outlined in figure 8.5. Because nutrition education is geared towards behaviour change, it should be based on a thorough study of behaviour, attitudes, and practices of the social communities concerned (Oshaug, 2011; Adrien, 1994:5). A baseline survey to assess the socio-demographic data, nutritional status of mothers and their children six to 59 months, as well as the KAP of the mothers, were perfomred at baseline to identify the prevalence of known risk factors for ID and anemia in the study population.

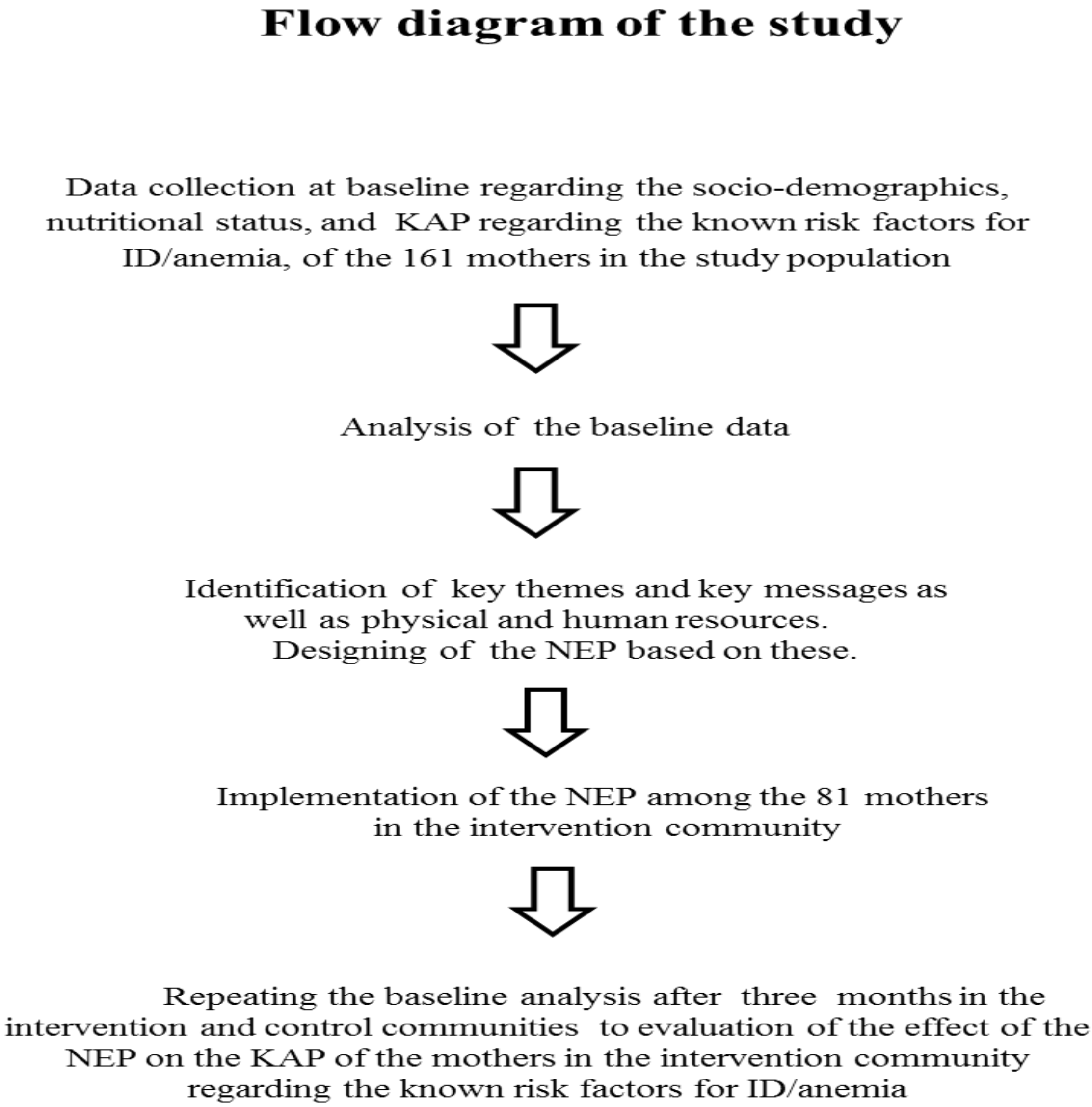

Figure 8.5: Application of the triple A approach in the current study

Gaps in knowledge, and attitudes and practices, which may increase the risk for ID and anemia were identified at baseline and used to development the content of the NEP. The NEP (action) was implemented. The impact of the NEP was monitored and evaluated three months after the implementation of the NEP. Lessons learned from the evaluation, in the form of impact assessment, were used to further improve the intervention for future application. The evaluation also denote the re-annalysis of the problem in the community in order to evaluate whether the identified gaps at baseline have been addressed with the intervention.

8.3.2 Baseline survey: Application of UNICEF conceptual framework for malnutrition

WRA and pre-school aged children are among the communities most affected by ID and anemia. In this study mothers (WRA) who were the primary caregivers of children 6 to 59 months, were targeted for a NEP to effectively communicate and contribute to change in the community. As nutrition education interventions are directed at changing behaviour, this intervention addressed the KAP of mothers regarding ID and pica (Contento, 2008).

UNICEF's conceptual framework for malnutrition (Figure 2.2) was used to design the objectives (described in chapter 1) and choose the variables to measure (described in chapter 3; figure 3.1). Data were therefore collected regarding the basic, underlying and immediate causes of ID and anemia in the community.

8.4 Development of the NEP

Behaviour occurs in the context of environment, community and society. KAP of a mother is greatly influenced by her environment; including people or even the climatic condition in her immediate surroundings. The process of behaviour change is also affected by the society she lives in and the existing cultural practices that have been handed down by the older generations through formal and informal education. The setting (described in chapter's four to seven) was therefore considered and attempts were made to address perceptions, attitudes, social norms, and environmental factors in the NEP, as suggested by Contendo (2008:178) (figure 8.2).

The adaptation of nutrition messages and nutrition interventions according to the context and the specific needs of communities, is in line with the recommendation for urgent global interventions for maternal and child nutrition (Locks *et al.*, 2014; Black *et al.*, 2008).

The KAP model postulates that an increase in the knowledge of an individual leads to change in behaviour (Lytle, 2005). The focus on an individual is however not enough for an intervention in a community where formal interaction is low and a child belongs to everybody. In such an environment, others who contribute to the mother and child feeding practices and attitudes in feeding, may include significant others like grandmothers (Aubel, 2012), in-laws or the TBA. Thus, though a mother may acquire knowledge, the existing practices may still affect the translation of new and contradictory knowledge to practice.

The NEP designed for this study incorporated the principle of the KAP model and included components to increase participants' knowledge on the risk factors for ID and anemia (including pica), in order to influence practices.

To complement the KAP model, the social cognitive theory (SCT) (Lytle, 2005), which postulates that the environment affects behaviour change, was also incorporated in the form of household visits after the main nutrition intervention. The household members were encouraged to participate in the discussion or ask questions if they showed interest. The NEP focused on improving the confidence of mothers through provision of information to induce change in health choices (Snetselaar, 2008).

The HBM is considered the most appropriate model for an intervention which involves causes, effects, and potential serious impact. However, an intervention that involves only the mother could be a limitation, due to the impact of environment on behaviour change. Community health workers who work with the community and its leadership should be made part of the programme and help to sustain the programme. In the setting where poverty and food insecurity is endemic, mothers are more likely to be interested in cost effectiveness as a motivation to behaviour change; the relevance of the intervention to her and her family's health; and more practical changes that can be easily applied in their situation (Becker & Rosenstock, 1987). All these factors were considered in the development of the intervention. The intervention was designed to integrate the KAP model, HBM, and SCT, and to incorporate the principles of adult learning and learning styles. The complementary effect of such an integrated approach is expected to be more effective, and more likely to lead to sustained behaviour change (Actherberg & Miller, 2004).

8.4.1 Sustainality of NEP

To encourage support for the intervention, the District Health Directors introduced the research team and project the District Nutrition Officer. These officers are responsible for the nutrition-related programmes implemented in these communities and are assisted by community volunteers who have good relationships with the mothers, the leadership of the communities, and the community health workers who carry out growth promotion and others health services. The team and project was introduced to all of these contact persons in the community. The community volunteers became the main liaison between the research team and the community, while the clinic staff, including community health nurses and nutrition officers, were invited and took part in all activities. Copies of training materials were shared with them. The “assembly man”, who is also the local government representative of the community, was also involved; he attached importance to the intervention by showing support for the project and encouraging the mothers to participate.

The NEP consisted of two components. The first consisted of simple theoretical messages delivered to mothers in community presentations using pictorial aids, thus focusing on the visualising and auditory learning styles. The second was a practical component appealing to tactile (kinaesthetic) learning styles. A training manual was designed for the intervention as a guide for the NEP implementation.

8.4.2 Consideration of baseline findings and available resources

The baseline findings that were considered in the development of the NEP are reported and discussed in chapters 4 to 7.

8.4.2.1 Structure of the NEP

After analysis of the baseline data, ten themes were identified as basis for the content of the NEP. Table 8.1 summarises the ten themes; the gaps identified in the baseline findings that each theme was meant to address; the rationale for the methods used; and the translation of these themes to content and delivery methods.

Theme 1: Intake of organ meat, muscle meat, and fruit to prevent ID;

Key message 1: Eat more meat, fish and fruits to increase access to available iron

Mothers in this study had inadequate intake (in terms of quantity and frequency) of organ meats and fleshy meat, as observed in the occasional intakes reported on the FFQ for both mothers and children. Analysis of dietary intakes based on the mean of three 24-hour recalls, confirmed inadequate intakes of iron and vitamin B12 in mothers and children. Reported frequency of fruit intake was low for mothers and children who are reflected in low vitamin C intakes as computed from 24-hour recalls. It was therefore relevant to increase the mothers' knowledge regarding the importance of organ and fleshy meat as iron sources and fruits as enhancers of iron absorption. The knowledge score on sources of iron and enhancers of iron absorption was below average. To compensate for the mothers' low literacy; pictures and real food samples were used as teaching aids during intervention interactions. All foods used as examples could be found either within the community, or the regular markets that they patronised.

Theme 2: Intake and the timing of tea intake to prevent ID

Key message 2: Do not brew tea; allow time between tea intake and meals, to increase iron availability

More than 50% of the mothers and of the children consumed tea from the 24 hour recall. Many mothers prepared their tea by brewing it over heat. Tea was usually consumed with meals or used as a complementary food for children. Through interaction with community tea intake was seen as a status symbol. The rationale for this theme therefore was to educate mothers on the role of tea as an inhibitor of iron absorption, and to teach proper spacing of tea consumption relative to meals. Tea bags were used for education and demonstrations.

Theme 3: Birth spacing and the role of contraception to prevent ID;

Key message 3: Choose contraceptive with a health person, and space children to reduce nutrient requirements

Almost none of the mothers used contraceptives. They reported they abstain from sex during lactations since there are other wives to satisfy the sexual desires of the husband. There were also other reported cultural practices as reported in table 8.1 which acted as birth control methods. The rationale of this theme was to educate mothers on the types of contraceptives, and the positive and negative aspects of contraceptive use with regard to ID. Pictures and samples of contraceptives were shown to mothers. Beliefs were usually not religious but myths held by community members and then handed down.

Table 8.1: NEP: Themes developed from baseline findings, rationale, and translation to content and delivery

Theme	Baseline findings	Rationale		Intervention	
		Content	Mode of delivery	Content (Key message)	Mode of delivery
1. Intake of organ meat, muscle meat, and fruit to prevent ID	Most mothers had **no formal schooling** (91.9%). According to the 24-hour recall, 11.1% of children and 10.1% of mothers consumed **citrus fruit** **Organ meat** was only consumed occasionally: among mothers 78.2% consumed liver, 81.5% kidneys, and 81.5% heart only occasionally. **Fleshy meat** was only consumed occasionally: among mothers 51.9% Consumed beef, 70.1% lamb, 81.5 % goat meat and 78.2% chicken only occasionally.	*To help mothers appreciate the roles of fruit intake, organ and fleshy meat in ID prevention.*	Pictures of familiar and available foods to improve the mothers' understanding since they are not formally educated.	Fruits contain vitamin C and sometimes A: Pawpaw, dawadawa Oranges contain vitamin C which helps to make iron in food more available to the body. Organ meat, fish and fleshy meat are good sources of iron. (**Eat more meat, fish and fruits to increase access to available iron**)	Pictures: Fruits Pictures: Organ meat Pictures: Fleshy meat Real fleshy meat, organ meat and fruit samples
2. Intake and the timing of tea intake to prevent	According to the 24-hour recall, 56.6% of mothers and 54.6% of the children **consumed tea.** While 85.1% of mothers approved of drinking **tea with**	*To sensitise the mothers to the ID risk associated with tea and the role of tannins in inhibiting iron absorption.*	Pictures to enable mothers to see how tea should be prepared for less tannin extraction.	- Tea should **not be brewed** (the bag should be steeped in hot water and not boiled in water. - The same **teabag** should **not be**	Picture - Tea bags Picture - Tea bag steeping in hot water

ID	**meals**, 40% of mothers reported drinking tea during meals: Some mothers reported drinking tea only in the early morning. Tea was observed to be **brewed**, which increases the release of tannins. **Plain tea (with nothing added)** was given **as a complementary food** to children.	*To discourage drinking of tea with meals or as a complementary feed.*		**used extensively**. - It is best to drink tea **at least an hour before or after meals** to prevent it's interaction with food. -Tea does not contain a lot of nutrients so mothers should **not use it as a complementary food**. **(Do not brew tea; allow time between tea intake and meals, to increase iron availability)**	
3. Birth spacing and the role of contraception to prevent ID;	Only one mother reported using contraceptives (a hormonal drug, *Depo provera*) During interactions with mothers, they reported they did not use contraceptives because **they either did not like it**, but most importantly because according to them, in this **polygamist society**, a woman **stopped** "**visiting her husband**" when she delivers a child. Another cultural practice where the mother goes to **live with her family after delivery until the child is "walking**", also serves as a birth control method.	*To help the mothers appreciate the positive and negative effects of contraceptives with regard to ID***.**	Pictures to enable mothers to see examples of contraceptives. *The various types of contraception will be shown to mothers to identify.*	**Some pills have an iron containing coating** and while using it, the woman has an advantage for both child spacing and improving iron status The intra-uterine device **(IUD) may cause heavy menstrual flow**, which easily cause ID if mothers do not make up with good food sources of iron. (**Choose contraceptive with health person, and space children to reduce nutrient requirements)**	Picture: Coated pills Pictures: Types of contraceptives Samples of contraceptives

4. Treatment of malaria and personal and environmental hygiene; to prevent ID;	- 2% of mothers had **malaria** less than a week prior to the interview. - 40.8% of the mothers who reported having had malaria, used over the **counter (OTC) drugs or herbal remedies** (4.1%) as primary treatment. - 1.9% of children were reported to have **diarrhoea** and 80.8% to have had **fever** within the two weeks prior to the interview. - 61.5% of mothers and 76.6% of children had not been **de-wormed** in the three months prior to the interview. - 50.0% of the mothers did not think that **de-worming** affects ID and a further 5.7% did know if it does.	*To teach hygiene practices and the importance of a clean environment; hand washing; not defecating in water sources; and improving the quality of water, and how these practices contributes to improved iron status.* *To teach practices to prevent parasitic infections: malaria and worm infestation*	Pictures to enable mothers see examples of a clean environment and hand washing. Practical hand washing with soap and water purification using alum was done with observation by the mothers.	When one has **diarrhoea**, they go to the toilet shortly after any food is eaten. This reduces the time that the food should stay in the body. The body **is less able to absorb iron** and other nutrients When one does **not wash hands** with **soap** germs can cause diarrhoea - **Water that is not clean** can also cause diarrhoea or worms: Boil water from dam and others sources before drinking - When consumed, **worms feed on the food that is eaten** by the mother/child and also cause **bleeding of the intestines**. Together this can cause the iron levels in the body to reduce. - Sleep in treated **nets** to prevent **mosquito** bites and keep the **environment clean** to reduce mosquito breeding. **(Prevent malaria, diarrhoea and worms which can increase risk for ID)**	Picture: Hand washing with soap Picture: Clean environment Picture: Mosquito bites Practical hand washing and water purification during session.

5. Complementary feeding in areas with high risk for ID	- 58.9% of children were being **breastfed** at the time of interview. - 80.0% of children were reported to be **exclusively breastfed** - Only one child was never breastfed because "the mothers' breast milk would not flow", and in the place of breast milk, the child was given **maize porridge**. - 54.5% of children were **introduced to liquid food between 4-6 months** and 1.8% of them at younger than 2 months. - The 12.7% who introduced solid foods at 4- 6 months, prepared **porridge** from maize or millet usually **without addition of other food types/soup/sauce**.	*To help mothers identify good food choices to improve complementary feeding practices that will improve child iron status.*	Pictures will enable mothers identify good food choices and feeding practices for babies to prevent ID.	Like adults, the feeding of children is important for their **growth and development**. Children also like variety and the **variety will help meet most of the nutrient needs**. Since **fish** contains iron and also enhances the iron in the other food in a meal to be easily used by the body, it will help if mothers use them in baby's meals For children who are fed porridge, **add pounded fish, beans and groundnuts to porridge** to improve the nutrient quality. **(Increase variety of food during complementary feeding and fortify with iron rich foods)**	Picture: Plate model Samples of anchovies acquired from the market.
6. Pica as a risk factor for ID	- 1.9% of **mothers** reported having **craved non-food substances**: of these 66.7% craved clay, 22.3% craved soil and 3.1% indicated that they have had cravings for cola nuts. - Mothers of 9.0% of children reported that their **children** showed **pica behaviour**, 0.6% of them did not know if their	*Pica practices can put one at risk for ID.* *The possibility of worm infestations from clay and soil or other raw foods,*	Pictures to enable mothers identify the concept of risk of pica	Pica is the **increased appetite for food and non-food substances.** Some of these foods may **contain germs or disease causing agents**, that lead to infections and worm	Picture: child eating soil Picture: worms in soil Picture: Processed clay

	children showed pica, while the rest indicated that their children showed no pica. - Of the children reported to show pica, 64.3% craved soil, (while 28.6% actually eats clay), 14.3% for dust, 7.1% for paper and 7.1% for chalk. - **Pica practice in pregnancy** was observed in 29.3% of the mothers. The foods craved were cola nut (7.8%), Bambara beans (3.9%) and raw rice (2.0%). - **Geophagea** was reported by 8.6% of the women who reported having practiced pica in pregnancy; actual soil intake was reported by 19.6% of them	*will further affect ID.*		infestations and consequently make the person iron deficient During pregnancy, mothers should find other foods to satisfy their cravings like fruits rather than clay, since the negative nutritional effect could also translate to the unborn child's health. **(Pica is a risk factor for ID)**	Sample clay form main sources (sold in the local market and termite mound)
7. **Pica as an indicator for ID**	- Asked why people display pica behaviour; 63.6% of the mothers said they did not know why people display pica, the rest indicated that the community sees people with pica as sick people (17.2%); that pica is not good for them (8.6%); or that it was their personal business (6.0%). - Though many see people who practice pica as sick people, 53% thought that pica cannot be treated. - Regarding children who practice pica, 49.2% of the mothers thought that a **child should be beaten or scared into stopping**.	*Pica may also be a sign of ID.* *To enable mothers associate pica practice with ID and not as a spiritual problem or a normal practice in pregnancy.*	Pictures to help m*others identify physical signs of ID including pica practice*	When a person **is iron deficient**, they may have **cravings** to eat these foods or sometimes things that are not food. When a child or a grown-up has an urge to eat these foods, **one can suspect ID.** Soil or clay eating in children may be a **sign of ID** rather than just part of developing.	Picture: Atrophied tongue Picture: Spoon finger nails Picture: Angular stomatitis Picture; Pica practice

		Apart from pica the other signs of chronic anemia with signs like smooth (atrophied) tongue, sores at the corners of the mouth (angular stomatitis) and spoon nails. Pica is a good sign of ID being present. **(Pica may be a sign of ID)**

8. Myths and misconceptions regarding ID and pica.	**<u>FACTORS</u>** <u>THAT MOTHERS BELIEVED TO</u> **<u>CAUSE ANEMIA</u>** - **Standing** in the sun for long hours **for long hours (**69.4%) - Hard work can cause - Stress - Sickness (fever) **<u>FACTORS</u>** <u>THAT MOTHERS BELIEVED TO</u> **<u>PREVENT ANEMIA</u>** - Regular growth monitoring of children at clinic (88.8%) - Circumcision of baby boy (45.3%); many did not know (24.9%) - Shaving baby hair (38.0%); many did not know (37.3%) - Regular visit of mother to the clinic - Malt drink combined with milk **<u>FOODS MYTHS</u>** <u>BELIEVED AMONG THE MOTHERS</u>: - Only 7 mothers indicated that there were **food totems for children** and these include pork, cashew, fish, cowpea and eggs. - **Fish and eggs** are believed to cause a child to be a thief. - **Cowpea** is said to cause malaria in children but this was observed in only one participant. **<u>OTHER BELIEFS</u>:**	*To help mothers identify myths and truths on causes and pre-cautions related to ID.* *-There are faddisms about foods eaten as pica: e.g. the association of headache relief with cola nuts.* *-Food taboo's or totems may be significant in ID prevention since most food foo taboos are good iron sources.*	-Cards will enable messages to be easily communicated -The list of myths regarding the causes of ID was addressed. - Mothers will be made to answer the "whys" and "how's" on the myth, thus why and how true they believe in the myths - The explorative nature of work enabled mothers to contribute to the intervention.	• Cuts/injury leading to blood loss can cause ID/anemia • Hard work does not cause ID/anemia • Stress does not causes ID/anemia • Regular visit alone to the clinic will not reduce anemia • Anemia is a disease condition not just God's will. • Drinking tea with meals has an effect on iron uptake • Malta drink and milk does not prevent anemia • Drinking tea with meals has effect on iron • Cashew fruit-when taken with groundnut is not dangerous • Cowpea does not cause malaria • Fish, and eggs does not make child steal • People who practice pica are not insane	Lists of myths and misconceptions Cards with messages

	- Anemia is God's will - Edema is a sign of anemia - Itching body is a sign of anemia			• Pregnancy or hormonal changes alone does not causes pica • Pica is not due to headaches • Ignoring cravings of pica may not treat it • Getting a substitute/ chewing stick may not treat pica • Pica may not stop after delivery • Beating /scaring the child to stop will not stop pica • Children will not stop pica when they grow **(There is an association between pica and ID)**	
9. Other risk factors: perinatal care versus unassisted home	- 91.8% of children were **born at home**, hence birth weight was not known. - 9.1% of mothers reporting having to change their pads during the night due to **heavy menstruation**.	*To help mothers identify bleeding related to place of delivery and menstruation as risks for ID*	Discussions will enable mothers to identify these practices as risks for ID.	When a mother finds out she is pregnant it is advisable to **report to the health centre immediately** to make sure she and the baby are not at any risk.	Illustrate key messages

deliveries	- 7.5% reported **passing blood clots** about 1cm diameter or bigger during - menstruation			Subsequent **visits to health care centre** not only help her know that all is well but it also helps her to get interaction on how to manage her pregnancy, what to eat and how to initiate breastfeeding and maintain it until the child is 2 years. It is equally important to **deliver in the hospital** since help is readily available in case of complications. (**Report heavy bleeding and pregnancies to health facility; delivery in the health care centre could save the lives of both mother and child)**	
10. Practical demonstrations: cooking methods; the plate model, selection of	- When asked which a better choice to prevent anemia, 88.8% of mothers chose vegetables over **meat** to prevent anemia. - 62.5% of mothers chose **oranges** over mangoes to prevent anemia. - Between **spinach** and **okra**, 70.3% did not know which was better. - Of the 69.0% chose **liver** as a better food to prevent anemia	*To help mothers have a practical, hands on experience on food preparation with the intention to improve iron status.* *Home fortification of*	**Cooking demonstrations** facilitated by researcher. -In communities cook an iron rich complementary food, and general household meal. -Two mothers from each	- Choose food with high iron when cooking for the entire household and also for children. - Reduce the carbohydrates in the food. - Do not overcook vegetables. - Increase variety in meals.	Group food preparations

protein foods, and the addition of fish powder in complementary foods.	than bread. - From observation **vegetables are usually over-cooked** and **very few non-heme iron sources are used.** - From observation**,** meals are served with **more carbohydrate and very little soup or sauce** to accompany starches.	*complementary food and general household meals using legumes (beans, soya beans, groundnut) and anchovies.*	community would present their foods prepared and the rest will ask questions. They would be given the key message card to be taken home.	- Serve food with more heme iron containing soup/sauces **(Cooking methods can improve access to iron; improve food quality with fish and legumes)**

Theme 4: Treatment of malaria and personal and environmental hygiene; to prevent ID;

Key message 4: Prevent malaria, diarrhoea and worms which can increase risk for ID

The recall of malaria incidence was low among mothers and children, however; treatment was done with herbal remedies and the use of over-the-counter drugs. Diarrheal episodes were also reported at baseline among children. The rationale was to educate mothers on the importance of these environmental factors and on practices to improve hygiene. Practical hand washing using the correct technique was demonstrated. Water purification was also demonstrated.

Theme 5: Complementary feeding in areas with high risk for ID;

Key message 5: Increase variety of food during complementary feeding and fortify with iron rich foods

Sub-optimal breastfeeding and complementary feeding practices were identified in the community. The rationale was to educate mothers on appropriate food choices and practices for complementary feeding. Food samples of a variety of appropriate food choices for complementary feeding were shown.

Theme 6: Pica as a risk factor for ID

Key message 6: Pica is a risk factor for ID

Pica for food and non-food substances was reported among both mothers and their children. The most common pica substance was clay and soil. Pica practices were also reported for the pregnancy with the index child. The rationale was to educate mothers on the risk associated with the intake of pica substances. Clay samples from the community and the market were shown to mothers, as well as a picture of worms in soil (The concept of microscopic hookworm was explained, but the picture was used to help these uneducated mothers understand the concept and the risk for worm infestation through soil or clay intake).

Theme 7: Pica as an indicator for ID

Key message 7: Pica may be a sign of ID

Pica practice was associated with several myths and beliefs. Mothers viewed as a sign of mental illness, or as normal growth pattern of children, and reported that they thought the community did not think well of people who participate. It was also seen as a sickness did not think well of people who practiced pica. Pica was also viewed as a condition that cannot be treated. Proposals from the mothers for treatments of pica practice included canning and scaring children. The rationale of this theme was to help mothers appreciate the association between pica and ID, and to use pica as an early identification sign of ID which should be taken to health personnel for treatment and counselling.

Theme 8: Myths and misconceptions regarding ID and pica

Key message 8: There is an association between pica and ID

There were several myths and misconceptions as listed in table 2 regarding ID and pica. These were addressed through discussions where mothers shared "why" they believed stated myths related to ID and "how" beliefs could cause ID was posed to mothers. For instance, most mothers believed hard work caused ID, because working hard may make one dizzy; but they could not explain "how" it lead to ID (reduced quantity or quality of blood). To address this myth; a closed bottle containing water was used to represent the body with blood. If a person works hard, illustrated by shaking the bottle, does not compromise the quality or reduce the quantity of water. However, a hole pieced into the bottle (indicating a cut or menstruation) causes the water (iron) to leak out. To maintain the quantity and quality of the water (blood) the mothers' have to keep topping up the water (iron status; by eating iron-rich diets). The rationale for this message was to help mothers identify the myths on ID by understanding the concept of the development of ID.

Theme 9: Other risk factors: perinatal care versus unassisted home deliveries;

Key message 9: Report heavy bleeding and pregnancies to health facility; delivery in the health care centre could save the lives of both mother and child.

Over 90.0% home deliveries were reported; which made it difficult to determine birth weight of children in the study. Discussions were done with mothers on the content in table 8.1 to enable mothers to identify the risks of bleeding related to ID during menstruation and delivery. Mothers were enlightened on the risk of complications during delivery and how delivery in the health care facility could reduce this risk for both mother and child.

Theme 10: Practical demonstrations: cooking methods; the plate model, selection of protein foods, and the addition of fish powder in complementary foods.

Key message 10: Cooking methods can improve access to iron; improve food quality with fish, meat and legumes.

Based on these themes a key messages card (Appendix 10) was designed with more simplified language and pictures for easy understanding.

8.4.2.2 Schedule of the NEP

The themes were developed into a five day programme. For logistical purposes the intervention group was divided into three smaller groups. Each group was taken through the following programme schedule:

Day 1- Introduction and themes 1-2;

Day 2- Theme 3-5;

Day 3- Theme 6-8;

Day 4- Theme 9; and

Day 5 - Theme 10; feedback.

After the five day intervention, each mother was visited at home by (twice) to reinforce the NEP messages and address any questions she might have on the application of the messages into individual household meals and routines. Each interaction with the mothers was kept to about 30 minutes in order not to interfere with her daily activities.

8.4.2.3 Venue, logistics and course material

The intervention interactions took place at the health centre in the community, which had a hall big enough to accommodate about 50 people. To prevent sessions from being overcrowded and facilitate good interactions during sessions, the mothers were randomly divided into three communities, of 27 mothers in a group. These three communities were randomly allocated to attend the sessions in the mornings (8h00 -10h00) (11h00 -13h00) and afternoons (14h00-16h00) for the first four days of the training programme. On the fifth day, all three communities joined in a practical food demonstration session which took about 5 hours (9h00-14:00). All these interactions took place in a WFP feeding centre, which was a fenced space where mothers could sit and the space was big enough to be used for cooking during the practical session. The researcher and an assistant, who was a nutritionist and spoke the local language (Dagbani), facilitated all sessions. The assistant was the translator. A daily journal of activities during the sessions is attached as appendix 11.

Announcements on these sessions were made by the community volunteers who already work with these women on child growth promotion programmes. The mothers were encouraged to come on time in order to get programmes started on schedule.

Course materials like the training cards containing key messages with pictures, were provided to the mothers on the first day of the intervention. During sessions, samples of food, pills and pica substances, as well as pictures, were used to enhance visual learning. Fresh produce and ingredients for the demonstrations were provided by the researcher, but were obtained from within the community. A plate divided into four parts to illustrate the plate model was also used. A clean cloth and alum was also used to show simple ways of water purification.

The intervention was hosted before the Muslim fasting period to enhance participation and improve the success of the food demonstrations.

The intervention took place 14 months after the baseline was performed. To allow for growth and weight changes that occurred since baseline, the anthropometry of both mothers and their children were repeated at this point. Since the change in growth was one of the variables to evaluate the intervention, reassessing anthropometry before implementing the NEP, enabled better assessment of the intervention. Mothers were therefore encouraged to attend the first day of the NEP with their children for anthropometry measurement.

Taking into account the low educational level of mothers (who were mostly unschooled), care was taken to create an informal and relaxed environment, as opposed to a rigid formal setting, which could have intimidated them. For this reason, a circular sitting arrangement was used to enhance effective communication (Contento, 2008; Klatt, 1999).

Simple language and familiar terms were used to present key messages related to each of the ten themes. During the interaction, to keep mothers participating, energisers like songs were integrated into the sessions.

8.4.2.4 Interaction sessions

The sessions on days one to four were grounded in the HBM, which holds that giving people information on the negative effects or the causes of an illness encourages them to take precautions. The principles of adult learning were incorporated into the NEP. As adults are self-directed and internally motivated; and relevance-oriented, mothers were assured on how the intervention was relevant to them and would help them to improve their own health, that of their children and entire families. Theory on adult learning further holds that adults bring their own life experiences and knowledge to the learning experience; making them active participants with contributions to training sessions. Such sharing of ideas and active participation in the sessions was facilitated throughout the NEP. To this end mothers were made to feel comfortable and encouraged to contribute their knowledge in a non-intimidating atmosphere (Patterson, 2004). For example a mother who lost a child to ID, shared her experiences with the community. Another mother shared her experience of how she tried to enforce hand washing in her household after a previous day's session on hand washing. Prizes for contributions in sessions were also given, in the form of soap to encourage hand washing.

Mothers were also facilitated and guided to explore their existing knowledge on food, nutrients, and feeding choices, as a basis for the new knowledge imparted to them. As theory holds that adults are practical and need to experience practically how their learning applies to their own context, practical examples relevant to their situation were tied into the key messages.

On day one, a general introduction on ID, the prevalence, causes, associated symptoms, and prevention was shared with the mothers. Themes 1 and 2 regarding the intake of organ meat, muscle meat, and fruit to prevent ID; and intake and the timing of tea intake to prevent ID, were incorporated.

On day two, the role of birth spacing, contraception, malaria, personal and environmental hygiene, as well as complementary feeding to prevent ID were discussed.

On day three, when everyone was more relaxed already, the focus moved to pica. (At baseline it became apparent that the mothers thought that the community and society they lived in, frowned upon people who practice pica).

On day four other risk factors including perinatal care versus unassisted home deliveries were addressed.

8.4.2.5 Practical session

On day five practical points regarding, selection of iron-rich foods, cooking methods and the addition of fish powder in complementary foods, were addressed. A plate model adapted from the USDA was introduced to mothers to help them visualise the concept of a balanced meal and to compare their food intake to. For ease of understanding, the plate model was adapted to four portions; one part for starch foods (foods eaten in the community were used as examples), one part protein foods such as meat, beans, or groundnut; and other two parts for vegetables and fruits. Fat and diary are on the side and fat is encouraged to be eaten with moderation (USDA, 2011).

The practical session was conducted in an equally informal manner as the interactions on the other days (Kennedy, 2003: Klatt, 1999). All the mothers participated at least once, but were divided into three communities. Each group was guided by the facilitator (the researcher) to select foods and prepare three sets of meals. The goal was to prepare one meal as complementary food for young children, and another for the entire household while applying the principles of selecting, preparing and serving foods in a way that enhances iron status of the entire family. A third meal focused on general healthy food for the entire household. The complementary food for children and the regular staples for the household are cereal-based food, therefore there is the need for education to reduce inhibitory factors and enhance the benefits of cereal-based foods. This education constituted storage, preparations methods and combinations of food.

This practical component of the NEP, as well as the subsequent household follow-up visits to enhance and refresh the messages learned, went beyond the theory of HBM and was designed to address the published limitations of the theory, which were discussed before. The aim was to help the mother incorporate simple changes into her own context and to personalise the messages while she was being supported by her environment (people and place).

8.4.3 Follow-up household visits

Two household follow-up visits of 30 min each per household were also incorporated into the intervention. These household visits were done two weeks after the intervention was carried out. This helped to refresh mothers on the key messages and also to address questions on application of the messages into their individual household meals and routines. The follow-up sheet in appendix 12, which probed the mothers memory about the key messages, how she had applied the key messages in her daily chores, and any challenges that she had encountered, were used to guide these visits. This section of the intervention addressed the context in which the required behaviour change was to take place. As recognised by the SCT, the mothers' immediate environment and personal and household challenges would influence the changes that they were able to make. Family members who showed interest during these sessions, where also made part of the discussions. A full report is attached as appendix 13.

8.5 Conclusions

To date approaches have mostly focused on supplementation and fortification to curb the high rates of anemia among WRA and children in Ghana. These methods are, however, foreign and/or unsustainable in the rural communities of Northern Ghana most affected by ID. In the long-term, communities need to be empowered to improve their own health. A food-based approach may be more culturally acceptable and sustainable. Nutrition education is therefore important to empower these communities to make the most of their available resources to enhance iron status, within the context of their culture and society.

Note: The impact of the intervention on the KAP regarding pica and other dietary practices that affect ID are written in the next three chapters: 9.10 and 11.

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PHASE III: IMAPCT OF NEP

CHAPTER 9

IMPACT OF AN EDUCATIONAL INTERVENTION ON DIETARY RISK FACTORS FOR IRON DEFICIENCY AMONG MOTHERS AND THEIR YOUNG CHILDREN IN NORTHERN GHANA

This section of the research was presented as a *Poster presentation in* ***Africa Nutrition Epidemiology Conference*** *(ANEC VI), 21th - 26th July, 2014, Accra, Ghana* . As; Impact of educational intervention on dietary risk factors for iron deficiency among mothers in Northern Ghana.

9 IMPACT OF AN EDUCATIONAL INTERVENTION ON DIETARY RISK FACTORS FOR IRON DEFICIENCY AMONG MOTHERS AND THEIR YOUNG CHILDREN IN NORTHERN GHANA

9.1 Abstract

Background: The effect of a nutrition education intervention on dietary risk factors for iron deficiency (ID) among mothers and their young children (6-59 months) in Northern Ghana, where anemia endemic population, was assessed.

Methods: A five-day intervention addressing dietary practices, designed from a baseline survey which assessed the dietary risk factors for ID, was implemented in July 2013 among 73 mothers in Tolon-Kumbungu District, with 70 mothers from Tamale Metropolis as control. Anthropometry, food frequencies, 3x24-hour recalls, and food security, assessed via questionnaires in semi-structured interviews at baseline (April 2012) were repeated three months post-intervention (October 2013).

Results: Post intervention, significant change in the generally low meat intake reported at baseline was observed among both mothers and children post-intervention. The prevalence of inadequate intake of iron was 93.0% at an assumed 5% bioavailability and 46.1% at 10% among mothers. Among children, the prevalence of inadequate intake of iron was 71.3% at an assumed 5% bioavailability and 27.7% at 10%. About 20% of mothers had inadequate intakes of both protein and vitamin A in the intervention community, compared to 27.5% and 16.0%, who had inadequate intakes of protein and vitamin A in the control community, although the difference was not statistically significant. Almost all mothers and children in both communities had inadequate intake of vitamin B12 but the prevalence of inadequate intake was significantly higher (p=0.016) among the children in the intervention community 94.7% than the control community 51(78.5%).

Conclusion: A nutrition education intervention translated to some positive change in dietary practices which lead to increased protein intake in the intervention group but not vitamin B12among mothers and children in an anemic-prone rural community.

Key words: nutrition education intervention, dietary risk factors, mothers, iron deficiency

9.2 Introduction

Anemia is a global public health challenge that affects 42% of pregnant women and 47% of preschool children worldwide (MacLean *et al.*, 2007). In Africa, about 65% of people of all age groups, and 64.6% of pre-schoolers, 55.8% of pregnant women, and 44.4% of non–pregnant women, are anemic (Benoist *et al.*, 2008; McLean *et al.*, 2007:7). At a prevalence of above 40% , evidence suggest that iron deficiency (ID) may be assumed to affect an entire population (McLean *et al.*, 2007). In women of reproductive age (WRA) and young children, iron stores may be progressively depleted due to increased physiological needs posed by menstruation, pregnancy and growth, particularly when combined with inadequate intake of the nutrient (Agarwal, 2010). The adequacy of iron intakes depend of the quality, quantity and frequency of iron sources consumed, as well as the bioavailability of iron in the diet (Teucher *et al.*, 2004; WHO, 2001). Among children, ID is usually seen in those older than six months, when complementary foods, which do not provide adequate iron, are introduced (Domellöf *et al*., 2014).

In early 2000, MOST/USAID collaborated with the Ghana Health Services (GHS) to develop an integrated anemia control strategy for Ghana. An Anemia Control Coordinating Committee (ACCC) was established to guide the design of a national anemia control programme (GHS/USAID/MOST, 2003). The strategy for Ghana, with the objective 'to contribute to the health of women in the fertile age group, and the growth and development of children, by reducing morbidity and mortality due to anemia', aimed to reduce anemia prevalence by 25% in each target groups by 2007. According to the GDHS, the national prevalence of anemia among children, which was 76.6% in 2003, was 78% in 2008, despite the implementation of the programme (GDHS, 2008:194).

The strategy has five key components, namely food-based approaches emphasising food fortification and dietary diversification; iron-folate supplementation; malaria control; helminthes infection control; and education, information and communication (GHS/USAID/MOST, 2003). Nutrition education as a component of nutrition interventions (Contento, 2008) refers to communication activities aimed at helping people to voluntarily change nutrition-related behaviour, in order to improve the nutritional status and wellbeing of the population (Adrien, 1994). A meta-analysis of 300 studies concluded that nutrition education is more likely to be successful when it focuses on behaviour, and systematically links relevant theory, research and practice (Contento, 2008). Globally, nutrition education alone, or integrated with other interventions, have been effectively used to address public health challenges (Sanou *et al.*, 2010; Mahr *et al*., 2005; Balachander, 1991). Similarly, a systematic review of 42 studies from 25 developing countries, concluded that education interventions may be successfully applied to improve the intake of iron, given that messages are focused (Adu-Afarwuah & Dewey, 2008).

The Northern Region of Ghana is among the worst affected by anemia. According to the 2008 GHDS, about 60% of WRA and about 80% of children were anemic in this area. It is the largest region in Ghana and consists of 20 districts. The region shares boundaries with the Upper East and the Upper West Regions to the north, with the Brong Ahafo and the Volta Regions to the south, the Republic of Togo to the east, and La Cote d' Ivoire to the west. The area has a dry climate, with a rainy season that starts in May and ends in October, followed by a dry season. Mothers in this setting are mostly responsible for the household chores, cooking and the care of the children.

In 2012, a baseline survey among mothers and their children, 6 to 59 months, from two low socio-economic agrarian communities in the Northern Region, identified high prevalence of several dietary-related risk factors for ID. The mothers were mostly illiterate, had low socio-economic status and lived off subsistence farming. For both mothers and children, low frequency of meat intake (heme-source of iron); sub-optimal and seasonal frequency of intake of non-heme iron sources, including green leafy vegetables and eggs; low intake of vitamin C-rich fruit; high intakes of phytate, fibre and tea; and low intakes of folate and vitamin B12 sources were documented. This was coupled with low food security, seemingly due to prolonged periods of food scarcity during the dry season lasting 11.5 ± 6.7 weeks on average, but lasting longer than 13 weeks in about 25% of households (Abu, 2015:121-156). From the baseline findings, 10 themes were identified, and key messages were designed around each of the themes as the basis of a nutrition education intervention programme (NEP). The NEP was implemented in the original study population in one of the two communities in 2013. The current study aimed to evaluate whether the NEP successfully translated to improve risk behaviour related to the dietary intake of iron, among these mothers and their children, 6 to 59 months. In order to achieve the aim, the baseline data collection regarding dietary practices, was repeated three months after the intervention community had been exposed to the NEP. If successful, a focused NEP, such as this, may offer a more sustainable and cost-effective solution to ID in the area. The findings of the study may inform the development of NEPs in similar rural agrarian communities in Ghana and other developing countries.

9.3 Methods

9.3.1 Study design and sampling

A quantitative descriptive survey was conducted in April 2012, in the northern and largest region of Ghana, in two randomly selected districts, namely Tolon-Kumbumgu district and Tamale metropolis. One community was randomly selected from within each of these two districts Gbullung (Tolon-Kumbumgu district) and Tugu and Tugu-yeplala (Tamale metropolis). In these two communities, randomly selected households were approached and all mothers who had lived in the selected community for at least 12 months; were not pregnant; and had one or more children aged six to 59 months (henceforth referred to as the index child(ren), were invited to participate in the study. Mothers who voluntarily agreed to participate signed an informed consent form, after the study procedures were explained to them. The final sample included 161 mothers; 81 from the Tolon-Kumbumgu district and 80 from Tamale metropolis. The intervention was implemented in July, 2013 and an evaluation conducted in October, 2013.

The study was approved by the Institutional Review Boards (IRB) of Noguchi Memorial Institute of Medical Research (NMIMR) in Ghana (NMIMR-IRB CPN 064/11-12) and the Ethics Committee of the Faculty of Health Sciences, University of the Free State, South Africa (ECUFS NR 24/2012).

9.3.2 Intervention Design and Implementation

At baseline mothers and their children, six to 59 months in both communities were assessed to identify the prevalence of socio-demographic risk factors for ID; nutritional status; dietary habits; adequacy of iron and anemia-related micronutrient intakes; household food security; and food production (Abu *et al*, 2013a, 2013b, 2013c; Abu, 2015:121-156).

The identified gaps regarding the known risk factors for ID were summarised into ten themes with associated key messages, to form the framework of a NEP, focused on dietary-related risk factors for ID within the local context of these mothers and their children (Abu *et al.*, 2014 a; 2014b). The low literacy levels of the mothers, and the theory on adults learning and different learning styles, were considered in the design of the intervention (Kennedy, 2003; Barbe *et al.*, 1981).

Four of the themes were related to dietary-related risk factors, namely:

Theme 1: Intake of organ meat, muscle meat, and fruit to prevent ID;

Key message 1: Eat more meat, fish and fruits to increase access to available iron;

Theme 2: Intake and the timing of tea intake to prevent ID;

Key message 2: Do not brew tea; allow time between tea intake and meals, to increase iron availability;

Theme 5: Complementary feeding in areas with high risk for ID;

Key message 5: Increase variety of food during complementary feeding and fortify with iron rich foods;

Theme 10: Practical demonstrations: cooking methods; the plate model, selection of protein foods, and the addition of fish powder in complementary foods.

Key message 10: Cooking methods can improve access to iron; improve food quality with fish, meat and legumes.

A fifth theme was related to the environment and hygienic treatment of food:

Theme 4: Environmental hygiene to prevent ID;

Key message 4: Prevent malaria, diarrhoea and worms which can increase risk for ID;

To improve the contextual relevance, local food samples, pictures that mothers could relate to, and resources from within the communities, were used to enhance interactions. The intervention was implemented in July 2013 in the community in Tolon-Kumbungu District, which was randomly selected as the intervention community, as part of the larger five-day intervention. The intervention community consisted of 73 mothers. At the time that the intervention was implemented, eight mothers (10.0%) had been lost from baseline, as they had migrated to southern Ghana to engage in menial jobs for income; a common practice in the Northern Sector during the dry season, referred to as "Kayayie". For logistical reasons, the remaining 73 mothers were subdivided into three equal sized communities. The themes were presented during a 90-minute session each. Two weeks after the intervention, and again two weeks after that, the researchers visited each individual household in the intervention community to help mothers to address challenges in applying and adhering to the education messages. The household visits were also used to refresh the messages of the NEP. Each household was visited twice, two weeks apart, for about 30 minutes/household/session. The impact of the NEP was evaluated in October 2013, by repeating the baseline survey in both communities. At this point, 20 mothers and 23 children had been lost from baseline to follow-up from both communities in total with about the same number of patricipants lost to follow-up.

9.3.3 Data collection

The researchers developed a questionnaire, based on an in-depth survey of the literature on ID, to assess the socio-demographics, food security, and dietary intakes and usual eating patterns related to ID and anemia. The questionnaire was administered during structured interviews conducted with the mothers in their homes.

Food security, as assessed with the validated 8-item Community Childhood Hunger Identification Project (CCHIP) Household Hunger Scale (Wehler *et al*., 1992).

The researcher and two trained field workers measured the heights/lengths and weights of the women and children, observing all standard protocols (Gibson, 2005). All mothers and index children were assessed for physical signs of chronic anemia, namely angular stomatitis, atrophic glossitis and koilonychias. Pictures were used to train the assistants to recognise these signs.

To assess the dietary patterns of the study population, a 75-item food frequency questionnaire (FFQ) was developed to include the 16 food groups used in the FAO Dietary Diversity Questionnaire (Kennedy *et al.,* 2011), and adapted to reflect foods commonly consumed in this population. The reference period of the recall was three months prior of the interview.

To assess dietary intakes, 24hr-recalls for three non-consecutive days were included in the questionnaire and administered according to a multiple-pass interview approach (Lee & Nieman, 2013) in which mothers were facilitated to give an account for all foods eaten, the amount consumed, and the mode of preparation of the foods (for both mothers and their index child (ren).

Three additional open-ended questions were add to the questionnaire in order to evaluate the recall of, and adherence to the NEP messages, as well as challenges encountered during the implementation of the messages in the households.

To ensure reliability, all standard methods and standard published procedures were followed accurately. The scale was calibrated every morning, using a known weight. Research assistants were properly trained to improve skills on estimation and non-bias probing of participants to ensure accurate questionnaire data collection. Calibrated food models and household measures from the communities were used to help mothers describe portion sizes of foods eaten (Gibson & Ferguson, 2008:48). In the case of foods purchased from outside, the monetary values were asked to assist the accurate estimation of the amounts of these food consumed. To maximise truthful and accurate information, interviews were, as at baseline, conducted in the privacy of each woman's own home and they were assured of the confidentiality of data collected. Since most mothers were not formally educated, questions were read to them in Dagbani and these responses were then captured by the researcher in English. To improve understanding of the local situation and contextualise the findings, the primary researcher observed the local customs and recorded these in a field journal.

9.3.4 Data analysis

Data were analysed using SAS/STAT software (Version 9.3 of the SAS system for Windows; Copyright © 2010 SAS Institute Inc.). Socio-demographic and FFQ data were summarised as frequencies and percentages for categorical data and medians, means and standard deviations (SD) for continuous data.

The socio-demographic data of the intervention and control communities were compared by the independent t-test for continuous variables, and Fisher's exact test for categorical data ($p<0.05$ was considered statistically significant).

The paired t-test was also used to assess the changes in mean nutrient intakes, food frequency intake, and BMI and Z scores from baseline to post-intervention within groups. To assess the difference in changes from baseline, between groups, categorical data for food security, FFQ, nutrient intakes and anthropometry, were assigned ordinal ranking orders; baseline and post-intervention scores were calculated and compared with analysis of variance (ANOVA). Baseline and post-intervention categorical data was also cross tabulated to indicate exactly how categories changed from baseline to post-intervention, and the Fisher's exact test was used to assess significance of changes.

Household food security was assessed according to an 8-item hunger scale from the Community Childhood Hunger Identification Project (CCHIP) (Wehler *et al.*, 1992). Scores were further categorised as: 0 indicated that the household is food secure; 1-4 indicated that the household is at risk of hunger, and ≥5 indicated that the household is experiencing chronic hunger for the sake of comparison.

FFQ data were scored by assigning ordinal numbers to the intake categories as follows: daily (7); 3-4x/week (6); 1x/week (5); 2-3x/month (4), 1x/month (3), occasionally=2 and never (1).

Mean intakes of the micronutrients relevant to iron status, namely vitamins C, A, B12, folate and iron, were calculated from the 3x24h-recalls using the Ghana Nutrient Database (Version 6.02); and the averages of the three days' intakes were calculated with Microsoft Office Excel to express the final absolute intake values. The age-specific estimated average requirements (EAR) cut-points were used to evaluate the adequacy of intakes of energy and all the nutrients (except iron), according to the FAO/WHO (2004) vitamin and mineral requirements in human nutrition (Gibson & Ferguson, 2008). The probability method was used to assess the adequacy of iron intake at 5% and 10% bioavailability, according to the HarvestPlus methodology and recommendations for populations in developing areas (Gibson & Ferguson, 2008; Allen *et al.*, 2006; WHO/FAO, 2004). The differences in mean intakes from baseline to post-intervention were compared with the paired t-test and $p<0.05$ was considered statistically significant.

The Z–scores were calculated using the WHO Anthro Plus software based on WHO standards for children and categorised as over-nutrition (>2.01SD), normal (-2≥ and ≤2SD), moderate malnutrition (-2.01-3SD), and severe malnutrition (>-3.01SD) (Seal and Kerac, 2007; WHO, 2006). Stunting (height-for-age) (HAZ), underweight (weight-for-age) (WAZ), and wasting (weight-for-height) (WHZ) (Gibson, 2005) were evaluated from these measurements. To assess the change from baseline, WAZ, HAZ and WHZ categories were scored by assigning ordinal numbers: ≥-2SD (3); -2.01 to -2.99 (2) and ≤-3SD (1).

For the mothers, body mass index (BMI) was calculated as kg/m2 and categorised, according to WHO recommendations, as underweight (<18.5 kg/m2), normal (18.5–24.9 kg/m2), overweight (25.0–29.9 kg/m2), and obese class 1 (30.0–34.9 kg/m2) (WHO, 2004). Categories were further scored by assigning ordinal numbers: underweight (<18.5 kg/m2 = 1), normal (18.5-24.49 kg/m2 = 2, overweight (24.5 – 29.9 kg/m kg/m2 = 3) and obese class 1 (30-39.99 kg/m2 = 4).

Manual content analysis was done on open-ended questions on NEP adherence by categorising responses into themes. In this manuscript, major themes identified, are reported as frequencies and percentages.

9.4 Results

9.4.1 Socio-demographic characteristics

Socio-demographical characteristics of the participants at post-intervention data collection are summarised and compared in Table 9.1. In both communities, most mothers were Dagomba (> 97.0%), all were Muslim (100%) and married (> 97.0%), and had a median number of four children. The mean ages of the mothers in the intervention community was 34.3 ± 9.3 years, and in the control community, 32 ± 6.9 years; and that of the children in the intervention community 46.0 ± 13.1 months, and in the control community, 40.0 ± 13.4 months. These characteristics were not statistically significantly different between the two communities. There were no significant differences in socio-demographic characteristics between baseline and post-intervention.

This was a polygamous society where families consisting of a husband and several wives (one to four in this survey), stayed together in the same household. Most households were therefore large with a median household size of 12 people living together in four- to five-roomed mud huts.

Most mothers in both communities had no formal education, and those in the intervention community were significantly less educated (p=0.017) than those in the control community, this was the same from baseline A significantly (p=0.001) higher number of households in the intervention community (94.1%) had electricity, than those in the control (63.6%), thus not changed from baseline. Less than 10% in both communities had a refrigerator and/or freezer in the household. Cross tabulation of data indicated that significantly more people in the intervention community had access to piped water, while more than 90% in the control community drew water from ponds/rivers. Households in both areas earned a median of 40 cedi ($13.3) / month, and spent an average of 6-7 cedis ($2-3) /week on food.

None of the mothers were formally employed and earning a salary. All were involved in subsistence farming, and in both communities, spent an average of around seven hours per day working away from the home. Index child(ren) in both the intervention and control communities were mostly left at home in the care of other siblings (54.1% and 42.1%, respectively), or with a grandparent (20.3% and 19.7%, respectively) when the mother was away from the home. As there were more of the older children in the intervention community, about a tenth (9.5%) attended school (kindergarten) when their mothers were working away from the house. There were no children in the control community that was attending a school.

Table 9.1: Socio-demography of the mothers and children

Variables	Intervention Community (n=71) n (%)	Control Community (n=70) n (%)	p-value for the mean difference
Mother's age (years)			
Mean ± SD	34.3 ± 9.3	32.1 ± 6.9	0.142
Median	30.0	35.0	
Mother's highest level of education			
None	68 (98.6)	61 (87.1)	0.017*
Primary school (1-6 years)	1 (1.4)	9 (12.9)	
Mother's religion			
Muslim	70 (100.0)	70 (100.0)	0.248
Marital status of the mother			
Married	69 (98.6)	67 (97.1)	
Single	1 (1.4)	0 (0.0)	0.500
Widowed	0 (0.0)	2 (2.9)	
Ethnicity			
Dagomba	69 (98.6)	67 (97.2)	
Moshi	1 (2.8)	0 (0.0)	0.370
Hausa	0 (0.0)	1 (1.4)	
Fulani	0 (0.0)	2 (2.8)	
Electricity			
Yes	64 (94.1)	42(63.6)	
No	4 (5.9)	24 (36.4)	<0.0001*
Cooling facilities			
Refrigerator	2 (3.0)	1 (1.5)	
Freezer	1 (1.5)	0 (0.0)	
Both freezer and refrigerator	1 (1.5)	0 (0.0)	0.335
Other cooling facilities	62 (93.9)	66 (98.5)	
Source of drinking water			
Bore hole	2 (2.9)	2 (2.9)	
Pipe borne water	58 (82.9)	0 (0.0)	
River/pond	0 (0.0)	65 (94.2)	
Well	10 (14.3)	2 (2.9)	<0.0001*
Household size			
Mean ± SD	14.3 ± 7.0	11.4 ± 5.0	0.007*
Median	12.0	11.0	
No of rooms in household			
Mean ± SD	6.0 ± 2.9	4.8 ± 2.7	0.989
Median	5	4	
Mother's employment status			
Self employed	69 (98.6)	67 (95.7)	0.592
Unemployment	1 (1.4)	3 (4.3)	
Household income (1cedis = 3$)			
Mean ± SD	41.5 ± 30.3	41.6 ± 2 4.6	0.468
Median	40.0	40.0	
Amount spent on food in a week (1cedis = 3$)			
Mean ± SD	10.6 ± 18.7	11.2 ± 23.9	0.731
Median	6.0	7.0	

Number of hours per day that mothers work away from home			
Mean ± SD	7.2 ± 3.8	7.5 ± 3.8	0.339
Median	6.00	6.00	
Age of child (months)			
Mean ± SD	46.0 ± 13.1	40.0 ± 13.4	0.137
Median	46.6	34.8	
Gender of children			
Male	41 (54.7)	42 (54.5)	
Female	34 (45.3)	35 (45.5)	0.560
Care of the index child while the mother works			
Mother takes child to work	4 (5.4)	16 (21.1)	
Child in school	7 (9.5)	0 (0.0)	
Leaves the child with other siblings	40 (54.1)	32 (42.1)	
Leave child with stepmother	2 (2.7)	3 (3.9)	0.057
Leaves child with grandmother	15 (20.3)	15 (19.7)	
Leaves child with a paid caretaker	2 (2.7)	2 (2.6)	
Leave child with other relations	4 (5.4)	8 (10.5)	

Independent t-test was used for continuous variable and fisher exact test for the categorical data. SD = standard deviation

The baseline findings, published elsewhere (Abu, 2015:121-185) indicated that both communities produced seasonal crops like maize, rice, millet, and sorghum, and raised livestock like cattle, sheep, goats and chicken. In addition, mothers kept vegetable gardens in which mostly seasonal green leafy vegetables and tomatoes, okra, eggplant and onions were grown for household consumption. Some households grew, or had access to fruit trees like mangoes, cashew, and baobab. For household use, mothers produced their own flour from the cereal crops (of which maize was the staple), as well as shea butter/oil from shea nuts (kernels). The animals raised, were however, mostly not slaughtered for households use. At baseline the mothers in both communities indicated that they experience periods of food shortages during the dry season every year whichlast average about three months. Overall, 20% of households in these communities reported that the crops they kept out for the household to eat, did not last through the dry season; whereas 60% reported that vegetables did not last, and 87% that fruit did not last. Table 9.2 is a summary of the reasons they gave for running out of food, namely the large family sizes, lack of land, low crop yields and not enough money to buy seed and farming equipment.

Table 9.2: Mothers views on the causes of periods of food scarcity post-intervention (n=58)

Responses to open-ended questions	**n (%)**
"Not enough land"	5(8.6)
"Not enough money to buy seed and equipment's"	30(51.7)
"Land not fertile"	19(32.8)
"Weather not good"	2(3.5)
"Consume more than harvest"	1(1.7)
"Household size too big"	1(1.7)

Compliance to exclusive breastfeeding up to 4-6 months was high, but many children received inadequate weaning foods.

9.4.2 Effect on food security

As indicated in Table 9.3, in the intervention community 50.7% were food secure, 42.0% were at risk of hunger, and 7.3% were experiencing hunger; and in the control community 65.2% were food secure, 28.8% were at risk of hunger, and 6 % were experiencing hunger post-intervention. Although there were 15% more food secure households in the control community than in the intervention community, this difference was not statistically significant.

Table 9.3 also illustrates a cross tabulation of household food security categories in both communities at baseline and post-intervention to illustrate the changes within each community. Food insecurity increased non-significantly from baseline in the intervention community, but stayed the same in the control community. Table 9.3 also indicates the percentages of individuals that changed categories from baseline to post intervention, but these changes, which occurred in both communities, were not significant. Noteworthy is that, whereas in the control community 41.4% of those households, who were food secure at baseline, were still food secure post-intervention, in the intervention community only about 21% of the households that were food secure at baseline, remained food secure post-intervention. These changes from baseline were not however, statistically significantly different between the two communities.

Table 9.3: Changes in household food security situation from baseline

	POST-INTERVENTION RESPONSES		
	Intervention community (n = 71)	**Control community (n=70)**	**p-value for the difference across categories#**
Food secure	36 (50.7)	43 (61.4)	
At risk of hunger	29 (40.8)	19 (27.1)	
Experiencing hunger	5 (7.0)	4 (5.7)	0.165

			POST-INTERVENTION RESPONSES				
			Food secure	**At risk of hunger**	**Experiencing hunger**	***TOTAL***	**p-value for the change across categories**
BASELINE RESPONSE	**Intervention community (n=71)**	Food secure	15 (21.1)	6 (8.5)	2 (2.8)	***23(33.3)***	
		At risk of hunger	15 (21.1)	21 (29.6)	3 (4.2)	***39 (56.5)***	
		Experiencing hunger	5 (7.0)	2 (2.8)	0 (0.0)	***7 (10.1)***	0.168
		TOTAL	***35 (50.7)***	***29 (42.0)***	***5 (7.3)***	***69(100.0)***	
	Control community (n=70)	Food secure	29 (41.4)	12 (16.9)	1(1.4)	***42 (63.6)***	
		At risk of hunger	13 (18.6)	7 (9.9)	2 (2.9)	***22 (33.3)***	
		Experiencing hunger	1(1.4)	0 (0.0)	1 (1.4)	***2 (3.0)***	0.173
		TOTAL	***43 (65.2)***	***19 (28.8)***	***4 (6.0)***	***66***	

Household food security was assessed according to an 8-item hunger scale from the Community Childhood Hunger Identification Project (CCHIP) (Wehler et al. 1992). To compare the difference between the changes from baseline in the communities, total scores were further categorised as; 0=Household is food secure; 1-4 indicates that the household is at risk of hunger, and a score of ≥5 indicates that the household was experiencing chronic hunger.

9.4.3 Effect on dietary and nutrient intake

The effects of the NEP on the dietary and nutrient intakes of the study population are summarised in Tables 9.4 to 9.6.

9.4.3.1 Dietary patterns for selected foods

The changes in dietary patterns as recorded by FFQ of the mother and children regarding a number of selected foods that may directly affect iron status are summarised in Table 9.4. For both mothers and children, in both communities, the intake of spinach increased from baseline; but the consumption increased significantly more in the intervention community, than in the control community. For both mothers and children in both communities, the intakes of amaranth decreased from baseline to post-intervention, but this decrease was significantly higher for the mothers in the control community, than in the intervention community.

Table 9.4: Changes in the frequency of consumptions of selected foods from baseline

Variable	Intervention Community (n=71)		Control Community (n=70)		Difference in mean change ± SD	p-value for the difference in the means
	n	Mean change from baseline to post intervention ± SD	n	Mean change from baseline to end ± SD		
Mother						
Spinach	67	0.70 ± 2.7	67	0.06 ± 1.7	0.60 ± 2.27	0.0001*
Amaranth leaves	67	-1.00 ± 1.8	67	-1.84 ± 2.3	0.84 ± 2.07	0.03*
Oranges	65	-0.092 ± 2.7	66	-1.17 ± 2.5	1.07 ± 2.57	0.4590
Beef	66	-0.14 ± 2.6	66	0.07 ± 2.7	-0.21 ± 2.67	0.6473
Liver	64	-0.11 ± 2.3	66	0.97 ± 2.1	-1.08 ± 2.20	0.4866
Dried beans	68	-0.5 ± 1.6	63	-0.87 ± 2.1	0.37 ± 1.85	0.041*
Child						
Spinach	70	0.80 ± 2.47	72	0.38 ± 1.67	0.43 ± 2.10	0.0014*
Amaranth	71	-0.38 ± 2.53	72	-0.75 ± 2.80	0.37 ± 2.67	0.3969
Oranges	67	0.54 ± 2.84	72	0.35 ± 2.90	0.19 ± 2.87	0.8610
Beef	69	0.39 ± 2.53	72	0.96 ± 2.67	-0.57 ± 2.62	0.8107
Liver	67	0.66 ± 2.34	72	1.33 ± 2.04	-0.68 ± 2.19	0.2497
Dried beans	72	0.11 ± 2.03	71	0.49 ± 2.8	-0.38 ± 2.41	0.0104*

FFQ data were scored by assigning ordinal numbers to intake categories as follows: daily (7); 3-4x/week (6); 1x/week (5); 2-3x/month (4), 1x/month (3), occasionally=2 and never (1).

Similarly, for mothers, the consumption of dried beans decreased from baseline to post-intervention, but this decrease was significantly higher for the mothers in the control community, than in the intervention community. On the other hand, among children in both communities the intakes of dried beans increased from baseline (probably because the index children were now 18 months older than at baseline and many of them were offered this food type), but the increase was significantly higher in the intervention community than in the control community, despite the change from baseline towards more food insecurity in the intervention community as indicated in Table 9.3.

The number of the index children being breastfed decreased considerably in both communities; post intervention only 4 (11.4%) in the intervention community and 10 (15.6%) in the control community were still breastfeeding. This is related to the 18 months that passed between baseline and post-intervention data collection. Generally, drinking tea during meals (which reduces iron absorption) decreased in both communities; the decrease was however only significant in the intervention community, decreasing from 43.8% to 4.3% ($p = 0.004$).

9.4.3.2 Adequacy of nutrient intakes

The mothers in the two communities were compared at post-intervention data collection point, with regard to mean daily intakes of energy, macronutrients, and micronutrients relevant to IDA and anemia, estimated from the average of three 24hr-recalls for non-consecutive days. Means for children were not compared as these are age-based. The adequacy of energy and nutrients intakes are however, reported for both mothers and children. These data are summarised in Table 9.5. Table 9.6 summarises the difference between the mean changes in intervention and control communities from baseline to post-intervention.

9.4.3.2.1 Mothers

Among mothers, according to Table 9.5, mean energy and fibre intakes were very high in both communities post intervention. In the intervention community, protein (55.5g/day; 944kJ), carbohydrate (466.6g/day; 7,932 kJ) and fat (74 g/day; 2,728kJ) contributed about 8.3%, 70.4% and 24.2% to the daily energy intake of mothers. In the control community, protein (49g/day; 833kJ), carbohydrate (479.3g/day; 8 097kJ) and fat (66.6g/day; 2 464 kJ), contributed about 7.5%, 72.7% and 22.1%, to the daily energy intake. The intervention community therefore had higher protein, fibre and fat intakes, and lower carbohydrate intakes than the control group, but these differences were not statistically significant. More mothers in the control community

(27.5%) had inadequate intakes of protein, compared to those in the intervention community (18.6%), but the difference was not significant.

There were no significant differences in the mean intakes of iron, vitamins A, C, B12, or folate between the intervention and control communities. Both communities had similar percentages of mothers with inadequate intakes of vitamin A (20% and 16.0%, respectively), vitamin B12 (100% and 98.6%, respectively) and folate (18.6% and 27.5%, respectively). None of these parameters were significantly different between the two communities.

If the bioavailability of iron from the diet was assumed to be 5%, 93.0% of mothers (N=138, entire study population) probably had inadequate intake of iron; if assumed to be 10%, 46.1% of mothers probably had inadequate intake of iron.

Table 9.6 indicates that energy, protein, fat and iron intakes were significantly lower in both communities post intervention, but that these changes were not significantly different between the communities. In the intervention community mean fibre intakes were significantly lower post intervention, and, although fibre intakes had also decreased in the control community from baseline, the change was not significant. In both communities, vitamins C and A intakes were significantly lower post intervention, than at baseline, and the decline were significantly more pronounced in the intervention group than in the control group.

Overall food intakes of the mothers appeared to be lower than at baseline in both communities, despite positive changes in food security scores noted in table 9.2. This trend was also seen in the FFQ assessments

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Table 9.5: Comparison of the post intervention mean intakes, and adequacy of intakes, of energy, macronutrients and micronutrients related to iron status

	Mean ± SD	Inadequate Intake	Adequate Inadequate	Excessive intake	Mean ± SD	Inadequate Intake	Adequate Inadequate	Excessive intake	p-value for the difference in the means#
		n (%)	n (%)	n (%)		n (%)	n (%)	n (%)	
MOTHER	**Intervention (n=70)**				**Control (n=69)**				
Energy (kCal/day)	2683.8 ± 554.7	0 (0.0)	67 (100.0)	-	2650.9 ± 701.1	1 (1.5)	67 (98.5)	-	1.000
(kJ/day)	11 271 ± 2329.7				11 133.8 ± 2944.2				
Macronutrients									
Protein (g/day)	55.6 ± 17.1	13 (18.6)	50 (71.4)	7 (10.0)	49.0 ± 16.2	19 (27.5)	45 (65.2)	5 (7.3)	0.165
Carbohydrate (g/day)	466.6 ± 94.0	0 (0.0)	70(100.0)	-	479.3 ± 139.5	0 (0.0)	69 (100.0)	-	--
Fat (g/day)	74 ± 25.8				66.6 ± 22.0				
Dietary fibre (g/day)	44.0 ± 10.9				42.8 ± 11.5				
Vitamins									
Vitamin C (mg/day)	124.4 ± 41.7	0 (0.0)	70 (0.0)	-	137.3± 47.3	0 (0.0)	69 (0.0)		
Vitamin A (µg RAE/day)	462.7 ± 151.7	14 (20.0)	56 (80.0)	-	539.3 ± 249.1	11 (15.9)	58 (84.1)	-	0.660
Vitamin B-12 (µg/day)	0.47 ± 0.30	70 (100.0)	0 (0.0)	-	0.61 ± 0.46	68 (98.6)	1 (1.4)		0.496
Folate (µg/day)	539.2 ± 323.9	13 (18.6)	50 (71.4)	7 (10.0)	464.5 ± 259.0	19 (27.5)	45 (65.2)	5 (7.3)	0.111
Mineral									
Iron	16.1 ± 5.1				14.7 ± 4.3				
CHILD	**Intervention community (n=57)**					**Control community (n=65)**			
Energy (kCal/day)	1679.7± 436.6	2 (3.5)	55 (96.5)	-	1713.8 ± 534.5	4 (6.15)	61 (93.9)	-	0.0684
(kJ/day)	7054.7± 1833.7				7198 ± 2245				
Macronutrients									
Protein (g/day)	34.7 ± 12.2	3 (3.5	55 (96.5)	-	32.8 ± 12.1	0 (0.0)	65 (100.0)	-	0.216

Carbohydrate (g/day)	287.9 ± 75.6	0 (0.0)	57 (0.0)	-	305.6 ± 102.3	0 (0.0)	65 (100.0)	-	--
Fat (g/day)	48.3 ± 18.1				44.0 ± 16.8				
Dietary fibre (g/day)	27.3 ± 7.7				26.3± 8.8				-
Vitamins									
Vitamin C (mg/day)	81.8 ± 28.5	0 (0.0)	57 (100.0)	-	87.0 ± 33.1	0 (0.0)	65 (0.0)	--	--
Vitamin A (µg RAE/day)	322.1 ± 134.8	28 (49.1)	29 (50.9)	-	359.0 ± 169.4	28 (43.1)	34 (52.3)	3 (4.6)	0.236
Vitamin B_{12} (µg/day)	0.397 ± 0.4	54 (94.7)	3 (5.7)	-	0.86 ± 2.8	51 (78.5)	14 (21.5)	-	0.016
Folate (µg/day)	319.3 ± 201.7	1 (1.8)	43 (75.4)	13 (22.8)	293.0 ± 118.9	2 (3.1)	39 (60.0)	24 (36.9)	0.193
Minerals									
Iron	9.8 ± 3.5				9.4 ± 3.3				-

MOTHERS (N=138)

Percentage of population which probably have inadequate intakes of iron if 5% bioavailability of iron is assumed : 93.5%

Percentage of population which probably have inadequate intakes of iron if 10% bioavailability of iron is assumed : 46.1%

CHILD (N=138)

Percentage of population which probably have inadequate intakes of iron if 5% bioavailability of iron is assumed : 71.3%

Percentage of population which probably have inadequate intakes of iron if 5% bioavailability of iron is assumed : 27.70%

Intakes of folate, vitamins A, B12, and C were evaluated against the estimated average requirement (EAR) and upper limit (UL) (WHO/FAO, 1988; 2002; 2004 guidelines). Considerations of weight (Kilograms) in evaluations lead to some missing values folate, vitamins A, B12, and C

9.4.3.2.2 Children

Post-intervention, more children in the control community (6.2%), than in the intervention community (3.5%), had inadequate energy intakes and there was a trend for this difference to be significant (p=0.068). Only 3.5% of children in the intervention community and none in the control community had inadequate protein intakes, but the difference was not significant.

There were no significant differences in the mean intakes of iron, vitamins A, C, B12, or folate between the intervention and control communities. Both communities had similar percentages of children with inadequate intakes of vitamin A (49.1% and 43.1.0%, respectively), and folate (1.8% and 3.1%, respectively), but these were not significantly different between the two communities. Significantly more children in the intervention community had inadequate intakes of vitamin B12, compared to the control community (94.7% and 78.5%, respectively).These observations were unexpected.

With 18 months between baseline and post intervention data collection, it was expected that the children's mean intakes of energy, and macronutrients would significantly increase, as it did in both communities (Table 9.5). The intakes of macronutrients and fibre were, however, significantly less pronounced in the intervention community, compared to the control. In the intervention community, vitamin C intake was significantly lower post intervention, than at baseline, and the change from baseline was significantly different between the communities. Similarly, while vitamin A intakes increased significantly from baseline in the control community, it declined in the intervention community; and the change from baseline was significantly different between the communities.

If the bioavailability of iron from the diet was assumed to be 5%, 71.3% of children (N=138, entire study population) probably had inadequate intake of iron; if assumed to be 10%, 27.7% of children probably had inadequate intake of iron.

Table 9.6: Difference between the mean changes in intervention and control communities from baseline to post-intervention

Variable	Change from baseline				Comparison of the mean change			
	Intervention Community (n=67)		Control Community					
	Mean change from baseline ± SD	p-value	Mean change from baseline ± SD	p-value	Difference between mean changes	Df	t-value	p-value
MOTHERS								
Energy (kCal/day)	-531.6 ± 1111.7	0.0002	-411.1 ± 293.6	0.0103	-120.4 1205.4	137	-0.59	0.5569
Macronutrients								
Protein (g/day)	-17.42 ± 36.93	0.0002	-23.40 ± 48.44	0.0002	5.98 ± 43.03	137	0.82	0.4140
Carbohydrate (g/day)	-50.82 ± 175.6	0.0181	7.15 ± 194.2	0.7608	-57.97 ± 185.1	137	-1.85	0.067
Fat (g/day)	-30.56 ± 48.88		-40.91± 52.33		10.35 ± 50.68	137	1.20	0.2308
Dietary fibre (g/day)	-6.35 ± 19.65	0.0086	-3.63 ± 18.62	0.1104	-2.73 ± 19.14	137	0.84	0.4022
Minerals								
Iron (mg/day)	-5.33 ± 11.44	0.0002	-5.30 ± 10.42	0.0001	-0.03 ± 10.94	137	-0.01	0.9886
Vitamins								
Vitamin C (mg/day)	-97.31 ± 86.17	0.0001	-46.19 ± 76.30	0.0001	-51.11 ± 81.4	137	-3.70	0.0003
Vitamin A (µg RAE/day)	-354.2 ± 418.0	0.0001	-192.1 ± 407.8	0.0002	-162.1± 413.0	137	-2.31	0.0222
Vitamin B_{12} (µg/day)	-0.05 ± 1.15	0.7381	-0.20 ± 3.70	0.6598	0.15 ± 2.73	137	0.32	0.7458
Folate (µg/day)	-361.3 ± 831.3	0.0218	-357.2 ± 708.4	0.0008	-4.03 ± 757.4	137	-0.02	0.9815
CHILD								
Energy (kCal/day)	162.5 ± 772.5	0.0785	507.4 ± 1106.6	0.0002	-344.8 ± 955.5	143	-2.17	0.0314
Macronutrients								

Protein (g/day)	0.51 ± 22.30	0.8460	4.04 ± 28.11	0.2235	-3.52 ± 25.39	143	-0.84	0.4044
Carbohydrate (g/day)	47.47 ± 120.4	0.0013	111.3 ± 194.7	0.0001	-63.84 ± 162.1	143	-2.37	0.0191
Fat (g/day)	2.67 ± 35.39		6.14 ± 33.19		-8.8 ± 34.30	143	-1.55	0.1243
Dietary fibre (g/day)	4.37 ± 13.07	0.0059	8.48 ± 16.15	0.0001	-4.11 ± 14.70	143	-1.68	0.0943
Minerals								
Iron (mg/day)	-0.35 ± 6.65	0.6526	0.65 ± 8.60	0.5234	-1.00 ± 7.69	143	-0.78	0.4353
Vitamins								
Vitamin C (mg/day)	-31.29 ± 63.83	0.0001	15.68 ± 61.03	0.7357	-46.98 ± 62.44	143	-4.53	<0.0001
Vitamin A (μg RAE/day)	-50.32 ± 273.3	0.1227	122.3 ± 202.7	<.0001	-172.6 ± 240.4	143	-4.32	<0.0001
Vitamin B_{12} (μg/day)	0.24 ± 0.48	<.0001	0.77 ± 2.84	0.0225	-0.53 ± 2.05	143	-1.58	0.1158
Folate (μg/day)	-84.82 ± 375.4	0.0592	-62.30 ± 463.0	0.2541	-22.52 ± 421.8	143	-0.32	0.7483

Abbreviations: DF= degrees of freedom, n=number of participants and % is percentage of participants. Paired t-test was used to assess the difference in mean intakes and was significant at $p<0.05$.

9.4.3.3 Effect on nutritional status

No physical signs of chronic anemia were observed in any of the mothers.

The nutritional status of the mothers and children, as assessed by weight and height, are summarised in Table 9.7. The mean BMI and categories of BMI was very similar between the two communities. Overall, around 10% were underweight, around 66% had normal weights, and around 15% were overweight/obese (class 1). Table 9.8 compares the mean changes from baseline to post intervention within and between the two communities. In both communities BMI decreased from baseline, but this decrease was significantly higher in the intervention than in the control group.

Table 9.7: Post intervention BMI of mothers and Z-scores of children

Variable	Intervention group	Control group	p-value for the difference in the means#
Mothers	**(n=70)** **n (%)**	**(n=70)** **n (%)**	
BMI (kg/m^2)			
Underweight (<18.5)	10 (14.3)	7 (10.1)	
Normal(18.5-24.49)	47 (67.1)	46 (66.7)	
Overweight (24.5 – 29.99)	10 (14.3)	14 (20.3)	
Obese Class 1 (30-39.99)	3 (4.3)	2 (2.9)	0.270
Mean weight(mothers) ± SD	57 ± 11.2	57.0 ± 9.4	
Mean height (mothers) ± SD	1.6 ± 0.1	1.6 ± 0.1	
Mean BMI ± SD	22.3 ± 3.7	22.8 ± 3.1	
Children	**n=75** **n (%)**	**n=77** **n (%)**	
Z-score height-for-age (Stunting)			
Normal (≤2SD)	31(53.4)	42(63.6)	
Moderate stunting (-2.01-3SD)	17 (29.8)	16(24.2)	
Severe stunting(>-3.01SD)	9 (15.8)	8(12.1)	0.352
Z-score weight-for-age (Underweight)			
Normal (≤ 2SD)	46 (79.3)	46(8.7)	

Moderate underweight (-2.01-3SD)	8 (13.8)	18(26.9)	
Severe underweight (>-3.01SD)	4 (6.9)	3(4.5)	0.525
Z-score weight-for-height (Wasting)			
Normal (≤2SD)	56 (92.4)	58(84.3)	
Moderate wasting (-2.01-3SD)	2 (3.3)	8(11.8)	
Severe wasting(>-3.01SD)	2(3.3)	2(2.9)	0.330

WHZ weight for height Z-Score; HAZ Height for age Z-Score; WAZ Weight for age Z-score, BM1= body mass index. Fishers exact test were run for the changes in categories for mothers and children

Among children in the intervention community, compared to the control community, 45.6% and 36.2%, respectively, were stunted; 19.4% and 31.4%, respectively, were moderately to severely underweight, and 6.6% and 14.7%, respectively, were wasted. There was no significant difference between the groups regarding these categories.

Table 9.8 indicates the changes in the Z-score categories among children and the BMI among mothers. Though there were changes in the various categories among both mothers and children, no significant difference were observed. A change of -2 showes 2 redutions in categories levels; -1 showes 1 reduction in categories levels; 0 showes no change; 1 showes improvement by one category level; 2 shows improvement by 2 categories levels.

9.5 Reported recall of and adherence to nutrition education messages

Table 9.8 summarises the responses of the mothers in the intervention community to open ended questions regarding changes she had made, and challenges that she encountered in implementing the key messages.

About 70% of the mothers recalled the theme hygienic practices. Overall, 40.8% indicated that they were washing their hands more often particularly after using the toilet and before handling food. In addition, 8.5% indicated that they cleaned the environment in which food was handled and 2.8% that they strained and boiled drinking water. The constraints that mothers mentioned to hamper their implementation of these key messages included having no money to buy soap, forgetting and not being supported by others in the household.

About 40% recalled the theme on sources of iron and bioavailability of iron, and 23.3% of the mother reported that they increased their weekly intake of meat. Once again lack of money to buy meat, fruit, and vegetables was mentioned as the biggest constraint to implementing this key message.

Table 9.8: Difference of the difference of child Z-Scores and BMI categories

Variable	Intervention Community n	Intervention Community: Mean change from baseline to post intervention ± SD	Control Community N	Control Community: Mean change from baseline to post intervention ± SD	Intervention mean – Control mean: Change in means ± SD	p-value for the change in the means
Child						
WHZ	60	-0.51 ± 1.34	68	-0.30 ± 2.1	-0.2152 ± 1.76	0.001
HAZ	57	-0.25 ± 2.08	65	0.103 ±1.57	-0.3492 ± 1.82	0.029
WAZ	58	-0.46 ± 1.25	66	-0.051 ± 1.4	-0.407 ± 1.34	0.5042
Mother						
BMI	70	-8.03 ± 2.0	68	-0.71 ± 2.7	-0.09 ± 2.4	0.0085

Change in Z-Scores and BMI categories in individuals from baseline to post-intervention

		-2	**-1**	**0**	**1**	**2**	**p-value**
		n (%)	n (%)	n (%)	n (%)	n (%)	
WHZ	Intervention community (n=60)	2 (3.3)	1(1.7)	46 (76.7)	9 (15.0)	2 (3.3)	
	Control community(n=67)	4 (6.0)	5 (7.5)	45 (67.2)	9 (13.4)	4 (6.0)	0.509
	Total	**6**	**6**	**91**	**18**	**6**	
HAZ	Intervention community (n=57)	3 (5.3)	6 (10.5)	30 (52.6)	15 (26.32)	3 (5.3)	
	Control community (n=65)	2 (3.1)	9 (13.9)	44 (67.7)	8 (12.3)	2 (3.1)	0.2534
	Total	**5**	**15**	**74**	**23**	**5**	
WAZ	Intervention community (n=58)	2 (3.5)	1 (1.7)	39 (67.2)	13 (22.4)	3 (5.2)	
	Control community (n=66)	0 (0.0)	9 (13.6)	42 (63.6)	12 (18.2)	3 (4.6)	0.0721
	Total	**2**	**10**	**81**	**25**	**6**	
BMI	Intervention community (n=69)	1(1.5)	11 (15.9)	50 (72.5)	7 (10.1)	0(0.0)	
	Control community (n=66)	2 (3.0)	8 (12.1)	48 (72.7)	8 (12.1)	0 (0.0)	0.856
	Total	**3**	**18**	**98**	**15**	**0**	

WHZ weight for height Z-Score; HAZ Height for age Z-Score; WAZ Weight for age Z-score, BM1= body mass index.

Z- Scores categories were categorised and assigned ordinal numbers as follows: ≥-2SD=3; -2.01 to -2.99 = 2 and ≤-3SD=1.

BMI categories were categorised and assigned ordinal numbers as follows: Underweight (<18.5) =1, Normal (18.5-24.49) =2, Overweight (24.5 – 29.99) =3 and Obese Class 1 (30-39.99) = 4

Fishers exact test were run for the changes in categories for mothers and children and paired t-test was used to assess the difference in mean intakes, P-values were considered significant at <0.05.

Note: -2 showes 2 redutions in categories; -1 showes 1 reduction in categories; 0 showes no change; 1 showes improvement by one category, 2 shows improvement by 2 categories.

Some mentioned the large family sizes, seasonality that affects the availability of the fruits and vegetables.

About 40% recalled the theme on tea drinking practices and 19.2% that they made a point to drink tea 1-2 hours before or after meals and not with meals anymore, and 16.4% that they had brewing tea over heat which releases more iron inhibitory tannins. Financial constraints to buy enough tea bags to avoid that tea had to be brewed from one bag needs for an entire household, as well as forgetfulness, being too busy to drink tea between meals instead of with meals, being not interested, not fully understanding the message and lack of support from the household members, were mentioned as constraints.

About 40% recalled the theme on complementary feeding to prevent ID, and 27.4% reported that they now fortified the children's food with fish and 5.5% indicated giving larger portions of fortified porridge. Once again lack of money to buy iron rich foods like meat/fish, as well as forgetfulness, were mentioned as constraints.

Table 9.9: Recall of the themes and challenges of adherence to education messages in the intervention group (N=71)

Theme discussed	**Percentage of mothers who recalled the theme**	**Changes that mothers reported making**		**Challenges mothers faced when implementing messages**	
	%		**%**		**%**
Sources and bioavailability of iron	**42.5**	Increased weekly red meat intake	**23.3**	No money to buy iron-rich foods	**35.6**
				Large family size	**4.1**
				Seasonality affects availability	**1.4**
				She forgets	**5.5**
Intake of tea and	**42.5**	Took tea 1-2 hours before or after meals; avoided tea with meals	**19.2**	Financial constraints hence household used one bag of tea to a large amount of water thus	**8.2**

the timing of tea intake				brewing tea and risking more release of tannins.	
				She forgets	**4.1**
		Has changed tea preparation to reduce release of tannin (no longer brews tea during preparation)	**16.4**	She was always busy, so it is difficult to wait for one to two hours to eat others meals	**1.4**
				Lack of support and encouragement/ people told her she was a “ know it all”	**2.7**
				Not interested	**1.4**
				Did not fully understand	**1.4**
				Lack of support	**1.4**
				Financial constraints	**1.4**
Prevention and treatment of malaria and other parasitic infections	**69.9**	Washed hands more often	**40.8**	She forgets especially with the hand washing	**8.5**
		Strained and boiled water for drinking	**2.8**	Lack of support from families in terms of keeping the environment clean	**2.8**
		Kept environment clean	**8.5**	Financial constraints to buy soap	**15.5**
Complementary feeding in ID risk areas	**42.5**	Fortified children’s food (e.g. with fish)	**27.4**	No money to buy iron rich foods to fortify foods	**15.1**
				She forgets	**1.4**
		Increased quantity of soup for children	**5.5**	Baby did not like the fortified porridge	**2.7**

9.6 Discussion

In this manuscript, the effect of a component of a NEP to address the dietary risk factors for ID and anemia among low income, unschooled mothers with children six to 59 months, in an agrarian society, was evaluated. Data was collected in the wet season at baseline and post intervention. Food security levels were not significantly changed from baseline in either community. Recall of the relevant nutrition education themes and key messages covered in the NEP, was between 42% and 70% for different themes. This seemed to translate to more positive changes regarding the intake of sources of non-heme iron, as well as improved practices regarding tea consumption, which were observed for both mothers and children in the intervention community relative to the control. Uptake of the messages, particularly regarding sources of heme iron, was however, apparently hampered by financial constraints. In both communities, the percentages of the population with probable inadequate iron intake, were high among mothers and children alike. Chronic malnutrition, evidenced by stunting, was also high among the children in both communities and declined even further from baseline to post-intervention in both communities.

At baseline before and after intervention, the two communities were very similar with regard to socio-demographic characteristics. In both communities, mothers were from the same ethnic group and religion, and were mostly unschooled, not formally employed, and in polygamous marriages. The mean ages of the mothers and children did not differ significantly between the communities, although there were more of the older children in the intervention community, than in the control. Large households with 13 people on average, consisting of a husband and several wives with their children, lived together in mud huts with four to five rooms. Significantly more households in the intervention group had electricity and piped water than in the control community. All households reported a low income and were engaged in subsistence farming.

Food insecurity was high in both communities at around 35% to 50%. Although there were 15% more food secure households in the control community than in the intervention community, tfood security does not necessarily guarantee nutrition security. Nutrition security of households is affected by the availability of food and food prices. In developing countries, studies have shown that low income families have competing utilisation of income (Drewnowski, 2009). When food and financial resources are limited, households often try to stretch their food budgets by purchasing cheap, energy-dense foods that are filling and staves off hunger, but typically have lower nutritional quality (Drewnowski, 2009). During a food security project implemented in Northern Ghana in a similar environment to that of the current study, mothers who gained increased income, was seen to be direct it to feed and the educate their children (Abu *et al.*, unpublished). In the current study population there was no financial intervention.

The baseline survey conducted in May 2012 (Abu, 2015:121-246) found that these communities, which survive on subsistence farming, face extended periods of food scarcity during the dry season from November to April. The mean period of food scarcity was reported to be 11 weeks, but about 25% of households reported periods of scarcity lasting between 12 and 36 weeks. Food insecurity did increase non-significantly from baseline in the intervention community, probably due to more food being available at the end of the wet season when post intervention data collection was performed, than at the start of the wet season when baseline was performed.

At baseline 20% of households in these communities reported that crops did not last through the dry season; whereas 60% reported that vegetables did not last, and 87% that fruit did not last. The mothers reported that the reasons for this state of affairs were due to the large family sizes, lack of land, low crop yields and not enough money to buy quality seed. Only one household in the study population owned a freezer.

The combined effects of these factors, may be reflected in the high prevalence of inadequate intakes of protein (18.6% in the intervention community, 27.5% in the control community), vitamin A (20% in the intervention community, 15.9% in the control community), folate (18.6% in the intervention community, 27.5% in the control community), and vitamin B12 (100% in the intervention community, 98.6% in the control community), among the mothers. Similar inadequate intakes were also found for the children. Folate, vitamins A, C and B12 are necessary to support iron status and erythropoiesis (WHO/FAO, 2004). The overall decrease in the dietary quality may be reflected in Table 9.5 which indicates that energy, protein, fat and iron intakes decreased significantly from baseline to post intervention in both communities, and these changes were not significantly different between the communities. This may be due to the change in season where food may be less available in the period just before harvest season (Quaye, 2008). In the intervention community vitamins C and A intakes also decreased significantly from baseline; and the decline was more pronounced in the intervention group than in the control group. Overall food intakes of the mothers appeared to be lower than at baseline in both communities. This trend is also seen in the FFQ and may also be reflected by the significant decrease in the mean BMI, HAZ and WHZ in both communities and particularly in the intervention community. These findings are similar to the irregular decline in stunting, underweight and wasting reported in developing countries (FAO, 2006) despite targeted interventions. This is possibly caused by the high infection rates leading to growth faltering (Bunn, 2011) and sub-optimal feeding practices (Domellöf *et al*., 2014).

Similarly, the combined effect of these factors is also echoed in the mothers in the intervention community's responses to open-ended questions regarding what she recalled about the NEP, what she had tried to change from baseline, and which challenges she faced. The mothers could recall the themes and key messages on increased meat, vegetable and fruit intakes that would positively affect iron status, generally well. Notably the challenges that they reported, are similar to those listed as reasons why the food supply did not last through the dry season, namely large family sizes and financial restraints (for example, too little money to buy expensive sources of heme iron).

It is not clear from the findings why the intervention community had more pronounced decreases in food security, anthropometry and food and nutrient intakes than the control community. Whatever the reasons, it seems that any positive effects of the NEP on iron status, may have been diluted by these outside factors. Furthermore, considering the high fibre intakes, which for some individuals were 2-3 times the recommended levels, even among the children; high phytate levels in the maize staple, and the low intake of heme-iron sources that provide the MFP-factor, the overall bioavailability of non-heme iron from the diets of this study population, is bound to be low. If iron bioavailable was thus assumed to be 5%, as suggested by the WHO/FAO for developing countries, the proportions of mothers and children in the two communities combined were 93.0% and 71.3%, respectively. Women are already vulnerable to iron deficiency due to their physiological needs. Chronic ID in WRA affects productivity, and when it occurs in pregnancy, affects the birth outcome of children (Agarwal, 2010; Shabert, 2004). The NEP targeted practices which may improve the intake of iron-rich foods and others factors that may affect iron status. Most studies with this approach have been successful in improving iron intake and consequently iron status (Adu-Afarwuah & Dewey, 2008). Mothers (42.2%) did recall the theme and key messages regarding the consumption, and about half reported positive changes regarding the spacing of tea consumption around meals, and no longer brewing tea. These positive changes were also reflected by the FFQ.

Overall, 42.2% of the mothers recalled the theme on increasing iron intake and making iron more bioavailable in the diet through correct food combinations. However, although 23.3% of the mothers reported that they increased meat intakes in the household (Table 9.9), this was not reflected in the analysis of the dietary data from the 24h recall or the FFQ. In light of the very high prevalence of anemia in the study area (GDHS, 2008) and the fact that under such circumstances, ID is assumed to affect all the vulnerable individuals in the population to some degree (Asobayire *et al.*, 2011), the low intake of heme iron and low bioavailability of non-heme iron in the study population, is need for an urgent intervention.

The very high prevalence of inadequate vitamin B12 intakes among mothers and children are of further concern, as this may predispose to anemia, but may also lead to neurological damage. Inadequate intakes of vitamin B12 were shown in urban Ghana among children of vegan families (Osei-Boadi, *et al.*, 2012). Although not a vegan society, this study population consumed foods from animal origin infrequently and in small quantities from the baseline data (Abu, 2015:121-185). Vitamin B12 needs to be supplemented in their diets to prevent long-term consequences (WHO/FAO, 2004).

The baseline survey among these women and children, found that most high protein foods and most heme sources available in the community, were rarely consumed and noted several half-truths, myths and misperception in these communities regarding factors that affect iron status (Abu, 2015:121-246). Dietary changes may also be influenced by practices handed down from family members and by religious believes. Food choices in communities where culture is entrenched may be highly influenced by food taboos, myths and faddisms. These beliefs may often lack scientific backing to their alleged benefits or reasons for them being forbidden. The designed NEP was targeted to address these myths and cultural beliefs, which were not scientifically justifiable, and also educate mothers on the risk of ID (Abu 2015:176-205). One component of the intervention also addressed improving the nutrient quality of complementary foods. Mothers were educated on the importance of fortifying meals using other foods that are high in iron. Overall, it was found that the intervention improved knowledge, attitudes and some practices related to ID prevention and risk factors as reported elsewhere (Abu, 2015:225-246). These may have contributed to the fact that, although vegetable and legume intakes decreased from baseline, the decreases were significantly less pronounced in the mothers and children of the intervention community than those in the control community.

Personal and environmental hygiene may also affect iron status and contribute to ID, due to increased infections and malaria cases. Persistent diarrhoea increases the risk of children for chronic nutrient inadequacy by reducing the time lag for nutrient absorption from food eaten. Among children, early introduction of other foods may also increase risk for infection (Quigley *et al.*, 2007). An intervention in Burkina Faso, which successfully decreased anaemia prevalence among children, integrated a nutrition intervention on meal planning, with hygiene practices. The meal planning included improving the bioavailability of iron by adding meat, vitamin C and also iron rich condiments to complementary foods, while the hygiene component focussed on hand washing and the use of individual (Sanou *et al.*, 2010). In this study 70% of the mothers recalled the theme and key messages regarding hand washing practices and keeping the environment clean. The main challenge reported in this regard, was being able to afford soap.

Low self-efficacy is another possible barrier to positive change. Mothers in this study population stated that enforcing change within their households was difficult, because the other members of the households would call them "know-it-all's" (Table 9.9). Household members, like grandmothers (Aubel, 2012) may be targeted to bring about sustainable changes in behaviour and to provide support for carrying out change. Including husbands/partners, who were mostly the main decision makers in these households, may also positively influence the outcome of interventions in these communities. Uptake of the messages imparted by a targeted 5-day NEP aimed at improving iron status by addressing dietary risk factors for ID among mothers with young children in an area of Ghana where anemia is a serious public health problem, as well as the translation of these practices to increased intakes of heme and non-heme iron sources, were apparently hampered by high levels of food insecurity, financial constraints and lack of social support. These factors may have affected the success of the intervention in a way that was expected.

9.7 Limitations

A major limitation of this study may be the fact that biochemical analysis was not in order to confirm micronutrient deficiencies and ID/IDA. This was due to logistical problems regarding the storing and transporting of blood samples across long distances and poor roads to the nearest laboratory that could perform the tests; as well as lack of funding.

Assessment of how well the key messages of the NEP were implemented by the intervention group was based on self-reporting, which may not be the true representation of practices. However, some of the changes, such as increased intake of green leafy vegetables are reflected to some extent by the results from the 24h recall and FFQ.

9.8 Conclusions and recommendations

Involving men, who are the main decision makers and providers for the households in these communities, may be important to increase the success of interventions. Male involvement may also be critical in interventions that have a food security component, since this affects food availability and consequently nutrient intake, similar to the identified role of men in promoting breast feeding (Brown & Davies, 2014). Some positive trends were more apparent in the intervention community from baseline to post-intervention compared to the control community, and more time post-intervention, may have been required to observe significant changes.

In these communities the seasonality of sources of non-heme iron and enhancers of non-heme iron absorption, are a major problem. The need to provide foods all year round, has to be addressed through sustainable interventions. Practical ways to process foods during the wet season and keep it for the dry season, may be one way of addressing the problem. Another is helping communities with irrigation facilities that could increase the availability of vegetables and also ensure food security for farm animals (Abu *et al.,* 2010; Steiner-Asiedu *et al.,* 2012 and Abut *et al.,* unpublished). A third way is by improving the outputs of the local industries such as "dawadawa" preparation, (a condiment made from the dried and powdered wild fruit), as well as shea butter production and other income generating activities. This may improve the income levels of households so that they may have more money available to buy food when the household runs out of food in the dry season.

These findings may have implications for research and practice by illustrating that, although anemia results from complicated physiological processes; messages may be targeted at low literate mothers to prevent anemia through the use of simple scenarios and preambles. This means that with innovative approaches health workers will be able to educate mothers on complicated health issues. The methods of implementation should consider any barriers to education, such as the low education level in this community, which was overcome by using pictures and real food samples, while applying the principles of adult learning.

9.9 References

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CHAPTER 10:

IMPACT OF A NUTRITION EDUCATION INTERVENTION TO IMPROVE KNOWLEDGE, ATTITUDES AND PRACTICES REGARDING IRON DEFICIENCY AMONG GHANAIAN MOTHERS

This section of the research was presented at the Nutrition Congress, September, 2014, Johannerburg, South Africa with the following abstract, also published in the South African Journal of Clinical Nutrition as;

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10 IMPACT OF A NUTRITION EDUCATION INTERVENTION TO IMPROVE KNOWLEDGE, ATTITUDES AND PRACTICES REGARDING IRON DEFICIENCY AMONG GHANAIAN MOTHERS

10.1 Abstract

Objective: The study assessed the effect of an education intervention on knowledge, attitudes and practices (KAP) related to for iron deficiency (ID) among mothers with young children in Ghana.

Methods: A longitudinal community intervention trial with a cluster design where two randomly selected districts in the Northern region with one of them as an intervention and the other a control group. Two randomly selected districts in Ghana, an area with a known high anemia prevalence. Rural mothers (N=141); 71 in intervention and 70 in control community post intervention with younger children (six to 59 months). A once–off five-day educational intervention addressing knowledge, attitudes and practices (KAP) regarding pica and iron deficiency summarized in ten key messages designed from a baseline survey (April, 2012), was implemented 90min/ Day in July, 2013. A follow-up household visit (about 30mins /household) was performed two weeks after the 5-day interaction and a second household visit two weeks later.

Main Outcome Measure: change in KAP were assessed via questionnaires (test statements, preambles and open ended questions) in structured interviews at baseline, and repeated three months post-intervention to the same mothers. Responses to test statements were scored, and

responses to open ended questions grouped into themes. Data were analyzes with SAS/STAT software, version 9.3.

Results: In both groups, about 97.0% of the mothers were married; 98.6% in intervention and 87.1% in the control group were unschooled. There was a significant increase in mean scores of maternal knowledge on "iron sources or iron absorption enhancers" in both groups from baseline to post-intervention (intervention (2.324 ± 2.431SD; p=0.0001) and control (0.886 ± 2.262SD; p=0.001), with a significantly higher magnitude of change in the intervention compared to the control group. A significant increase in mean scores for practices (0.408 ± 2.074SD; p = 0.001) in the intervention group was reported compared the non-significant change in control group (0.214 ± 1.382SD). Reported from non-scored open ended questions revealed improved reasons regarding the timing of tea drinking and meals and associated risk for ID was observed post-intervention in the intervention group compared to the control. Reported contraceptive use in the intervention community improved from 0.0% to 4.2% in the intervention group compared to from 1.4% to 4.3% in the control group post intervention.

Conclusion and Implications: Exposure to a nutrition education intervention led to significant improvement in knowledge on food sources of iron and iron absorption enhancers and practices regarding risk factors for ID among mothers in an anaemia-prone area three months post-intervention. A longer term follow-up and refresher contacts with the participants could deepen understanding and affect attitudes.

Key words: 'Knowledge attitudes and practices', 'nutrition education intervention', 'iron deficiency'

10.2 Introduction

Anemia is a condition which negatively affects activity and productivity levels in adults, and has profound long-term consequences with regard to cognition and physical development in children (McLean *et al.,* 2007). In cognizance of these effects on individuals and economies, anemia remains a global public health issues and its effects in developing countries may be even greater than in developed countries (McLean *et al.,* 2007).

In 2008, the Ghana Demographic and Health Survey (GDHS, 2008) reported that 59% of women of reproductive age and 78% of children (six to 59 months) were living with diagnosed anemia. In these settings the prevalence of iron deficiency (ID) may be deduced by the assumption that about 50% of all anemia cases worldwide are attributable to ID (MacLean *et al.,* 2007). Furthermore, studies indicate that if the prevalence of anemia is above 40% in a population, it may be accepted that the entire population suffers from some level of ID (Asobayire *et al.,* 2001). Globally, interventions to address the public health issue of ID and iron deficiency anemia (IDA), include supplementation (Sazawal *et al.,* 2006), fortification of commonly consumed foods (Sablah *et al.,* 2013), deworming (Alderman & Horton, 2007), irrigation farming (Abu *et al.,* 2010; Steiner-Asiedu *et al.,* 2012) homestead gardening, animal husbandry, as well as integrated nutrition education in countries in Asia (Talukder *et al.,* 2014) and Africa (Faber & Benadé 2003). Though these efforts have been successful to various degrees, some, such as fortification and supplementation, may not be sustainable, or may be difficult to scale up due to challenges of non-compliance, supervision, and inference by high levels of malaria and worm infestation (Venkatesh Mannar, 2007).

Sanou & Ngnie-Teta, (2012) observed that interventions that were adapted to the context of the particular setting were the most effective to bring about the desired changes. According to the UNICEF conceptual framework for the development of malnutrition, the causes of ID are multifactorial, and may vary in different contexts. The need to adapt guidelines and interventions to community settings have been re-emphasised in the context of breastfeeding and infant feeding (Locks *et al.*, 2013) in response to the global call for more interventions to address maternal and child nutrition gaps (Black et al, 2008). Similarly Thompson & Amoroso (2014) re-echoed the need for proper understanding of the contextual factors and the consideration thereof in the design and implementations of policies, programmes and interventions targeted at improving health. In spite of these observations, few interventions have addressed gaps in knowledge, attitudes and practices (KAP) regarding ID using context specific adaptations of standard guidelines to address ID and IDA.

Nutrition education, as a long-term effort to educate individuals on risk factors for anemia, usually promotes the intake of iron-rich foods (Egal & Oldewage-Theron, 2012), and the identification and management of risk factors for infections, which negatively affects iron status (Sanou *et al.,* 2010). To assess the effectiveness of nutrition education, and maximize the impact of interventions, evaluation should be done directly assessed (Oshaug, 2011; Adrien, 1994). According to the health belief model, the knowledge of risk and the cost effective means to effect change, is enough motivation to bring about change (Stoltzfus, 2011; Stoltzfus & Dreyfuss, 1998; Becker & Rosenstock, 1987). A systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries concluded that nutrition education is effective in addressing IDA if education messages focus on promoting the intake of iron-rich foods (Dewey and Adu-Afarwuah, 2008). Education is targeted towards bringing about behaviour change (Adrien, 1994) by first increasing knowledge. Therefore a thorough baseline assessment of the KAP of the social groups targeted for behaviour change interventions, will inform the education intervention design and implementation process.

In 2012, a baseline survey among mothers and their children, 6 to 59 months, from two low socio-economic agrarian communities in the Northern Region, identified many gaps in KAP regarding the known risk factors for ID and anemia, which may be addressed by a nutrition education programme (NEP) (Abu *et al.,* 2013; Abu, 2015:253-298). The mothers were mostly illiterate, had low socio-economic status and lived off subsistence farming. From the baseline findings, 10 themes were identified, and key messages were designed around each of the themes as the basis of a nutrition education intervention programme (NEP). The NEP was implemented in the original study population in one of the two communities in 2013. The current study aimed to evaluate whether the NEP successfully translated to improve KAP related to known risk factors for ID and anemia, among these mothers. In order to achieve the aim, the baseline data collection on KAP, was repeated three months after the intervention community had been exposed to the NEP. If successful, a focused NEP, such as this, may offer a more sustainable and cost-effective solution to ID in the area. The findings of the study may inform the development of NEPs in similar rural agrarian communities in Ghana and other developing countries and guide health personnel to develop context-specific simple key messages to educate low literate mothers on ID, and prevent IDA.

10.3 Methods

10.3.1 Study population and setting

A quantitative descriptive survey was conducted in April 2012, in Tolon-Kumbumgu district and Tamale metropolis, which were randomly selected from the 20 districts that constitute the Northern Region of Ghana. The community of Gbullung was randomly selected from Tolon-Kumbumgu district, and Tugu and Tugu-yeplala community from Tamale metropolis. In these two communities, randomly selected households were approached and all mothers who had lived in the selected community for at least 12 months; were not pregnant; and had one or more children aged six to 59 months (henceforth referred to as the index child(ren), were invited to participate in the study. Mothers who voluntarily agreed to participate signed an informed consent form, after the study procedures were explained to them. The final sample included 161 mothers; 81 from the Tolon-Kumbumgu district and 80 from Tamale metropolis. The intervention was implemented in July, 2013 and an evaluation conducted in October, 2013.

The study was approved by the Institutional Review Boards (IRB) of Noguchi Memorial Institute of Medical Research (NMIMR) in Ghana (NMIMR-IRB CPN 064/11-12) and the Ethics Committee of the Faculty of Health Sciences, University of the Free State, South Africa (ECUFS NR 24/2012). The study design is summarised in Figure 10.2.

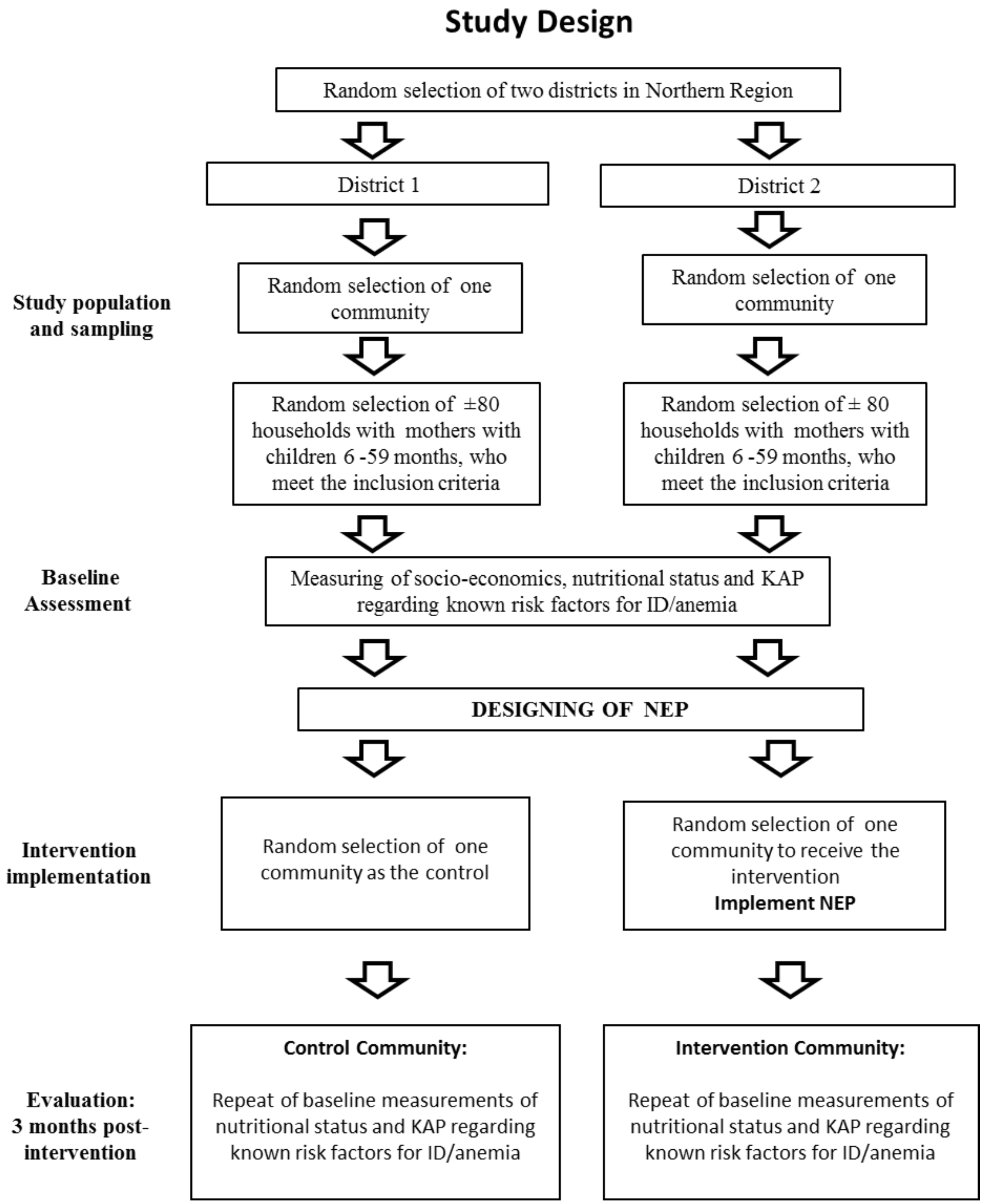

Figure 10.1: NEP planning and implementation process

10.3.2 Intervention design and implementation

At baseline mothers and their children, six to 59 months in both communities were assessed to identify KAP that pose risk factors for ID and anemia; as well as to assess nutritional status; dietary habits; adequacy of iron and anemia-related micronutrient intakes; household food security; and food production (Abu *et al*., 2013a, 2013b, 2013c; Abu, 2015:121-298).

The identified gaps regarding the known risk factors for ID were summarised into ten themes with related key messages, to form the framework of a NEP, focused on d KAP that pose risk factors for ID and anemia within the local context of these mothers and their children (Abu *et al.*, 2014).

Eight of the themes were targeted at improving gaps in the KAP regarding ID and anemia:

Theme 1: Intake of organ meat, muscle meat, and fruit to prevent ID;

Key message 1: Eat more meat, fish and fruits to increase access to available iron;

Theme 2: Intake and the timing of tea intake to prevent ID;

Key message 2: Do not brew tea; allow time between tea intake and meals, to increase iron availability;

Theme 3: Birth spacing and the role of contraception to prevent ID;

Key message 3: Choose contraceptive with health person, and space children to reduce nutrient requirements;

Theme 4: Treatment of malaria and personal and environmental hygiene; to prevent ID;

Key message 4: Prevent malaria, diarrhoea and worms which can increase risk for ID;

Theme 5: Complementary feeding in areas with high risk for ID;

Key message 5: Increase variety of food during complementary feeding and fortify with iron rich foods;

Theme 8: Myths and misconceptions regarding ID and pica;

Key message 8: There is an association between pica and ID;

Theme 9: Other risk factors: perinatal care versus unassisted home deliveries;

Key message 9: Report heavy bleeding and pregnancies to health facility; delivery in the health care centre could save the lives of both mother and child;

Theme 10: Practical demonstrations of cooking methods; the plate model, selection of protein foods, and the addition of fish powder in complementary foods.

Key message 10: Cooking methods can improve access to iron; improve food quality with fish, meat and legumes.

The intervention was also designed with consideration of the level of literacy of the target community (mothers) by using pictures and the resources found within the communities at baseline to engage mothers during intervention implementation and also to promote successful interaction sessions (Abu, 2015:253-298).

To improve the contextual relevance, local food samples, pictures that mothers could relate to, and resources from within the communities, were used to enhance interactions. The intervention was implemented in July 2013 in the community in Tolon-Kumbungu District, which was randomly selected as the intervention community, as part of the larger five-day intervention. The intervention community consisted of 73 mothers. At the time that the intervention was implemented, eight mothers (10.0%) had been lost from baseline, as they had migrated to southern Ghana to engage in menial jobs for income; a common practice in the Northern Sector during the dry season, referred to as “Kayayie”. For logistical reasons, the remaining 73 mothers were subdivided into three equal sized communities. The themes were presented during a 90-minute session each. Two weeks after the intervention, and again two weeks after that, the researchers visited each individual household in the intervention community to help mothers to address challenges in applying and adhering to the education messages. The household visits were also used to refresh the messages of the NEP. Each household was visited twice, two weeks apart, for about 30 minutes/household/session. The impact of the NEP was evaluated in October 2013, by repeating the baseline survey in both communities. At this point, 20 mothers and 23 children had been lost from baseline to follow-up from both communities in total

10.3.3 Data collection

The researchers developed a questionnaire, based on an in-depth survey of the literature on ID. The questionnaire was administered during structured interviews conducted with the mothers in their homes.

The questionnaire assessed socio-demographic information and medical backgrounds of the mothers with regard to practices and/or conditions that may pose risks for ID, including age, education level, menstrual history, the use and type of contraception, age at marriage and first pregnancy, spacing of pregnancies, number of live births, miscarriages and still births, as well as the gestational ages and birth weights of the index children (children who were 6 to 59 months old at baseline). The mothers’ history of anemia and malaria were recorded. The use of treated mosquito nets, use of iron supplements, and recent history of malaria and worm infections as potential causes of anemia were assessed. Further questions were related to food totems and taboos (foods forbidden due to cultural reasons), and cooking methods.

The researcher and two trained field workers measured the heights and weights of the women observing all standard protocols (Gibson, 2005). Weight was determined with an electronic scale according to the standard procedures recorded to the nearest 0.1kg. Height was determined using a mobile tape (Microtoise) to the nearest 0.1 cm. Body mass index (BMI) in kg/m2 of mothers was estimated using the formula weight (kg)/height (m2) (Gibson, 2005).

All mothers and index children were assessed for physical signs of chronic anemia, namely angular stomatitis, atrophic glossitis and koilonychias. Pictures were used to train the assistants to recognise these signs.

Knowledge regarding measures that prevent ID, knowledge of risk factors for ID, and symptoms associated with anemia, as well as the mothers' attitudes (defined for the purpose of the study as approval of certain behaviors associated with poor iron status); and preventive practices were assessed with multiple choice questions, sets of test statements, and questions to which the mothers could answer "yes/no", "agree/don't agree", or "I don't know". Knowledge of food sources of iron and enhancers of iron absorption were assessed with sets of paired foods such as "meat versus bread" from which the better source had to be selected. Open-ended questions were also included to allow mothers to share their own ideas about ID and anemia. Additional questions (not scored) assessed the mothers' perceptions on the availability of food sources of iron, cooking methods, as well as where the mothers had learned what they knew about anemia.

The same questionnaire on KAP was repeated three months after the intervention (October 2013) in exactly the same way as at baseline in both the intervention community (Kumbungu District) and control community (Tamale District).

10.3.4 Data analysis

The data was analyzes with SAS/STAT software, version 9.3 of the SAS system for Windows (Copyright © 2010 SAS Institute Inc). Categorical data was summarised as frequencies and percentages and continuous variables were expressed as means and standard deviations.

Based on BMI, the women were categorized according to WHO recommendations, as underweight (<18.5 kg/m2), normal (18.5-24.9 kg/m2), overweight (25.0-29.9 kg/m2), obese class I (30.0-34.9 kg/m2) and obese class II (35.0- 39.9 kg/m2) (WHO, 2008).

BMI were compared between the groups with analysis of variance (ANOVA) and $p<0.05$ was considered significant. Fisher's exact test was used to access the change in BMI categories from baseline to post-intervention between the two communities.

To assess knowledge, a score of one was allocated if the mother could identify a measure which prevents ID, or an incorrect test statement regarding ID and associated risk factors; a zero score was allocated if she chose an incorrect answer or the "do not know option". The same method was used to evaluate knowledge regarding food sources of iron and iron absorption enhancers, and risk factors and symptoms of ID. To assess attitudes regarding ID and risk factors, a score of zero were allocated for each high risk behaviour, or each "do not know option" that she chose. To assess practices regarding ID and risk factors, a score of one was allocated for each positive preventive measure a mother reported practicing and each negative practice that she reported to abstain from. A zero score was allocated for each risk behaviour that she admitted to

The changes in responses to the sets of test statements, as well as the changes in the scores, from baseline to post-intervention were categorized into four groups:

Group 1: "correct pre - correct post" referred to the participants who answer the test question correctly at baseline and post intervention.

Group 2: "correct pre - wrong post" referred to the participants who answer the test question correctly at baseline, but gave the wrong answer post intervention.

Group 3: "wrong pre - correct post" referred to the participants who gave the wrong answer at baseline, but answer the test question correctly post intervention.

Group 4: “wrong pre - wrong post” referred to the participants who answered the test question wrongly at baseline and post intervention.

Fisher’s exact test was also used to access the change in the scored test-statements from baseline to post-intervention between the two communities. The paired t-test was used to assess the mean change within the groups from baseline to post-intervention. Due to the relatively small sample size, multivariate analysis was not performed.

Manual content analysis was done on open-ended questions by categorizing responses into themes. The major themes are reported in this paper.

10.4 Results

10.4.1 Socio-demographic characteristics (Table 10.1)

Socio-demographical characteristics of the participants at post-intervention data collection are summarised and compared in Table 10.1. In both communities, most mothers were Dagomba (> 97.0%), all were Muslim (100%) and married (> 97.0%), and had a median number of four children. The mean ages of the mothers in the intervention community was 34.3 ± 9.3 years, and in the control community, 32 ± 6.9 years. These characteristics were not statistically significantly different between the two communities

This was a polygamous society where families consisting of a husband and several wives (one to four in this survey), stayed together in the same household. Most households were therefore large with a median household size of 12 people living together in four- to five-roomed mud huts.

Most mothers in both communities had no formal education, and those in the intervention community were significantly less educated (p=0.017) than those in the control community. A significantly (p=0.001) higher number of households in the intervention community (94.1%) had electricity, than those in the control (63.6%). Less than 10% in both communities had a refrigerator and/or freezer in the household. Cross tabulation of data indicated that significantly more people in the intervention community had access to piped water, while more than 90% in the control community drew water from ponds/rivers. Households earned a median of 40 cedi ($13.3) / month, and spent an average of 6-7 cedis ($2-3) /week on food.

None of the mothers were formally employed and earning a salary. All were involved in subsistence farming, and in both communities, spent an average of around seven hours per day working away from the home. Index child (ren) in both the intervention and control communities were mostly left at home in the care of other siblings (54.1% and 42.1%, respectively), or with a grandparent (20.3% and 19.7%, respectively) when the mother was away from the home. As there were more of the older children in the intervention community, about a tenth (9.5%) attended school (kindergarten) when their mothers were working away from the house. There were no children in the control community that was attending a school.

Table 10.1: Socio-demography of the mothers and children

Variables	**Intervention Community (n=71) n (%)**	**Control Community (n=70) n (%)**	**p-value for the mean difference**
Mother's age (years)			
Mean ± SD	34.3 ± 9.3	32.1 ± 6.9	0.142
Median	30.0	35.0	
Mother's highest level of education			
None	68 (98.6)	61 (87.1)	0.017
Primary school (1-6 years)	1 (1.4)	9 (12.9)	
Mother's religion			
Muslim	70 (100.0)	70 (100.0)	0.248
Marital status of the mother			
Married	69 (98.6)	67 (97.1)	
Single	1 (1.4)	0 (0.0)	0.500
Widowed	0 (0.0)	2 (2.9)	
Ethnicity			
Dagomba	69 (98.6)	67 (97.2)	

Moshi	1 (2.8)	0 (0.0)	0.370
Hausa	0 (0.0)	1 (1.4)	
Fulani	0 (0.0)	2 (2.8)	
Electricity			
Yes	64 (94.1)	42(63.6)	
No	4 (5.9)	24 (36.4)	<0.0001
Cooling facilities			
Refrigerator	2 (3.0)	1(1.5)	
Freezer	1 (1.5)	0 (0.0)	
Both freezer and refrigerator	1 (1.5)	0 (0.0)	0.335
Other cooling facilities	62 (93.9)	66 (98.5)	
Source of drinking water			
Bore hole	2(2.9)	2 (2.9)	
Pipe borne water	58 (82.9)	0 (0.0)	
River/pond	0 (0.0)	65(94.2)	
Well	10 (14.3)	2 (2.9)	<0.0001
Mother's employment status			
Self employed	69 (98.6)	67 (95.7)	0.592
Unemployment	1 (1.4)	3 (4.3)	
Number of hours per day mothers works			
Mean ± SD	7.2 ± 3.8	7.5 ± 3.8	0.339
Median	6.00	6.00	
Age of child (months)			
Mean ± SD	46.0 ± 13.1	40.0 ± 13.4	0.137
Median	46.6	34.8	
Gender of children			
Male	41 (54.7)	42 (54.5)	
Female	34 (45.3)	35 (45.5)	0.560
Care of the index child while the mother works			
Mother takes child to work	4 (5.4)	16 (21.1)	
Child in school	7 (9.5)	0 (0.0)	
Leaves the child with other siblings	40 (54.1)	32 (42.1)	
Leave child with stepmother	2 (2.7)	3 (3.9)	0.057
Leaves child with grandmother	15 (20.3)	15 (19.7)	
Leaves child with a paid caretaker	2 (2.7)	2 (2.6)	
Leave child with other relations	4 (5.4)	8 (10.5)	

Abbreviations; SD = standard deviation; Paired t-test was used for continuous variable and fisher exact test for the categorical data

10.4.2 Anthropometry (Table 10.2 & 10.3)

The nutritional status of the mothers assessed by BMI is summarised in Table 10.2. The mean BMI and categories of BMI was very similar between the two communities. Overall, around 10% were underweight, around 66% had normal weights, and around 15% were overweight/obese (class 1).

Table 10.2: BMI of mothers post-intervention

	POST-INTERVENTION		
Variable	**Intervention community (n=70) n (%)**	**Control community (n=70) n (%)**	**p-value**
BMI of mother(kg/m^2)			
Underweight (<18.5)	10 (14.3)	7 (10.1)	
Normal(18.5 - 24.49)	47 (67.1)	46 (66.7)	
Overweight (24.5 – 29.99)	10 (14.3)	14 (20.3)	
Obese Class 1 (30 - 39.99)	3 (4.3)	2 (2.9)	0.270
Mean weight (mothers) ± SD	57±11.2	57.0 ± 9.4	
Mean height (mothers) ± SD	1.6 ± 0.1	1.6 ± 0.1	
Mean BMI ± SD	22.3±3.7	22.8± 3.1	

Abbreviations; BMI-Body Mass Index, ANOVA was used to assess the differences and significant at * p<0.05.

Table 10.3 cross tabulates the BMI at baseline and post intervention and indicates that 5.6% of mothers in the intervention community, who were underweight at baseline, remained underweight post intervention; compared to just 1.4% in the control group. On the other hand, about 4% of the mothers in both communities improved from underweight to normal BMI. These changes were significant (p<0.05).

Table 10.3: Changes in the mothers' bmi categories from baseline to post intervention (n=141)

BMI CATEGORIES AT BASELINE		BMI CATEGORIES POST- INTERVENTION: Underweight	Normal	Overweight (Pre-Obese)	Obese class I	Obese class II	TOTAL	p-value
Intervention community (n=71)		4 (5.3)	3 (4.2)	0 (0.0)	0 (0.0)	0 (0.0)	**7 (9.9)**	0.001*
	Normal	4 (5.3)	48(67.6)	5 (7.0)	1 (1.4)	0 (0.0)	**58 (81.7)**	
	Overweight (Pre-Obese)	0 (0.0)	2 (2.8)	1 (1.4)	0 (0.0)	0 (0.0)	**3 (4.2)**	
	Obese class I	0 (0.0)	0 (0.0)	1 (0.0)	1(1.4)	1 (1.4)	**3 (4.2)**	
	TOTAL	***8 (11.3)***	***53 (74.6)***	***7 (9.9)***	***2 (2.8)***	***1 (1.4)***	***71 (100.0)***	
Control community (n=70)	Underweight	1 (1.4)	3 (4.3)	1 (1.4)	0 (0.0)	0 (0.0)	**4 (6.1)**	0.001*
	Normal	1 (1.4)	48(68.6)	2 (2.9)	0 (0.0)	0 (0.0)	**52 (78.8)**	
	Overweight (Pre-Obese)	0 (0.0)	2 (2.9)	5 (7.1)	1 (1.4)	0 (0.0)	**8 (11.3)**	
	Obese class I	0 (0.0)	0 (0.0)	2 (2.9)	0 (0.0)	0 (0.0)	**2 (2.9)**	
	TOTAL	***2(2.8)***	***53 (80.3)***	***10 (15.2)***	***1 (1.4)***	***0 (0.0)***	***66 (100.0)***	

Abbreviations; BMI-Body Mass Index

There were 4 missing values in the control community

WHO classification of BMI; underweight (<18.5 kg/m2); normal (18.5-24.9 kg/m2); overweight (25.0-29.9 kg/m2); obese class I (30.0-34.9 kg/m2) and obese class II (35.0- 39.9 kg/m2) (WHO, 2008)

Fisher's exact test was used to asses difference; and *p-value is significant at p<0.05

10.4.3 Changes in KAP (Table 10.4, 10.5 & Figure 10.2)

Table 10.4 presents the changes in the answers that mothers gave to the KAP test statements from baseline to post-intervention for six categories of statements. The change of interest is those that answered a test statement wrong at baseline, but correct after the intervention, as this, if more pronounced in the intervention group, would indicate that learning took place due to the NEP. Table 10.5 indicates the change from baseline to post-intervention in the mean scores obtained in each of the six categories of test statements.

The first category of test statements referred to measure to prevent ID:

In this category test statement on which the participants had existing correct knowledge, since they answered it correctly both at baseline and again post-intervention, was on taking iron supplements to prevent ID (>80% in both communities), drinking juice with food (>62% in both communities), and eating lots of eggs (26.8% in the intervention community and 48.6% in the control community).

Test statements on which the knowledge of participants in the intervention community increased (since they answered it wrong at baseline, but correct after the intervention) more than those in the control group, was on circumcision of a baby boy (39.4% in the intervention community and 25.7% in the control community), shaving a baby's hair (50.7% in the intervention community and 25.7% in the control community), drinking tea with meals (52.1% in the intervention community and 38.6% in the control community), and drinking a lot of milk (19.7% in the intervention community and 8.6% in the control community).

According to Table 10.5 the scores in this category decreased from baseline for both communities, but the change was not significant.

The second category of test statements referred to picking out the better food sources of iron/enhancers of iron absorption given two possibilities at a time:

In this category test statements on which the participants had existing correct knowledge, since they answered it correctly both at baseline and again post-intervention, was on oranges vs mango (>36% in both communities), meat vs corn (>33% in both communities), and liver vs bread (>55% in both communities),.

Test statements on which the knowledge of participants in the intervention community increased (since they answered it wrong at baseline, but correct after the intervention) more than those in the control group, was on oranges vs mango (39.4% in the intervention community and 14.3% in the control community), meat vs corn (39.4% in the intervention community and 21.4% in the control community), red meat vs chicken (32.4% in the intervention community and 15.7% in the control community), and liver vs bread (>55% in both communities).

According to Table 10.5 the scores in this category increased significantly from baseline for both communities, but the change was more pronounced in the intervention community.

The third category of test statements referred to knowledge of risk factors for ID:

In this category test statements on which the participants had existing correct knowledge, since they answered it correctly both at baseline and again post-intervention, was on poor nutrition (>72% in both communities), bleeding (>77% in both communities), pregnancy (>67% in both communities), multiple pregnancies (>64% in both communities), and age at pregnancy (>38% in both communities.

The intervention community did not show improved knowledge relative to the control group for any of these test statements According to Table 10.5 the scores in this category decreased non-significantly from baseline for both communities.

The fourth category of test statements referred to the symptoms of ID:

In this category symptoms that the participants already knew at baseline, since they answered it correctly both at baseline and again post-intervention, was tiredness (>48% in both communities), weakness (>51% in both communities), and dizziness (>68% in both communities).

The intervention community did not show improved knowledge relative to the control group for any of these test statements. According to Table 10.5 the scores in this category decreased non-significantly from baseline for both communities.

The fifth category of test statements referred to attitudes towards behaviour that may predispose to ID:

In this category test statements on which the participants had existing correct knowledge, since they answered it correctly both at baseline and again post-intervention, was on taking iron supplements to prevent ID (>73% in both communities), marrying young (>59% in both communities), having babies before 20yrs (>45% in both communities), giving birth at short intervals (>74% in both communities), and taking iron supplements after eating (>78% in both communities).

The intervention community did not show improved knowledge relative to the control group for any of these test statements. According to Table 10.5 the scores in this category increased non-significantly from baseline for the intervention group and decreased non-significantly from baseline for the control group.

The sixth category of test statements referred to practices that mothers were doing which may protect against ID:

In this category test statements on which the participants had existing good practices, since they answered it correctly both at baseline and again post-intervention, was on having and using a treated mosquito net (>55% in both communities).

Table 10.4: Changes in responses to test statements at baseline and after three months post intervention (n=141)

Item	Intervention Community (n=71)					Control Community (n=70)				
	% Correct Pre-Correct Post	% Correct Pre-Wrong Post	% Wrong Pre-Correct Post	% Wrong Pre-Wrong Post	p-value for the change from baseline	% Correct Pre-Correct Post	% Correct Pre-Wrong Post	% Wrong Pre-Correct Post	% Wrong Pre-Wrong Post	p-value for the change from baseline
Knowledge on measures to prevent ID: Does the following actions help prevent ID/anemia? (Protective)										
Deworming	77.5	5.6	**5.6**	8.5	0.1611	67.1	21.4	**5.7**	5.7	0.1631
Taking iron supplements	83.1	7.0	**1.4**	2.8	1.0000	82.9	10.0	**7.1**	0.0	1.0000
Drinking fruit juice with food	70.4	14.1	**4.2**	5.6	1.0000	62.9	25.7	**8.6**	0.0	0.8707
#*Regular weighing (growth monitoring) of a child*	73.2	5.6	**2.8**	15.5	0.1163	1.4	10.0	**7.1**	81.4	0.0270
Circumcision of baby boy	15.5	11.3	**39.4**	28.2	0.2337	15.7	17.1	**25.7**	41.4	0.1124
Shaving of the baby's hair	11.3	2.8	**50.7**	29.6	0.4468	18.6	14.3	**25.7**	41.4	0.3210
Drinking tea with meals	8.5	7.0	**52.1**	26.8	0.4683	4.3	4.3	**38.6**	52.9	0.6238
Eating a lot of eggs	26.8	39.4	**12.7**	15.5	0.1805	48.6	27.1	**14.3**	10.0	0.1321
Drinking a lot of milk	4.2	21.1	**19.7**	47.9	0.4988	5.7	8.6	**8.6**	77.1	0.1919
Knowledge of good iron sources and absorption enhancers										
Which food is better to prevent anemia?										
Meat Versus *Vegetables*	2.8	7.0	**23.9**	63.4	1.0000	1.4	8.6	**14.3**	75.7	0.9086
Orange Versus *Mango*	36.6	12.7	**39.4**	8.5	0.1719	52.9	20.0	**14.3**	12.9	0.0765
Spinach Versus *Okra*	4.2	0.0	**84.5**	9.9	0.3885	2.9	0.0	**77.1**	17.1	0.6068
Maize Versus Meat	33.8	7.0	**39.4**	12.7	0.5286	44.3	20.0	**21.4**	14.3	0.1920
Red meat Versus *Chicken*	35.2	16.9	**39.4**	7.0	0.1841	34.3	24.3	**21.4**	12.9	0.9386

Meat	Versus	*Milk*	16.9	11.3	**32.4**	38.0	0.4148	15.7	8.6	**28.6**	47.1	0.1616
Liver	Versus	*Bread*	59.2	4.2	**32.4**	1.4	0.2553	55.7	18.6	**15.7**	10.0	0.4766
Knowledge of risk factors of ID **Is the following a risk factor for ID?**												
Standing for long hours			1.4	9.9	**19.7**	66.2	0.8974	1.4	5.7	**11.4**	81.4	0.7282
Poor nutrition			77.5	8.5	**11.3**	1.4	0.6822	72.9	2.9	**17.1**	7.0	0.3618
Bleeding			83.1	7.0	**8.5**	0.0	1.0000	77.1	5.7	**17.1**	0.0	1.0000
Pregnancy			67.6	15.4	**14.1**	0.0	1.0000	75.7	8.6	**10.0**	4.3	0.2557
Multiple pregnancies			71.8	11.3	**15.4**	0.0	1.0000	64.3	12.9	**11.4**	11.4	0.4389
Age at pregnancy			38.0	40.9	**9.9**	9.9	1.0000	42.9	40.0	**12.9**	4.3	0.2043
Spacing of pregnancies			2.8	28.2	**12.7**	54.9	0.4773	4.3	18.6	**14.3**	62.9	0.4450
The use of an intra-uterine Device (IUD)			0.0	2.8	**16.9**	77.5	0.5679	0.0	5.7	**12.9**	74.3	0.3388
Adolescent girls vulnerable			8.5	11.3	**31.0**	47.1	0.2370	2.9	17.1	**20.0**	60.0	0.5250
Knowledge of symptoms ID **Are the following symptoms of ID?**												
Tiredness			57.7	12.7	**23.9**	4.2	0.4804	48.6	4.3	**28.6**	18.6	0.4175
Obesity			5.6	14.1	**32.4**	46.5	0.2071	21.4	15.7	**15.7**	51.4	0.2152
Rashes			19.7	28.2	**14.1**	36.6	0.5264	25.7	20.0	**14.3**	40.0	0.3865
General weakness			56.3	23.9	**9.9**	11.3	0.2077	51.4	11.4	**20.0**	17.1	0.0631
Dizziness			74.6	11.3	**9.9**	2.8	0.1124	68.6	2.9	**22.9**	5.7	0.6069
Hair loss			7.0	9.9	**7.0**	49.3	0.3376	7.1	10.0	**11.4**	71.4	0.2250
Headaches			9.9	39.4	**4.2**	28.2	0.1266	35.7	8.6	**34.3**	20.0	0.7730
Attitudes towards behaviour related to ID **Does the mother approve of the following?**												

Taking iron supplements	73.2	9.9	**14.1**	1.4	1.0000	90.1	2.9	**2.9**	0.0	1.0000
Getting married young (Less than 16 years)	64.8	9.9	**19.7**	4.2	0.4633	59.2	12.9	**16.9**	5.7	0.5788
Having many babies	23.9	23.9	**16.9**	33.8	0.4762	16.9	22.9	**15.7**	41.4	0.0944
Having babies before 20 years old	57.7	11.3	**22.5**	7.0	0.2547	45.1	21.4	**16.9**	12.9	0.4634
Using an IUD	16.9	43.7	**12.7**	25.4	0.7072	36.6	22.9	**21.4**	15.7	0.6577
Drinking tea with meals	14.1	14.1	**43.7**	26.8	0.7812	0.0	1.4	**38.6**	57.1	0.0567
Taking iron supplements with milk and tea	21.1	19.7	**36.6**	21.1	0.4918	18.3	16.9	27.1	34.3	0.1804
Taking iron supplements after eating	78.9	4.2	**7.0**	8.5	1.4040	84.5	8.5	1.4	0.0	0.0907
Giving birth every year	74.6	5.6	**16.9**	1.4	0.0244	85.9	8.5	1.4	0.0	1.0000
Practices of ID preventive measures										
Is the mother practicing any of the following										
Drinks milk with meals or within an hour before or after meals	7.0	9.9	**38.0**	23.9	0.7867	5.7	4.3	20.0	42.9	0.1076
Drinks tea during meals	53.5	2.8	**39.4**	1.4	0.7712	10.0	25.7	10.0	54.3	0.2292
Has and is using a mosquito net	64.8	4.2	**12.7**	2.8	0.1679	55.7	11.4	5.7	12.9	0.1543
Has been de-wormed within the last three months prior to the survey	9.9	9.9	**25.4**	53.5	0.0767	20.0	34.3	20.0	25.7	0.6282
Currently uses an iron supplement	22.5	29.6	**12.7**	32.4	0.4508	15.7	25.7	18.6	40.0	0.6178

Incorrect items are shown in italics;

A score was given if the mother was able to correctly identify a preventive measures or a wrong test statement. A zero score was given if the mother chose the wrong preventive measures for ID or did not know the right answer

A score was given if the mother was able to correctly identify a better iron food sources. A zero score was given if the mother chose the less iron food source or did not know the right answer.

A score was given when a mother was able to correctly identify whether a variable was a risk factor or not. A zero score was given when a mother wrongly identified a risk factor or admitted she did not know that right answer.

A score was given when a mother was able to correctly identify a variable as a symptom of ID or not. A zero score was given when a mother wrongly a symptom or admitted she did not know the right answer.

A score is given when a mothers approves of the less risky behaviour. A zero score is given when a mothers chooses a high risk behaviours or does not know the right answer. Some missing values (12 mothers) occurred were this section was skipped in 12 questionnaires.

A score was given when a mother reported practicing a positive preventive measure or abstained from a negative practice. A zero score was given when a mother reported practicing a negative preventive measure or admitted she did not remember.

Correct pre-Correct post refers to the participants who were able to correctly answer the test question at baseline and also after 3 month post intervention.

Correct pre-Wrong post refer to the participants who were able to correctly answer the test question at baseline and got it wrong after 3 month post intervention.

Wrong pre-Correct post refer to the participants who were answered the test question wrongly at baseline and got it correct after 3 month post intervention.

Wrong pre- wrong post refers to the participants who answered the test question wrongly at baseline and also after 3 month post intervention.

Table 10.5: Change in mean scores to KAP questionnaire for intervention and control communities

	Intervention Community(n=71)			**Control Community (n=70)**		
Category of test statements	**Mean**	**Standard Deviation**	**Paired t-test**	**Mean**	**Standard Deviation**	**Paired t-test**
Change in total score for attitudes towards ID preventive actions	0.155	3.306	0.39	-0.086	2.529	-0.28
Change in total score for knowledge on iron sources and iron absorption enhancers	2.324	2.431	8.06**	0.886	2.262	3.28**
Change in total score for knowledge on preventive measures of ID	0.408	2.074	1.66	0	1.963	0.00
Change is total score for ID preventive practices	0.577	1.317	3.70**	0.214	1.382	1.30
Change in total score for knowledge on risk	-0.408	2.011	-1.71	-0.357	2.502	-1.19

factors for ID						
Change in total score for knowledge on symptoms of ID	-0.211	1.820	-0.98	-0.243	2.102	-0.97

The variables are scores in the various categories:* p<0.05; ** p<0.001.

The paired t-test indicates the change within sample and that of the community

Some missing values (12 mothers) occurred were this section was skipped in 12 questionnaires.

A score was given if the mother was able to correctly identify a preventive measures or a wrong test statement. A zero score was given if the mother chose the wrong preventive measures for ID or did not know the right answer.

A score was given if the mother was able to correctly identify a better iron food sources and enhancers of iron absorption. A zero score was given if the mother chose the less iron food source or did not know the right answer.

A score was given when a mother was able to correctly identify whether a variable was a risk factor or not. A zero score was given when a mother wrongly identified a risk factor or admitted she did not know that right answer.

A score was given when a mother was able to correctly identify a variable as a symptom of ID or not. A zero score was given when a mother wrongly a symptom or admitted she did not know the right answer.

A score is given when a mothers approves of the less risky behaviour. A zero score is given when a mothers chooses a high risk behaviours or does not know the right answer.

A score was given when a mother reported practicing a positive preventive measure or abstained from a negative practice. A zero score was given when a mother reported practicing a negative preventive measure or admitted she did not know.

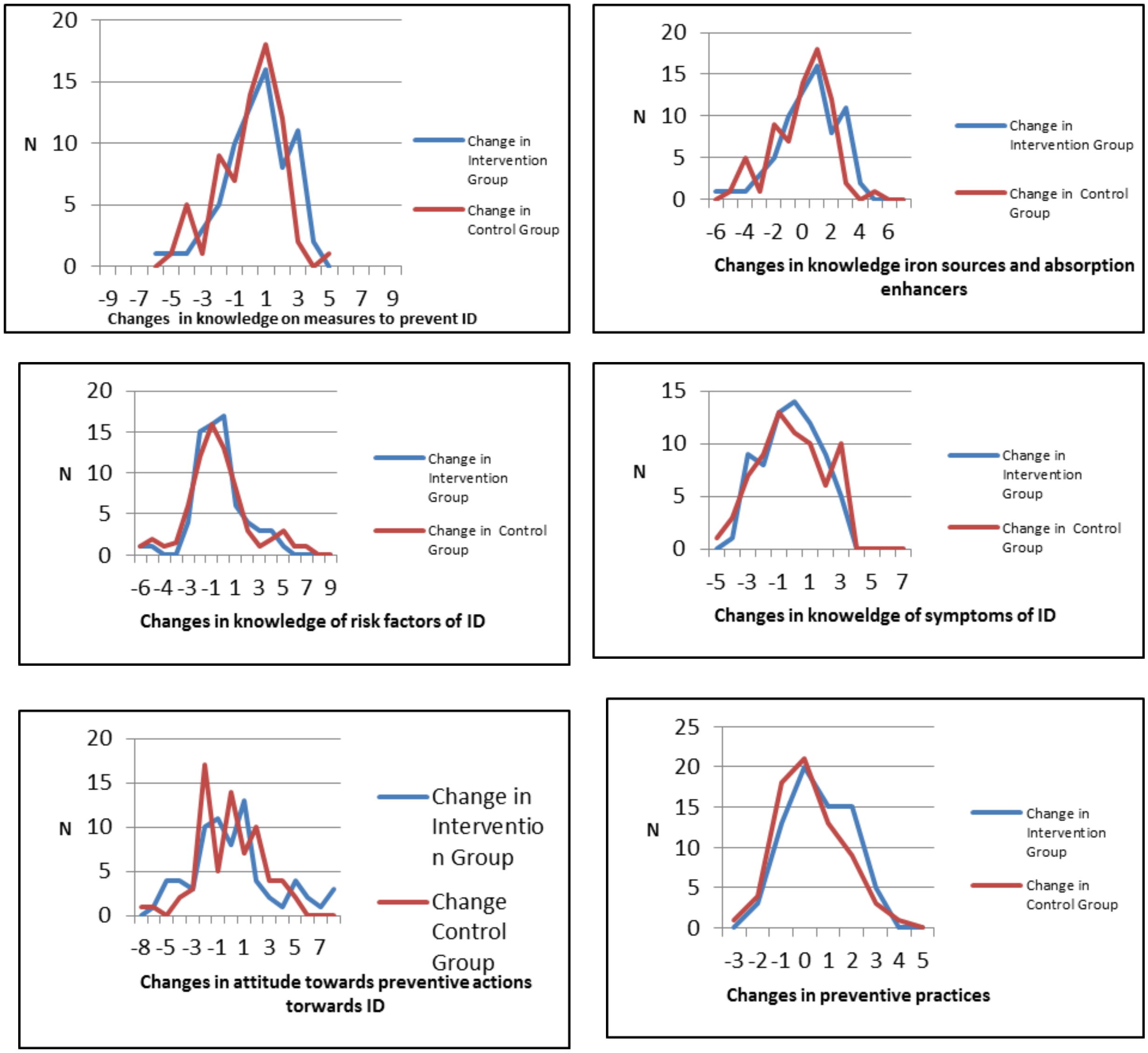

Figure 10.2: Frequencies of the individual change in test scores for KAP from baseline to post-intervention.

Practices that improved in the intervention community (since they answered it wrong at baseline, but correct after the intervention) to a greater extent than in the control group, was spacing milk drinking correctly relevant to meals (38% in the intervention community and 20% in the control community), spacing tea drinking correctly relevant to meals (39.4% in the intervention community and 10% in the control community), and using a mosquito net (12.7% in the intervention community and 5.7% in the control community).

According to Table 10.5 the scores in this category increased significantly from baseline in the intervention community, but not in the control community.

10.4.4 Additional KAP relating ID/anemia (Not scored)

There were no significant changes on the perceptions of the mothers regarding the affordability of meat, fish, chicken, vegetables, and fruits (all good sources of iron and iron absorption enhancers). Overall, 12.7% mothers in the intervention group who agreed that meat was expensive at baseline re-affirmed their perception post-intervention; compared to 2.9% of the mothers in the control group.

Regarding contraceptive use, which was non-existent in both communities at baseline, was only taken up by around 4% of mothers post intervention.

About 7% of mothers in the intervention group and 15% in the control group who had not been diagnosed with anemia pre-intervention, reported they had been diagnosed with anemia post-intervention.

Asked when they drink their tea, post intervention significantly more mothers in the intervention group reported correct spacing of tea intake relative to meals than in the control group (55.3% vs 18.6%, p=0.012).

The incidence of malaria less than three months prior to the intervention was generally low in both groups. For those who had had malaria, more mothers in the intervention group (31.8%) than the control group (15.4%) treated it post-intervention, with prescribed drugs.

Mothers also reported varied ideas regarding ID/anemia that was not discussed in the administered questionnaire including that one can die from anemia, stress causes anemia and transfusion helps people with anemia.

Asked where they learn about anemia, post intervention more mothers in the intervention group (38.0%) than the control group (25.7%) indicated that it was a health professional.

10.4.5 Self-reported adherence to intervention messages (Table 10.6)

Table 10.6 summarises the responses of the mothers in the intervention community to open ended questions regarding changes she had made, and challenges that she encountered in implementing the key messages.

Over 40% recalled the theme on sources of iron and bioavailability of iron, and 23.3% of the mothers reported that they increased their weekly intake of meat. Lack of money to buy meat, fruit, and vegetables was mentioned as the biggest constraint to implementing this key message. Some mentioned the large family sizes, and seasonality that affects the availability of the fruits and vegetables.

About 40% recalled the theme on tea drinking practices and 19.2% that they made a point to drink tea 1-2 hours before or after meals and not with meals anymore, and 16.4% that they had brewing tea over heat which releases more iron inhibitory tannins. Financial constraints to buy enough tea bags to avoid having to brew tea over heat for prolonged times using one bag for an entire household was the main challenge (8.2%). Other challenges included forgetfulness (4.2%), being too busy to drink tea between meals instead of with meals, not being interested, not fully understanding the message, and lack of support from the household members, were mentioned as constraints.

About 70% of the mothers recalled the theme hygienic practices. Overall, 40.8% indicated that they were washing their hands more often particularly after using the toilet and before handling food. In addition, 8.5% indicated that cleaned the environment in which food was handled, 2.8% that they strained and boiled drinking water, and 7% that they started using mosquito nets. The constraints that mothers mentioned to hamper their implementation of these key messages included having no money to buy soap, forgetting, not being supported by others in the household, and the nets being too warm and uncomfortable.

About 40% recalled the theme on tea drinking practices and 19.2% that they made a point to drink tea 1-2 hours before or after meals and not with meals anymore, and 16.4% that they had brewing tea over heat which releases more iron inhibitory tannins. Financial constraints to buy enough tea bags to avoid having to brew tea over heat for prolonged times using one bag for an entire household was the main challenge (8.2%). Other challenges included forgetfulness (4.2%), being too busy to drink tea between meals instead of with meals, not being interested, not fully understanding the message, and lack of support from the household members, were mentioned as constraints.

About 16% recalled the theme on contraception and birth spacing to prevent ID, but only 2.7% reported that they started using contraception. Financial constraints, having forgotten (6.8%), not being interested, not fully understanding the message, and lack of support from the spouse, were mentioned as constraints.

About 40% recalled the theme on complementary feeding to prevent ID, and 27.4% reported that they now fortified the children's food with fish and 5.5% indicated giving larger portions of fortified porridge. Once again lack of money to buy iron rich foods like meat/fish, as well as forgetfulness, were mentioned as constraints.

Only 2.7% recalled the theme on home deliveries and heavy menstruation, and only 1.4% indicated that she visited the antenatal clinic more often. Constraints reported were laziness and forgetting.

Table 10.6: Self-reported adherence to themes from the nutrition education intervention messages (N=71)

Theme / key message	Participants who remembered themes	Adherence to theme discussed		Reported challenges mothers faced while applying themes on intervention in their households	
	%		%		%
1. Sources and bioavailability of iron	**42.5**	Increased red meat intake in a week	**23.3**	No money to buy iron source foods	**35.6**
				Large family size	**4.1**
				Seasonality affects availability	**1.4**
				She forgets	**5.5**
2. Intake of tea and the timing of tea intake	**42.5**	Took tea 1-2 hours before meals	**19.2**	Financial constraints hence household used one bag of tea to a large amount of water thus brewing tea and risking more release of tannins.	**8.2**
				She forgets	**4.1**
		Has changed tea preparation to reduce release of tannin thus no longer brew tea	**16.4**	She was always busy, so it is difficult to wait for one to two hours to eat others meals	**1.4**
				Lack of support and encouragement/ people told her she was a " know it all"	**2.7**
3. The role of contraception and birth spacing in ID prevention	**16.4**	Started birth control by using pills/inject able	**2.7**	She forgets	**6.8**
				Not interested	**1.4**
				Did not fully understand	**1.4**
				Lack of support from spouse	**1.4**
				Financial constraints	**1.4**
4. Prevention and treatment of malaria and other parasitic infections	**69.9**	Did more hand washing	**40.8**	She forgets especially with the hand washing	**8.5**
		Strained and boiled water for drinking	**2.8**	Lack of support from families in terms of keeping the environment clean	**2.8**
		Cleans environment	**8.5**	Financial constraints to buy soap	**15.5**
		Use mosquito nets	**7.0**	Sleeping in mosquito net is uncomfortable and makes	**2.8**

				one feel warmer.	
5. Pica as a risk factor for ID	**46.6**	Reduced clay intake and also advised others to stop	**26.0**	It's not easy to stop the practice since it a formed behaviour	**5.5**
				She forgets	**5.5**
6. Pica as an indicator for ID	**20.5**	Stayed away from practicing it	**9.6**	She forgets	**1.4**
				She felt shy to tell people since they may tease her or say she is a "know it all"	
7. Complementary feeding in ID risk areas	**42.5**	Fortified children food with fish	**27.4**	No money to buy iron rich foods to fortify foods	**15.1**
				She forgets	**1.4**
		Increased quantity of soup for children	**5.5**	Baby did not like the fortified porridge	**2.7**
Other risk factors: home delivery and heavy menstruation	**2.7**	Visited the antenatal clinic more regularly	**1.4**	She forgets	**2.7**
				Laziness	**1.4**
8. Myths and misconceptions regarding causes and prevention of anemia	**4.1**	Hard work does not cause ID	**4.1**	She forgets	**1.4**
9. Cooking methods; plate model; protein foods; and use of fish powder in complementary foods		Increase quantity of soup for children to indicate the plate model	**1.4**		

Only mothers who reported that they remember, applied themes or had challenges in the adherence of ID are being presented on the table.

10.5 Discussion

In this manuscript, the impact of a NEP to address the gaps in KAP regarding the known risk factors for ID and anemia among low income, unschooled mothers with children six to 59 months, in an agrarian society, was evaluated. In both communities, knowledge on risk factors, symptoms of ID and preventive measure generally increased form baseline to post intervention, but these changes were more pronounced in the intervention community, than in the control. A scored questionnaire indicated that the knowledge of dietary iron sources and enhancers of iron absorption, as well as practices that protect against ID and anemia, increased significantly from baseline to post intervention in the intervention community

These significant changes in practices were confirmed by the uptake of some of the key messages of the NEP by the intervention group. The mothers reported integrating some of the key messages on hand washing (40.8%), fortifying their children's food with fish (27.4%) and increasing of their meat intake (23.3%). Proper spacing of tea drinking at least an hour before or after meals, prevents the interference with iron absorption. This information should be imparted to all people at risk of ID (Nelson & Poulter, 2004), and the message was taken up fairly well in the intervention community post intervention. These positive changes occurred in spite of challenges, which were mostly related to financial constraints, but also lack of social support from the spouse and other household members, lack of interest or forgetfulness on the part of the mother, and not fully understanding certain concepts (i.e. regarding contraception).

The income status among these subsistence farmers was low; and was derived mostly from the sale of surplus farm produce, or animals. Furthermore, the baseline survey in 2012 (Abu, 2015:121-217) indicated that the animals raised and kept in these communities, were not generally slaughtered for household consumption, but rather kept as financial collateral. In both communities, mothers perceived these foods to be too expensive. Financial constraints were also mentioned as a barrier to implementation of five out of the ten key messages. This may have implication for access to dietary iron sources and enhancers of iron absorption. Studies show that even middle to upper - income pregnant women cannot meet their estimated average requirement for iron from dietary intake alone (Turner *et al.,* 2003). Cole *et al.,* (2010) found that anemia is more prevalent among low income minority children. A mother with low educational status is more likely to have a child at risk of ID (GDHS, 2003). In the NEP implementation process, pictures, food sample, preambles and practical sessions were used to compensate for low literacy (Abu, 2015:253-298). The approach was successful to significantly improve practices which may prevent ID and protect against anemia, as seen from improved post intervention scores. The questionnaire also included open-ended questions that were not scored, since the method is more likely to actively engage mothers in NEP messages (Bandayrel & Wong, 2011). These improved practices were also reflected in the responses to open-ended questions.

Most of the mothers were married; and one of the key messages was to encourage the use of contraceptives. This message was not well understood and not taken up by the communities, due to among other reasons mentioned, lack of spousal support.. Thus education on contraceptive use should target both men and women alike, to enhance effectiveness. This approach has been successful in urban Nepal, where the involvement of husbands in antenatal clinic attendance and post-partum visits to the hospital was targeted for better pregnancy outcomes (Mullany *et al.,* 2007).

There were 10.6% underweight mothers in the intervention community, compared to only 2.8% in the control community. However, 4.2% of mothers in the intervention community who were in the underweight category at baseline, post-intervention changed to the normal category. Low income affects food security and food insecurity leads to persistent inability to meet the nutrient requirements, ultimately leading to underweight, and nutrient deficiencies, including ID. The nutritional status also physiologically affects erythropoiesis since proteins are required to ensure iron homeostasis in the body (Rouault, 2006; 2013). Undernutrition also impairs the body's immune response to infections and my lead to iron stores depletions (Chandra, 1991); hence the term: nutritional-acquired immune deficiency syndrome (NAIDS) referring to the suppression of the immune system due to malnutrition. The effects of NAIDS are similar to AIDS caused by the

Human Immune-deficiency Virus (HIV) (Duggal *et al.*, 2012; Rodgers, 2011). Therefore to improve ID status, optimum BMI should be reached and maintained.

Quarterly deworming of young children in Tanzania resulted in reduced anemia and wasting among children with light infections. The authors hypothesised that, since worm infection stimulates the immune response to inflammation and affect protein metabolism and erythropoiesis, deworming counteracts this process, thus improving iron and nutritional status. (Stoltzfus *et al.*, 2004). About a third of the mothers in the intervention reported being de-wormed post-intervention (about 70% of this population was not de-wormed pre-intervention). In the control community, though 40% of the mothers reported having been dewormed at baseline, only 50% of them were dewormed post-intervention.

Self-efficacy is an important motivator to change (Snetselaar, 2008), when coupled with an individuals' belief that they are at risk of a disease condition, as postulated by the health believe model. This was evident in a breast cancer study (Charles and Paschal, 2005; Reimer *et al.*, 1991). Because mothers in the intervention community now know that women are vulnerable to ID; this may motivate them to improved adherence to preventive measures.

Nutrition education interventions have been successful in addressing some public health conditions, to such an extent that the need for more expensive interventions like supplementation and fortification, have been reduced (Balachander, 1991). Engagement of adult mothers with little formal education has to be innovative in order to accommodate the deficiencies of participants. Olem et al. (2009) discussed the challenges in engaging participants in behavioural intervention trials and identified attendance as being one of the main challenges. In this study the recorded attendance throughout the 5 day programme, as well as the active participation therein, was high (Abu, 2015:253-298). Practical examples from within the community were used in the NEP to keep mothers engaged. During intervention sessions mothers were encouraged (in keeping with the principles of adult learning) to share experiences, and this made them feel respected and kept them interested. The use of real foods and practical food demonstrations which stressed the use of locally available foods may have translated to the significant improvement in the knowledge of irons sources and iron absorption enhancers, in the intervention community. In resource-poor communities such this one, nutritious foods which are available in the communities has to be highlighted through education to empower mothers to make better choices from available foods. This was seen in communities in Somalia were offal intake was encouraged to improve iron sources (FSNAU, 2010). Interventions conducted in similar developing countries which encouraged the intake of vegetables and fruits to improve iron intakes, have been successful (Sathyanarayana, 2011).

Green leafy vegetables are only available in this community during the rainy season. Since these households are farmers, the provision of an alternative rainy season through irrigation facilities could improve availability during the dry season (Abu *et al.*, 2010 ;Stiener-Asiedu *et al*., 2012). Irrigation has the potential to improve food availability, nutrition security and rural development, and to reduce rural-urban migration during the dry seasons in northern Ghana (Abu *et al.*, unpublished data). Post intervention, 20% of mothers were lost to follow-up, most of whom had migrated to the southern sector to engage in head portership called the “kayayie”. This mode of migration is associated with health risk, sexual exploitations and neglect of the care of their children (Twumasi–Ankrah, 1995). Therefore irrigation provides a solution to this seasonal exodus. Irrigation may increase crop yields and thus household income. Farm animals also benefit from greater water availability which may improve their growth. Fish from irrigation dams could also increase fish consumption among vulnerable communities and increase income (Abu *et al.*, 2010). Homestead gardening with simultaneous animal husbandry projects have also been successful to improve access to vegetable and meat, which are all good sources of iron (Talukder *et al.*, 2014).

Over the years, studies have shown that clients only understand 59% of what they are told by health professionals and in some setting it is even lower (Ulrey and Amason, 2001). All health professionals should develop effective counselling skills since ineffective communication could lead to wrong diagnosis and ineffective implementation of interventions (Patterson, 2004; Van Wieringen *et al.*, 2002). Personal hygiene practices (Abu, 2015:311-350) were observed to have improved post-intervention. Some mothers reported practicing more hand washing for themselves and for their children, but cited financial constraints to buy soap as a challenge. In some cases, mothers reported being called “doctors” or “know it all” when they tried to educate others on hygiene. Interventions which introduced hand washing together with meal planning, have been successfully at reducing both infections and anemia prevalence (Sanou *et al.,* 2010).

Generally the intervention was effective to addres some gaps in KAP regarding ID and anemia among mothers of young children in a resource-poor community in Northern Ghana where anemia is endemic. A targeted NEP improved their understanding of the concept of ID, and lead to minor changes such as improved timing of tea intake to reduce the inhibition of iron absorption, improved ability to identify vulnerable communities and good dietary sources of iron. However, some myths on ID still lingered as mothers find it difficult to let go of these believes. Though ID is a complicated physiological process, health messages regarding anemia and ID was simplified with the use of scenarios and preambles to accommodate these low literate mothers. This means that health workers can educate mothers on complicated health issues, through the use of innovative approaches. To overcome barriers of low education during education, pictures and real food samples familiar to the audience were used to interact with them. These approaches should be further explored.

10.6 Conclusion and recommendations

To bring about sustainability in the nutrition education and messages, it is hoped that mothers will become agents of change within their communities. This may be challenged by lack of self-confidence and fear of being ridiculed by their peers. This was mentioned by several mothers in the current study who reported that others called them “know-it-all’s” when they tried to relay the health messages imparted to them through the NEP. Mothers have to be motivated to build their confidence in dealing with their peers and positively influencing them.

To help mothers overcome the financial, self-efficacy and social barriers which may prevent them from making the desired behavioural changes, household heads as well as other influential members of the household such as grandmothers, should be equally targeted to improve support and sustainable adherence to interventions.

More time and engagement of the mothers in the NEP, may have yielded more positive impact. Nevertheless, similar less expensive and easily adoptable interventions should be promoted to empower mothers to make positive changes towards their own health and that of their children. Ultimately this may reduce national budgets spent on more expensive interventions. Further research should target addressing KAP gaps on ID and other nutrition deficiencies through nutrition education.

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CHAPTER 11

IMPACT OF AN EDUCATION INTERVENTION ON PICA ON PRACTICES AND PERCEPTIONS OF IRON DEFICIENCY AMONG WOMEN AND THEIR YOUNG CHILDREN IN GHANA

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11 IMPACT OF AN EDUCATION INTERVENTION ON PICA ON PRACTICES AND PERCEPTIONS AMONG WOMEN AND THEIR YOUNG CHILDREN IN GHANA

11.1 Abstract

Objective: This study assessed the effect of a nutrition education intervention on the practices and perceptions of mothers with children (6-59 months) regarding pica in northern Ghana.

Method: This study was a community intervention trial using a semi-structured questionnaire via structured face to face interviews of mothers at baseline and repeated three months post-intervention among the same mothers. In two randomly selected districts in Northern region of Ghana (N=161) at baseline conducted in April, 2011. One district was randomly chosen as intervention (n = 81) and the other as the control (n = 80) community post intervention. The intervention community received the education intervention while the control community did not. A five days once–off educational intervention addressing knowledge, attitudes and practices (KAP) regarding pica and iron deficiency made up of ten key messages designed from the baseline survey. The intervention was implemented in a 90min/day in July, 2013. A refresher of education messages was done in households (about 30mins /household) two and four weeks after 5-day interaction where all 73 mothers were visited in their households. The effect of the intervention on practices and perceptions of pica among mothers and their children (reported by the mother) was conducted in October, 2013.

Results: Reported consumption of non-food substances as a result of pica, decreased non-significantly in both mothers (2.5% to 1.4%, p = 0.167) and their children (12.9% to 1.4%, p = 0.483), but increased in the control community of children (1.8% to 5.9%). Post-intervention 13.2% of mothers stated that anemia causes pica, an association nobody in both communities was aware of pre-intervention and nobody in the control community was aware of post-intervention.

Post-intervention, 28.6% of the intervention community related iron deficiency to pica in statements such as "a person with pica should visit the hospital", "pica practice stops when iron deficiency is this time treated" and "education on diet can prevent pica".

Discussion: A nutrition intervention decreased the reported consumption of non-food substances among mothers and children who took part in a nutrition education intervention. It also raised awareness among mothers regarding the relationship between pica practices and iron deficiency.

Key words: Pica, nutrition education intervention, practices

11.2 Introduction

Pica refers to a craving for, and purposeful intake of largely non-nutritive substances like clay, soil, dust, paint, chalk, ice and uncooked starch, rice and pasta (Miao, 2015; Louw *et al.,* 2007). Pica occurs in developed and developing countries (Miao, 2015) and while some variants have been described as a "culture-bound-syndrome" with no associated psychopathology (Grigsby *et al*, 1999), some variants are linked to developmental disorders (Matson, 2013). Pica is most commonly associated with pregnancy and early childhood, and with low socioeconomic status (Rose *et al*, 2000). In Africa, pica has been described in different physiological groups in many countries (Mensah *et al.,* 2010; Kawai *et al.,* 2009; Louw *et al.,* 2007; Luoba *et al.,* 2004; Antelman *et al.,* 2000; Thomson, 1997; Vermeer, 1971). In Ghana, pica was reported among 47% of pregnant women in the Kumasi metropolis (Mensah *et al.,* 2010).

Many studies have associated pica with micronutrient deficiencies, particularly iron deficiency (ID) and iron deficiency anemia (IDA) (Barton, 2010; Young *et al.,* 2010; Adam *et al*., 2005). A recent meta-analysis of 43 studies found that pica is associated with a 2.35 times greater odds of anemia (Miao, 2015). Although the direction of the causal relationship between pica and ID, as well as the potential physiological mechanisms underpinning the relationship, is unknown, the magnitude of the relationships is comparable to other well-recognised causes of ID. The authors therefore suggest that pica is a clear marker for micronutrient deficiencies (Miao, 2015).

Pica practices are often difficult to assess (Miao *et al.,* 2013; Young *et al.,* 2008) due to the complex nature of the condition, the cultural context, and the unwillingness of people to admit that they practice pica. Other suggested barriers that contribute to the poor understanding of pica, include lack of awareness, as well as biases and judgmental attitudes among researchers, and the use of inappropriate research methods to establish causality (Young, 2007). The need therefore exists for more explorative research on the context, causes and consequences of pica.

Most interventions to change pica behaviour have been targeted at people in the clinical setting with established IDA (Louw *et al.,* 2007), developmental challenges, or disabilities (Williams & McAdams, 2012; Williams *et al.,* 2009). The use of food aversions (Ferreri *et al.,* 2006), teaching children to exchange non-edible substances for edible substances (Kern *et al.,* 2006), and alternative response training (Ricciardi *et al.,* 2003), are among the behavioural approaches that have been used to address pica in children in the clinical setting. To our knowledge, no published study to date has explored the use of a nutrition education intervention to address pica in the non-clinical setting among non-pregnant women and children in a developing country.

According to the Ghana Demographic and Health Survey (GDHS, 2008) the national prevalence of anemia among children and women of reproductive age was 78% and 59%, respectively. Some studies suggest that among these physiological communities in a setting with such high anemia prevalence, ID may be assumed among the entire population (McLean *et al.*, 2007; Asobayire *et al.*, 2001). A baseline survey conducted in 2012 among unschooled, low income mothers and their children six to 59 months old, from an agrarian society, in the Northern Region of Ghana, where the prevalence of anemia among these communities are even higher than the national averages, found self-reported pica among 17.0% of the mothers and 9% of their young children (as reported by their mothers). Almost 30% of the mothers reported having practiced pica when pregnant with these children. The study also found that whether or not the child practised pica, it was significantly associated with whether or not his/her mother practised pica while pregnant with him/her (Abu *et al.,* 2013a; Abu, 2015:225-246).

Countries that have made significant progress to control IDA and other nutritional problems, have identified contextual risk factors and implemented programs which are contextually relevant (Locks *et al.*, 2013; Sanou & Ngnie-Teta, 2012). A nutrition education program (NEP) was therefore designed to address pica within the local context of these mothers and their children (Abu, 2014a, 2014b; Abu, 2015). This manuscript assesses the effect of the NEP on knowledge, attitudes, and practices of the study population regarding pica. This study provides information on engaging rural women on pica, the related health effects, and the association with anemia and ID. As pica was commonly associated with pregnancy in this setting, we also believe an understanding of the practice and the health risk could help shape antenatal care education to pregnant mothers.

11.3 Methods

11.3.1 Study design and study population

The study was conducted in the Northern Region of Ghana among rural illiterate mothers in a farming community. The Northern Region, made up of 20 districts, is the largest in Ghana and shares boundaries with the Upper East and the Upper West Regions to the north; with the Brong Ahafo and the Volta Regions to the south, and the Republic of Togo to the east, and La Cote d' Ivoire to the west. It has a dry climate, with savannah vegetation, and a rainy season that starts in May and ends in October.

The baseline survey was a quantitative descriptive survey conducted in April 2012, in two randomly selected districts, namely Tolon-Kumbumgu district and Tamale metropolis. One community was randomly selected from within each of these two districts. In these two communities, randomly selected households were approached and all mothers who had lived in the selected community for at least 12 months; were not pregnant; and had one or more children aged six to 59 months were invited to participate in the study. The final sample included 161 mothers; 81 from the Tolon-Kumbumgu district and 80 from Tamale metropolis. A sample of 161 was chosen, as this was the limit in terms of cost-effectiveness for the study and intervention, while still allowing for some attrition during follow-up.

The study was approved by the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS NR 24/2012) and Noguchi Memorial Institute of Medical Research, Legon, Ghana (NMIMR-IRB CPN 064/11-12). Mothers who voluntarily agreed to participate, signed an informed consent form (mostly by thumb print), after the study procedures were explained to them. Children (six to 59 months) were only subjected to the study procedures if they were willing to comply, thereby implicating assent.

11.3.2 Intervention Design and Implementation

At baseline both communities were assessed to identify the prevalence of socio-demographic risk factors for ID, nutritional status, and knowledge, attitudes and practices regarding pica and other known risk factors for ID and anemia in this study population (Abu *et al.*, 2013a, 2013b, 2013c; Abu, 2015).

The identified gaps regarding the known risk factors for ID were summarised into ten themes with associated key messages, to form the framework of a NEP to address pica within the local context of these mothers and their children (Abu, 2014). Three of the themes were related to pica practices and the association thereof with ID and anemia. The following key themes were addressed in the NEP regarding pica:

Theme 6: Pica as risk factor for ID.

Key message: Pica is a risk factor for ID.

Theme 7: Pica as an indicator for ID.

Key message: Pica may be a sign of ID.

Theme 8: Correcting myths and beliefs regarding pica identified in the community.

Key message: There is an association between pica and ID.

The intervention on pica was designed with consideration of the low literacy levels of the mothers, and implemented with integration of the theory on adults learning, (Kennedy, 2003) and different learning styles (Barbe *et al.*, 1981). To improve the contextual relevance, clay and soil samples, pictures that mothers could relate to, and resources from within the communities, were used to enhance interactions. The intervention on pica was implemented in July 2013 in the community in Tolon-Kumbungu District, which was randomly selected as the intervention community, as part of the larger intervention addressing KAP regarding ID and anemia. The intervention community consisted of 73 mothers. At the time that the intervention was implemented, eight mothers (10.0%) had been lost from baseline, as they had migrated to southern Ghana to engage in menial jobs for income; a common practice in the Northern Sector during the dry season, referred to as “Kayayie”. These 73 mothers were subdivided into three equal sized communities for logistical purposes. The theme on pica was presented on day three of the intervention to each community separately during a 90-minute session each. Two weeks after the intervention, and again two weeks after that, the researchers visited each individual household in the intervention community to help mothers to address challenges in applying and adhering to the education messages. The household visits were also used to refresh the messages of the NEP. Each household was visited twice, two weeks apart, for about 30 minutes/household/time. The evaluation of the impact of the NEP was conducted in October 2013, by repeating the baseline survey in both communities. At this point, 20 mothers and 23 children from both communities all together, had been lost from baseline to follow-up.

11.3.3 Data Collection

The researchers had developed a questionnaire based on an in-depth review of the literature on pica practices and ID/IDA. This questionnaire was administered during structured interviews with the mothers at baseline, and repeated post-intervention. Data on socio-demographic characteristics of the mothers and the index child(ren), including age, gender, ethnicity, level of education, marital and employment status; and childcare, access to electricity and cooling facilities were collected. Weight and height/length of the mothers and index child (ren) were measured to assess levels of body fatness in the mothers and growth status in the children. Weight was determined with an electronic scale according to the standard procedures recorded to the nearest 0.1kg. Height was determined by means of a mobile tape (Microtoise) to the nearest 0.1 cm. Body mass index (BMI) in kg/m2 of mothers was estimated using the formula weight (kg)/height (m2) (Gibson, 2005).

Mothers and the index children were assessed for angular stomatitis, atrophic glossitis, and koilonychias, as possible physical signs of IDA.

The knowledge of the mothers regarding the causes of pica; her attitudes regarding the treatment options and her own management of pica; her perceptions of how pica is viewed by her community; as well as pica practiced by herself and her index child(ren) at the time of data collection, three months post-intervention, were assessed in both communities. The same questionnaires used at baseline were reapplied and the relevant questions are reflected in Tables 11.3 to 11.6. Additional open-ended questions were included for the intervention community regarding which of the themes the mother remembered form the NEP, changes that she had made, and the challenges she had faced in doing so.

11.3.4 Statistical analysis

The data were analysed using SAS/STAT software, Version 9.3 of the SAS system for Windows (Copyright © 2010 SAS Institute Inc.).

Anthropometry was expressed as body mass index (BMI) for the mothers and Z-scores for weight-for-age, height-for-age, and weight-for-height for the index children; and categorized according to WHO guidelines (WHO, 1995; Gibson, 2005; WHO, 2006), and compared between the intervention and control communities by the paired t-test.

Categorical data for socio-demography and anthropometry were expressed as frequencies, percentages, and continuous data as medians, means, and standard deviations. The data for the mothers who were lost to follow-up were excluded from all analysis.

Content analysis was done on open-ended questions and responses were categorized into response themes. These were cross-tabulated to indicate the frequency of each response theme for baseline and for post-intervention (Tables

To assess whether the change in response to a specific question that occurred from baseline to post-intervention, was significantly different between the intervention and the control communities, each response theme was cross-tabulated in a 2x2 table and, where the numbers per cell were large enough, compared by means of the Fishers exact test and a $p<0.05$ was considered significant (Table 11.7).

11.4 Results

11.4.1 Socio-demographic data

Socio-demographical characteristics of the participants are summarised and compared in table 12.1. The 71 mothers in the intervention community and 70 mothers in the control community were mostly (over 97.0%) Dagomba, Muslim and married. The mean ages of the two communities were 34.3 ± 9.3 years and 32 ± 6.9 years, respectively. Mothers in both communities had a median number of four children. The median ages of the index children were 46.6 months and a mean age of 46.0 ± 13.1 months in the intervention community (n = 75) and 34.8 months and a mean age of 40.0 ± 13.4 months in the control community (n = 78); with slightly more male than female index children in both communities (54.7% and 54.5%, respectively). These characteristics did not differ significantly between the two communities.

Most households were large with a median household size of 12 people, as this was a polygamous society where families consisting of a husband and several wives (one to four in this survey) stayed together in the same household. The mean number of rooms in each household was six. Mother in the intervention community significantly lower education (p=0.017) compared to the mothers in the control community. A significantly high number of households in the intervention community had electricity (p=0.001) compared to the control community. Over 95.0% of the mothers in both communities reported being self-employed, spending an average of six hours per day working away from the households. There were statistical difference in the types of caring for children in both communities, however, about a tenth (7 (9.5%)) of the intervention community sent their children to a school (kindergarten) when they were away to the farm, this was not reported in the control community. Many index child (ren) in both communities were mostly left at home in the care of other siblings (54.1% and 42.1%, respectively), or with a grandparent (20.3% and 19.7%, respectively) when the mother was away from home to work.

Table 11.1: Socio-demography of the mothers three months post-intervention

Variables	**Intervention Community (n=71) n (%)**	**Control Community (n=70) n (%)**	**p-value for the difference**
Mother's age (years)			
Mean ± SD	34.3 ± 9.3	32.1 ± 6.9	0.142
Median	30.0	35.0	
Mother's highest level of education			
None	68 (98.6)	61 (87.1)	0.017
Primary school (1-6 years)	1 (1.4)	9 (12.9)	
Mother's religion			
Muslim	70 (100.0)	70 (100.0)	0.248
Marital status of the mother			
Married	69 (98.6)	67 (97.1)	
Single	1 (1.4)	0 (0.0)	0.500
Widowed	0 (0.0)	2 (2.9)	
Ethnicity			
Dagomba	69 (98.6)	67 (97.2)	
Moshi	1 (2.8)	0 (0.0)	0.370
Hausa	0 (0.0)	1 (1.4)	
Fulani	0 (0.0)	2 (2.8)	
Electricity			
Yes	64 (94.1)	42(63.6)	
No	4 (5.9)	24 (36.4)	<0.0001
Cooling facilities			
Refrigerator	2 (3.0)	1(1.5)	
Freezer	1 (1.5)	0 (0.0)	
Both freezer and refrigerator	1 (1.5)	0 (0.0)	0.335
Other cooling facilities	62 (93.9)	66 (98.5)	
Source of drinking water			
Bore hole	2(2.9)	2 (2.9)	
Pipe borne water	58 (82.9)	0 (0.0)	
River/pond	0 (0.0)	65(94.2)	
Well	10 (14.3)	2 (2.9)	<0.0001
Mother's employment status			
Self employed	69 (98.6)	67 (95.7)	0.592
Unemployment	1 (1.4)	3 (4.3)	
Number of hours per day mothers works			
Mean ± SD	7.2 ± 3.8	7.5 ± 3.8	0.339
Median	6.00	6.00	

Age of child (months)			
Mean ± SD	46.0 ± 13.1SD	40.0 ± 13.4	0.137
Median	46.6	34.8	
Gender of children			
Male	41 (54.7)	42 (54.5)	
Female	34 (45.3)	35 (45.5)	0.560
Care of the index child while the mother works			
Mother takes child to work	4 (5.4)	16 (21.1)	
Child in school	7 (9.5)	0 (0.0)	
Leaves the child with other siblings	40 (54.1)	32 (42.1)	
Leave child with stepmother	2 (2.7)	3 (3.9)	0.057
Leaves child with grandmother	15 (20.3)	15 (19.7)	
Leaves child with a paid caretaker	2 (2.7)	2 (2.6)	
Leave child with other relations	4 (5.4)	8 (10.5)	

Abbreviations: SD = standard deviation; Paired t-test was used for continuous variable and fisher exact test for the categorical data p<0.05 was considered significant

11.4.2 Anthropometry and physical signs of chronic IDA

The nutritional status, based on anthropometry, of mothers and children for post intervention are illustrated in Table 11.2. The mean BMI and categories of BMI was very similar between the two communities. Overall, around 10% were underweight, around 66% had normal weights, and around 15% were overweight/obese (class 1). The comparison of these parameters at baseline, as well as the changes in anthropometry from baseline after the intervention, have been compared elsewhere

More than a third of the children in both the intervention and the control communities were stunted (15.6% and 36.3%, respectively), indicating chronic malnutrition. Around a quarter of both communities were underweight (20.7% and 31.4%), indicating acute malnutrition children. There was no significant difference between the groups regarding these categories. No signs of angular stomatitis, atrophic glossitis, or koilonychias were observed in any mothers.

Table 11.2: Anthropometry three months post-intervention

Variable	Intervention group	Control group	p-value for the difference in the means#
Mothers	**(n=70)**	**(n=70)**	

	n (%)	n (%)	
BMI (kg/m²)			
Underweight (<18.5)	10 (14.3)	7 (10.1)	
Normal(18.5-24.49)	47 (67.1)	46 (66.7)	
Overweight (24.5 – 29.99)	10 (14.3)	14 (20.3)	
Obese Class 1 (30-39.99)	3 (4.3)	2 (2.9)	0.270
Mean weight(mothers) ± SD	57 ± 11.2	57.0 ± 9.4	
Mean height (mothers) ± SD	1.6 ± 0.1	1.6 ± 0.1	
Mean BMI ± SD	22.3 ± 3.7	22.8 ± 3.1	
Children	**n=75** **n (%)**	**n=77** **n (%)**	
Z-score height-for-age (Stunting)			
Normal (≤2SD)	31(53.4)	42(63.6)	
Moderate stunting (-2.01-3SD)	17 (29.8)	16(24.2)	
Severe stunting(>-3.01SD)	9 (15.8)	8(12.1)	0.352
Z-score weight-for-age (Underweight)			
Normal (≤ 2SD)	46 (79.3)	46(8.7)	
Moderate underweight (-2.01-3SD)	8 (13.8)	18(26.9)	
Severe underweight (>-3.01SD)	4 (6.9)	3(4.5)	0.525
Z-score weight-for-height (Wasting)			
Normal (≤2SD)	56 (92.4)	58(84.3)	
Moderate wasting (-2.01-3SD)	2 (3.3)	8(11.8)	
Severe wasting(>-3.01SD)	2(3.3)	2(2.9)	0.330

Abbreviations: WHZ =weight for height Z-Score; HAZ= Height for age Z-Score; WAZ Weight for age Z-score, BM1= body mass index; SD = standard deviation (Z scores). Compared by paired t-test; p<0.05 was considered significant.

11.4.3 Pica

The knowledge of the mothers regarding the causes of pica; her attitudes regarding the treatment options and her own management of pica; her perceptions of how pica is viewed by her community; as well as pica practiced by herself and her index child(ren) at the time of data collection, three months post-intervention, are summarized in Tables 11.4 to 11.6.

11.4.3.1 Knowledge of mothers on pica

The mothers' responses at baseline and at post-intervention, to the open ended question of what causes pica were cross tabulated Table 11.3. At baseline, most mothers indicated that pica is caused by pregnancy, hormonal changes, and one's personal desires, but none of them in either community made the connection between pica and ID or anemia. After the intervention, 12.6% of the mothers in the intervention community, but none in the control community, associated pica with ID and anemia. At baseline, only 14.1% in the intervention community and 2.9% in the control community associated pica with pregnancy. After the intervention, this association had increased to 43.7% and 47.1%, respectively. In the both the intervention and control communities it was particularly mothers who at baseline said that pica is due to one's own desires (12.7% and 31.4%, respectively), or that they did not know (8.5% and 7.1%, respectively), who connected pica to pregnancy post intervention. About 10% of mothers in the intervention community reported that pregnancy was a cause of pica and maintained the same view post intervention; in the control community, 2.9% of mothers did not change their minds about this. Some of the mothers (24.3%) in the intervention community believed there was no treatment from pica only post intervention, this new believe was reported among 5 (7.3%) in the control community. Also post intervention, 7.1% of mothers in intervention community and 1 (1.5%) in the control community reported that pica practices would stop when anemia/ID is treated in a person.

Post intervention, in the intervention community, fewer mothers than at baseline reported negative comments, such as pica being a senseless practice, or a bad practice that can kill.However, in the control community, this rather increased from baseline to post intervention.Only 7.1% of mothers reported that pica may be a symptom of anemia/ID, while the control community both pre and post intervention made no mention of this.

Table 11.3: Changes in mother's knowledge, regarding the causes of pica (N=141)

		What do <u>you</u> think causes pica? **POST-INTERVENTION RESPONSES n (%)**						
		No response	**I do not know**	**Pregnancy**	**One's own desires**	**It is a form of sickness**	**Anemia/ ID**	**TOTAL**
BASELINE RESPONSE – Intervention community (n=71)	No response	2 (2.8)	3 (4.2)	3 (4.2)	1 (1.4)	0 (0.0)	3 (4.2)	*12 (16.9)*
	I do not know	0 (0.0)	5 (7.0)	6 (8.5)	4 (5.6)	0 (0.0)	0 (0.0)	*15 (21.1)*
	Pregnancy	1 (1.4)	2 (2.8)	7 (9.9)	0 (0.0)	0 (0.0)	1 (1.4)	*10 (14.1)*
	One's own desires	0 (0.0)	7 (9.9)	9 (12.7)	1 (1.4)	0 (0.0)	5 (7.0)	*23 (32.4)*
	Hormonal changes	0 (0.0)	4 (5.6)	5 (7.0)	0 (0.0)	0 (0.0)	0 (0.0)	*9 (12.7)*
	Headaches	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	*1 (1.4)*
	It is a form of sickness	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	*1 (1.4)*
	TOTAL	*3 (4.2)*	*21 (19.6)*	*31 (43.7)*	*1 (9.9)*	*0 (0.0)*	*9 (12.7)*	*71 (100.0)*
BASELINE RESPONSE – Control community (n=70)	No response	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	*1 (1.4)*
	I do not know	2 (2.9)	3 (4.3)	5 (7.1)	1 (1.4)	0 (0.0)	0 (0.0)	*11 (15.7)*
	Pregnancy	0 (0.0)	0 (0.0)	2 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	*2 (2.9)*
	One's own desires	9 (12.9)	14 (20.0)	22 (31.4)	4 (5.7)	1 (1.4)	0 (0.0)	*50 (71.4)*
	Hormonal changes	0 (0.0)	1 (1.4)	4 (5.7)	1 (1.4)	0 (0.0)	0 (0.0)	*6 (8.6)*
	TOTAL	*11 (15.7)*	*18 (25.7)*	*33 (47.1)*	*6 (8.5)*	*1 (1.4)*	*0 (0.0)*	*70 (100.0)*

11.4.3.2 Mothers' perceptions on the causes and treatment of pica and how their community views people that practice pica

Table 11.4 cross tabulates the mothers' responses to the open-ended questions of how their community views someone that practices pica; how they think women who practice pica should be treated (managed) in their community; and what treatments are available in their community for children that practice pica at baseline and post-intervention in the two communities. About a fifth of mothers in the intervention community who at baseline thought a child practicing pica should be beaten or scared to stop, changed their minds about this post-intervention. This change of mind was also observed among 36.2% of mothers in the control community. In the intervention community, 5.7% of mothers reported that pica in children could be caused by anemia/ID and so children should be taken to the hospital when they start to practice pica. This observation was not made in the control community.

Table 11.4: Changes in attitudes and perceptions of the mother, regarding her community's view towards pica, and how pica may be managed in the community (N=141)

			What do people in your community think about pica practice?						
			POST-INTERVENTION RESPONSES %						
			No response	**I do not know**	**Pica as a normal practic…**	**… an abnormal behavio…**	**… a sickness that cannot be …**	**… a bad practice - advice people …**	**TOTAL**
BASELINE RESPONSES	**Intervention community (n=71)**	No response	2 (2.8)	0 (0.0)	4 (5.6)	0 (0.0)	0 (0.0)	3 (4.3)	9 (12.7)
		I do not know	0 (0.0)	1 (1.4)	9 (12.7)	3 (4.2)	4 (5.6)	0 (0.0)	17 (23.9)
		Pica is a sickness that should be sent to the hospital	0 (0.0)	0 (0.0)	4 (5.6)	0 (0.0)	0 (0.0)	2 (2.8)	6 (8.5)
		Pica is a normal practice	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	1 (1.4)
		Pica is an abnormal behaviour	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	2 (2.8)	3 (4.2)
		Pica is a sickness that cannot be treated	0 (0.0)	0 (0.0)	12 (16.9)	2 (2.8)	7 (9.9)	14 (19.7)	35 (49.3)
		TOTAL	*2 (2.8)*	*1 (1.4)*	*30 (42.9)*	*5 (7.0)*	*12 (16.9)*	*21 (29.6)*	*71 (100)*
	Control community (n=70)	No response	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)	2 (2.9)
		Pica as a sickness that cannot be treated	1 (1.4)	0 (0.0)	2 (2.9)	0 (0.0)	1 (1.4)	0 (0.0)	2 (2.9)
		I do not know	0 (0.0)	0 (0.0)	10 (14.3)	3 (4.3)	6 (8.6)	0 (1.4)	21 (29.6)
		Pica is a normal practice	0 (0.0)	0 (0.0)	2 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.9)
		Pica is an abnormal behaviour	0 (0.0)	0 (0.0)	2 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.9)
		Pica as a sickness that should be sent to the hospital	6 (7.1)	1 (1.4)	25 (35.7)	3 (4.3)	2 (2.9)	2 (4.3)	39 (55.7)
		Pica as a bad practice; advise people to stop	0 (0.0)	0 (0.0)	2 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.9)
		TOTAL	*6 (8.6)*	*1(1.4)*	*43 (61.4)*	*6 (8.6)*	*9 (12.9)*	*6 (7.1)*	*70 (100)*

		How do you think a mother with pica can be treated in your community?								
		No response	**Send them to hospital**	**I do not know**	**There is no treatment for pica**	**Educate them**	**It will stop after delivery**	**Treat the anemia**	**Through self-control**	**TOTAL**
E S	**… =7 1)** No response	2 (2.8)	2 (2.8)	2 (2.8)	0 (0.0)	1 (1.4)	0 (0.0)	3 (4.2)	0 (0.0)	10 (14.1)

	I do not know	0 (0.0)	2 (2.8)	5 (7.0)	7 (9.9)	0 (0.0)	3 (4.2)	0 (0.0)	0 (0.0)	17 (23.9)
	Send them to hospital	1 (1.4)	1 (1.4)	2 (2.8)	5 (7.0)	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	10 (14.1)
	There is no treatment for pica	0 (0.0)	3 (4.2)	6 (8.5)	5 (7.0)	3 (4.2)	1 (1.4)	0 (0.0)	0 (0.0)	18 (25.4)
	Educate them	2 (2.8)	0 (0.0)	4 (5.6)	5 (7.0)	3 (4.2)	0 (0.0)	1 (1.4)	0 (0.0)	15 (21.1)
	Through self-control	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)
	TOTAL	*5 (7.0)*	*8 (11.8)*	*20 (11.3)*	*22 (31.4)*	*7 (9.9)*	*4 (5.7)*	*5 (7.1)*	*0 (0.0)*	*71(100.0)*
Control community (n=70)	No response	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)	2 (2.9)
	I do not know	3 (4.3)	0 (0.0)	10 (14.3)	4 (5.7)	0 (0.0)	3 (4.3)	0 (0.0)	1 (1.4)	21(30.0)
	Send them to hospital	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1(1.4)
	There is no treatment for pica	6 (8.6)	0 (0.0)	9 (12.9)	8 (11.4)	0 (0.0)	3 (4.3)	1 (1.4)	2 (2.8)	30 (42.9)
	Educate them	1 (1.4)	0 (0.0)	10 (14.3)	1 (1.4)	0 (0.0)	1 (1.4)	0 (0.0)	1 1.4)	17 (24.3)
	TOTAL	*10 (14.3)*	*0 (0.0)*	*31(44.3)*	*13 (18.6)*	*0 (0.0)*	*7 (10.0)*	*1 (1.4))*	*5 (7.1)*	*70(100.0)*

→ table cont...

		Are there any treatments available for children who practice pica in your community?								
			No response	I don't know	It cannot be treated	Train them to stop	Through health education	Beat them to make them stop	Give them what they want	TOTAL
BASELINE RESPONSES	Intervention community (n=71)	No response	24 (32.4)	10 (14.1)	1 (1.4)	2 (2.8)	0 (0.0)	6 (8.6)	0 (0.0)	43 (60.6)
		Don't know	2 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)	2 (2.8)	5 (7.0)
		No treatment	14(19.7)	2 (2.8)	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	0(0.0)	17 (23.9)
		Train them to stop	0 (0.0)	2 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.8)
		Send them to hospital	3 (4.2)	1(1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (5.6)
		TOTAL	*43 (60.6)*	*15 (21.1)*	*1 (1.4)*	*2 (2.8)*	*1 (1.4)*	*7 (9.9)*	*2 (2.8)*	*71 (100.0)*
	Control Community (n=70)	No response	20 (28.6)	8 (11.4)	2 (2.9)	1(1.4)	0 (0.0)	9 (12.9)	0 (0.0)	40 (57.2)
		It cannot be treated	17 (24.3)	3 (4.3)	0 (0.0)	1 (1.4)	0 (0.0)	6 (8.6)	1 (1.4)	29 (40.4)
		Through health education	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)
		TOTAL	*37 (52.9)*	*12 (17.1)*	*1(1.4)*	*2 (2.9)*	*0 (0.0)*	*15 (21.1)*	*1 (1.4)*	*70 (100.0)*

At baseline most mothers in both the intervention and control communities responded that the community had a negative view of someone who practiced pica, viewing it as a sickness' that cannot be treated (49.3% and 2.9%, respectively) and should be sent to hospital (8.5% and 55.7%, respectively). After the intervention, responses that the community viewed pica as a normal practice had increased from 1.4% and 2.9% at baseline in the intervention and control communities, respectively, to 42.9% and 61.4% post-intervention.

At baseline most mothers in the intervention (24.4%) and control (42.9%) communities responded that there is no treatment for a mother with pica in her community and no mother suggested treating anemia. After the intervention, 7.1% of the intervention community and 1.4% in the control community responded that she should be treated for anemia; although 31.4% and 18.6%, respectively still responded that there is no treatment for her in the community. Post-intervention (11.2%) of the intervention community suggested that a woman who practices pica should be sent to the hospital to find treatment, while this thought was not reported in the control community.

To the question regarding the treatment of pica in children in the community, most mothers in both the intervention and control communities did not give any response to the question at baseline or post-intervention. At baseline 23.9% and 40.4% of mothers in the intervention and control communities, respectively, reported that pica in children cannot be treated in their community; after the intervention only 1.4% and 2.9%, respectively, reported this point of view. After the intervention 10.0 % of mothers in the intervention community and 21.5% in the control community, reported that people in the community beat children in order to get them to stop pica practices.

11.4.3.3 Reported pica practices for mother and child (Table 11.5)

Table 11.5 summarizes the changes in pica practices from baseline to post-intervention. In the control community, 16 mothers (22.9%) who did not report practicing pica at baseline, reported doing so at the end of the study; whereas one mother (1.4%) who reported practicing pica at baseline, had stopped by the end of the study. This change was statistically significant p=0.003).

This increase in pica seemed to be all for clay (p=0.0496). In the intervention community, 14.1% of mothers had stopped, and another 14.1% did not report at baseline but did post-intervention.

The same trends were also seen among the children, where 17 (13%) in the control community who were not reported to practice pica at baseline, were reported to do so at the end of the study; while 2 (2.6%) had stopped since baseline. This change was not statistically significant (p=0.1320).

Mothers who reported experiencing cravings in the intervention community post-intervention (5.6%) reported that they looked for the food substance and ate it; only 2.8% stated that they used to consume the pica substance but had stopped after the intervention. In the control community however, 30% of the mothers look for the substance and consume it when they crave it.

Table 11.5: Changes from baseline in the mothers' reported pica practices

	INTERVENTION COMMUNITY					CONTROL COMMUNITY				
	Yes pre-Yes post %	**Yes pre-No post %**	**No Pre-Yes post %**	**No pre-No post %**	**p-value**	**Yes pre-Yes post %**	**Yes pre-No post %**	**No Pre-Yes post %**	**No pre-No post %**	**p-value**
Mother reported experiencing pica	4.2	14.1	14.1	67.6	0.6940	8.5	1.4	22.9	67.1	0.003*
Index child reported to be experiencing pica	1.3	12.0	0.0	88.0	0.1320	0.0	2.6	13.0	84.4	
Pica substances mothers reported for children :										
Uncooked rice	0.0	0.0	0.0	100.0		0.0	0.0	1.3	98.7	
Raw poha (Tamarind fruit)	0.0	0.0	0.0	100.0		0.0	0.0	2.6	97.4	
Garden eggs (uncooked eggplant)	0.0	0.0	0.0	100.0		0.0	0.0	1.3	98.7	
Tomatoes	0.0	0.0	0.0	100.0		0.0	0.0	1.3	98.7	
Clay	0.0	1.3	1.3	97.3		0.0	1.3	3.9	94.8	
Chalk	0.0	1.3	0.0	98.7		0.0	0.0	3.9	96.1	
Dust	0.0	1.3	0.0	98.7		0.0	1.3	0.0	98.7	
Soil	0.0	9.3	0.0	88.0		0.0	0.0	0.0	100.0	
Pica substances mothers reported for themselves:										
Cola nuts	1.4	0.0	0.0	98.6		0.0	1.4	0.0	98.6	
Raw uncooked rice	0.0	1.4	4.2	90.1		0.0	0.0	5.7	94.3	
Raw Poha (Tamarind fruit)	0.0	0.0	1.4	98.6		0.0	0.0	0.0	100.0	
Tomatoes	0.0	0.0	0.0	98.6		0.0	0.0	1.4	98.6	
Ice	0.0	1.4	1.4	88.7		0.0	0.0	0.0	0.0	
Clay	2.8	7.0	1.4	19.7		4.3	1.4	21.4	72.9	0.0496*
Dust	0.0	1.4	0.0	93.0		0.0	0.0	0.0	97.1	
Soil	0.0	2.8	1.4	91.5		0.0	100.0	0.0	94.3	
Chalk	0.0	0.0	0.0	98.6		0.0	0.0	2.9	97.1	

Number of participants; intervention community (71 mothers and 75 children) and control community (70 mothers and 77 children).

Fisher exact test; *p<0.05 was considered significant

Where no p-value is indicated the data was too skewed across the 2x2 table that significance could not be calculated.

Table 11.6 indicates the practices mothers reported to management pica cravings. Only 5.6% of the mothers in the intervention community reported that, when they experience cravings, they look for the pica substance and consume it, whereas 30.0% of the control community reported this. Only one mother reported that she used to practice pica but has stopped since the intervention. This was not reported among mothers in the control community.

Table 11.6: Changes in mothers' management of pica (N=141)

		What do you do when you have cravings for pica substances?						
		POST-INTERVENTION RESPONSES n (%)						
		No response	**I do not know**	**Look for the substance**	**Do nothing about it**	**Used to consume the food / non-food, but stopped since intervention**	**Smell wet sand instead of eating clay**	**TOTAL**
BASELINE RESPONSES n(%) – **Intervention community (n=71)**	No response	51 (71.8)	4 (5.6)	4(5.6)	1 (1.4)	1 (1.4)	0 (0.0)	*61(86.0)*
	I do not know	3 (4.2)	0 (0.0)	0(0.0)	0 (0.0)	0 (0.0)	0 (0.0)	*3(4.2)*
	Cooks the food/eats it	1 (1.4)	0 (0.0)	0(0.0)	0 (0.0)	0 (0.0)	0 (0.0)	*1(1.4)*
	Looks for the substance	4 (5.6)	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	1 (1.4)	*6(8.4)*
	TOTAL	***59(83.0)***	***4 (5.6)***	***4 (5.6)***	***2 (2.8)***	**1 (1.4)**	**1 (1.4)**	***71(100.0)***
Control community (n=70)	No response	40 (57.1)	4 (5.7)	21(30.0)	2 (2.9)	0 (0.0)	0 (0.0)	*67(95.8)*
	I do not know	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	*1(1.4)*
	I look for the substance	1 (1.4)	0 (0.0)	0(0.0)	0 (0.0)	0 (0.0)	0 (0.0)	*1(1.4)*
	I do nothing about it	1 (1.4)	0 (0.0)	0(0.0)	0 (0.0)	0 (0.0)	0 (0.0)	*1(1.4)*
	TOTAL	***42 (59.1)***	***5 (7.1)***	***21 (30.00)***	***2 (2.9)***	***0 (0.0)***	***0 (0.0)***	***70 (100.0)***

Table 11.7: Indicating the changes in mother's knowledge, attitudes and perceptions of pica pre and post intervention among intervention and control communities.

	Intervention					*Control*				
	Yes pre-Yes Post	**Yes pre-No post**	**No Pre-Yes post**	**No pre- No post**		**Yes pre-Yes Post**	**Yes pre-No post**	**No Pre-Yes post**	**No pre- No post**	
RESPONSES TO OPEN ENDED QUESTIONS	n (%)	n (%)	n (%)	n (%)	N	n (%)	n(%)	n (%)	n (%)	N
KNOWLEDGE ON PICA										
What do you think causes pica?										
• I do not know	5 (7.0)	10 (14.2)	**16 (22.5)**	40 (56.3)	71	3 (4.3)	9 (12.9)	**16 (22.9)**	42 (60.0)	70
• Pregnancy	7 (9.9)	3 (4.2)	**26 (36.6)**	35(49.3)	71	2 (2.9)	5 (7.1)	**31 (44.3)**	32 (45.7)	70
• One's own desires	1 (1.4)	25 (35.2)	**6 (8.5)**	39 (54.9)	71	4 (5.7)	48 (68.6)	**2 (2.9)**	16 (22.9)	70
• Hormonal changes	0 (0.0)	9 (12.9)	**0 (0.0)**	61 (87.1)	70	0 (0.0)	6 (8.6)	**1 (1.4)**	63 (91.3)	69
• Pica is caused by headaches	0 (0.0)	1 (1.4)	**0 (0.0)**	69 (98.6)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• It is a form of sickness	0 (0.0)	1 (1.4)	**0 (0.0)**	69 (98.6)	70	0 (0.0)	0 (0.0)	**1 (1.5)**	69 (98.5)	70
• Sickness caused by worms	0 (0.0)	0 (0.0)	**1 (1.4)**	68 (98.6)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• It is caused by anemia/ID	0 (0.0)	0 (0.0)	**9 (12.8)**	61 (87.2)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
How do you think pica should be treated in mothers in your community?										
• I do not know	5(7.1)	13 (18.6)	**14 (20.0)**	38 (54.3)	70	10 (14.5)	11 (15.9)	**21 (30.4)**	27 (39.1)	69
• Send them to hospital	1 (1.4)	9 (12.9)	**0 (0.0)**	53 (75.7)	70	0 (0.0)	1 (1.5)	**0 (0.0)**	68 (98.6)	69
• There is no treatment for pica	5 (7.1)	13 (18.6)	**17 (24.3)**	35 (50.0)	70	7 (10.1)	23 (33.3)	**5 (7.3)**	34 (49.3)	69
• Educate them	0 (0.0)	14 (20.0)	**1 (1.4)**	55 (78.6)	70	0 (0.0)	16 (23.2)	**0 (0.0)**	53 (76.8)	69
• It will stop after delivery	0 (0.0)	0 (0.0)	**4 (5.7)**	66 (94.3)	70	0 (0.0)	0 (0.0)	**7 (10.1)**	62 (89.9)	69
• Through self-control	0 (0.0)	1 (1.4)	**0 (0.0)**	69 (98.6)	70	0 (0.0)	0 (0.0)	**5 (7.3)**	64 (92.7)	69
• Advise them to stop	0 (0.0)	0 (0.0)	**6 (8.6)**	64 (91.4)	70	0 (0.0)	0 (0.0)	**3 (4.4)**	66 (95.7)	69
• When you treat anemia/ID the pica will stop	0 (0.0)	0 (0.0)	**5 (7.1)**	65 (92.9)	70	0 (0.0)	0 (0.0)	**1 (1.5)**	68 (98.6)	69
What do people in your community think about pica practice?										
• I do not know	4 (5.7)	29(41.4)	**5 (7.1)**	32 (45.7)	70	8 (11.6)	44 (63.8)	**1 (1.4)**	16 (23.2)	69
• They see pica as a sickness that should be sent to the hospital	1 (1.4)	12 (17.1)	**5 (7.1)**	52 (74.3)	70	1 (1.5)	8 (11.6)	**0 (0.0)**	60 (87.0)	69
• They see pica as a normal practice	0 (0.0)	1(1.4)	**20(28.6)**	49 (70.0)	70	1 (1.5)	1 (1.5)	**19 (27.5)**	48 (69.5)	69
• They see pica as a bad practice and would advise people who practice pica to stop	0 (0.0)	5 (7.1)	**11 (15.7)**	54 (77.1)	70	1 (1.5)	3 (4.5)	**14 (20.3)**	51 (73.9)	69
• They see pica as a senseless practice	0 (0.0)	1 (1.4)	**1 (1.4)**	68 (97.1)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69

• There see it to be caused merely by sheer will	1 (1.4)	6 (8.6)	**2 (2.9)**	61 (87.1)	70	1 (1.5)	1 (1.5)	**7 (10.1)**	6 (87.0)	69
• The think pica can kill	0 (0.0)	2 (2.9)	**0 (0.0)**	68 (97.1)	70	0 (0.0)	0 (0.0)	**3 (4.4)**	55 (95.7)	69
• They see it as a symptom of anemia/ID	0 (0.0)	0 (0.0)	**5 (7.1)**	65(92.9)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• They see pica to be caused by pregnancy	0 (0.0)	0 (0.0)	**12 (17.1)**	58 (82.9)	70	0 (0.0)	0 (0.0)	**9 (13.0)**	60 (87.0)	69
PERCEPTIONS/ ATTITUDES TOWARD PICA										
What do people in <u>your community</u> think of the people who practise pica?										
• I do not know	0 (0.0)	0 (0.0)	**1 (1.4)**	69 (98.6)	70	0 (0.0)	0 (0.0)	**1 (1.5)**	68 (98.5)	69
• Send them to hospital	0 (0.0)	0 (0.0)	**0 (0.0)**	70 (100.0)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• Community think people who practise pica are normal	0 (0.0)	1 (1.4)	**29 (41.4)**	40 (57.1)	70	0 (0.0)	0 (0.0)	**42 (60.9)**	27 (39.1)	69
• Community think people who practise pica are abnormal	0 (0.0)	0 (0.0)	**5 (7.1)**	65 (92.9)	70	0 (0.0)	0 (0.0)	**6 (8.6)**	63 (91.3)	69
• Community people think people who practise pica are sick but cannot be treated	0 (0.0)	0(0.0)	**12 (17.1)**	58 (82.9)	70	0 (0.0)	0 (0.0)	**9 (13.0)**	60 (87.0)	69
• Community think that pica practice is not good for people who practise it	0 (0.0)	0 (0.0)	**13 (18.6)**	57 (81.4)	70	0 (0.0)	0 (0.0)	**5 (7.3)**	64 (92.8)	69
• Community think that children practice pica they should be caned to stop	0 (0.0)	0 (0.0)	**0 (0.0)**	70 (100.0)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• Community think pica as a bad practice and would advise people who practise pica to seek treatment	0 (0.0)	0 (0.0)	**8 (11.4)**	62 (88.6)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
What do <u>you</u> think should be done about someone who craves non-food substances										
MOTHERS										
• I do not know	0 (0.0)	4 (5.7)	**0 (0.0)**	66 (94.3)	70	0 (0.0)	22 (31.9)	**0 (0.0)**	47 (68.1)	69
• Tell her to limit it	0 (0.0)	1 (4.3)	**0 (0.0)**	67 (95.7)	70	0 (0.0)	1(1.5)	**0 (0.0)**	68 (98.5)	69
• She should ignore the craving	0 (0.0)	26 (37.1)	**0 (0.0)**	44 (62.9)	70	0 (0.0)	24 (34.8)	**0 (0.0)**	45 (65.2)	69
• She should do away with the food / non-food substance	0 (0.0)	1 (1.4)	**0 (0.0)**	69 (0.0)	70	0 (0.0)	1 (1.5)	**0 (0.0)**	68 (98.6)	69
• She should entirely	0 (0.0)	13 (18.6)	**0 (0.0)**	57 (81.4)	70	0 (0.0)	3 (4.4)	**0 (0.0)**	66 (95.7)	69
• She should nothing	0 (0.0)	3 (4.3)	**0 (0.0)**	67 (95.7)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• She should be educated	0 (0.0)	3 (4.3)	**0 (0.0)**	67 (95.7)	70	0 (0.0)	1 (1.5)	**0 (0.0)**	68 (98.6)	69
• She should get a substitute/ chewing stick	0 (0.0)	0 (0.0)	**1 (1.4)**	70 (98.6)	71	0 (0.0)	3 (4.4)	**0 (0.0)**	66 (95.7)	69

• She should not start all	0 (0,0)	0 (0.0)	**0 (0.0)**	71(100.0)	71	0 (0)	10 (14.5)	**0 (0.0)**	59 (85.5)	69
CHILD										
• I do not know what should be done	0 (0.0)	4 (5.7)	**10 (14.3)**	56 (80.0)	70	3 (4.4)	19 (27.5)	**7 (10.1)**	40 (58.0)	69
• Beat /scare the child to stop	1 (1.4)	20 (28.6)	**7 (10.0)**	42 (60.0)	70	9 (13.0)	25 (36.2)	**7 (10.1)**	28 (40.6)	69
• Train the child to stop	0 (0.0)	21 (30.0)	**5 (7.1)**	44 (62.9)	70	0 (0.0)	2 (2.9)	**6 (8.7)**	61 (88.4)	69
• Give them something else edible	0 (0.0)	1 (1.4)	**6 (8.6)**	63 (90.0)	70	0 (0.0)	4 (5.8)	**0 (0.0)**	65 (94.2)	69
• Children will stop when they grow	0 (0.0)	1 (1.4)	**2 (2.9)**	67 (95.7)	70	0 (0.0)	0 (0.0)	**2 (2.9)**	67 (97.10	69
• Could be a sign of anemia/ID so will take child to the hospital	0 (0.0)	0 (0.0)	**4 (5.7)**	66 (94.3)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• Do nothing about it	0 (0.0)	0 (0.0)	**8 (11.4)**	62 (88.6)	70	0 (0.0)	0 (0.0)	**5 (7.3)**	64 (92.8)	69
• Discourage child/Limit intake	0 (0.0)	0 (0.0)	**3 (4.3)**	67 (95.7)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• Give child the non-food substance	0 (0.0)	0 (0.0)	**2 (2.9)**	68 (97.1)	70	0 (0.0)	0 (0.0)	**6 (8.7)**	63 (91.3)	69
Are there any treatments available for children who practice pica in your community? If yes, explain which										
• Do not know	0 0.0)	6 (8.6)	**14 (20.0)**	50 (71.4)	70	0 (0.0)	0 (0.0)	**12 (17.4)**	57 (82.6)	69
• There are no treatments available	0 (0.0)	6 (8.6)	**0 (0.0)**	64 (91.4)	70	1 (1.4)	0 (0.0)	**1 (1.5)**	67 (97.1)	69
• Train them to stop	0 (0.0)	2 (2.9)	**2 (2.9)**	66 (94.3)	70	0 (0.0)	0 (0.0)	**2 (2.9)**	67 (97.1)	69
• Send them to hospital	0 (0.0)	4 (5.7)	**0 (0.0)**	66 (94.3)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• Cannot be treated	0 (0.0)	11 (15.7)	**1 (1.4)**	58(82.9)	70	0 (0.0)	27 (39.1)	**1 (1.5)**	41 (59.4)	69
• Through health education	0 (0.0)	0 (0.0)	**1 (1.4)**	69 (98.6)	70	0 (0.0)	1 (1.5)	**0 (0.0)**	68 (98.6)	69
• Beat the child to stop	0 (0.0)	0 (0.0)	**7 (10.0)**	63 (90.0)	70	0 (0.0)	0 (0.0)	**15 (21.7)**	54 (78.3)	69
• Provide for them what they need	0 (0.0)	0 (0.0)	**2 (2.9)**	68(97.1)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
REPORTED PRACTICES OF PICA										
What do <u>you</u> do when you crave non-food substances?										
• 'I do not know"	0 (0.0)	3 (0.0)	**4 (5.7)**	63 (90.0)	70	1 (1.4)	0 (0.0)	**4 (5.8)**	64 (92.8)	69
• "I cook the food instead and eat it"	0 (0.0)	1 (1.4)	**0 (0.0)**	69 (98.6)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	69 (100.0)	69
• "I looks for the food substance and eat it "	0 (0.0)	6 (8.6)	**4 (5.7)**	60 (85.7)	70	0 (0.0)	1 (1.5)	**21 (30.4)**	47 (68.1)	69
• "I do nothing about it"	0 (0.0)	0 (0.0)	**2 (2.9)**	68 (97.1)	70	0 (0.0)	1 (1.5)	**2 (2.9)**	66 (95.7)	69
• "I used to eat non-food substance but stopped since this intervention (NEP)"	0 (0.0)	0 (0.0)	**1 (1.4)**	69 (98.6)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	0 (0.0)	69
• "I smell wet sand instead"	0 (0.0)	0 (0.0)	**1 (1.4)**	69 (98.6)	70	0 (0.0)	0 (0.0)	**0 (0.0)**	0 (0.0)	69

Abbreviations: NEP = nutrition education programme

Table 11.7 further summarizes the mothers' response to open ended questions regarding changes she had made, and challenges that she encountered in implementing the key messages. Overall, 26% reported that they reduced clay eating, and 9.6% that they "stayed away from pica substances". Challenges reported included that because it was a habit, it was not easy to stop and would take time, and that they forget. Some also raised the challenge to stand up to others, citing shyness or being viewed as a "know-it-all".

Table 11.8 summarises whether or not mothers who participated in the intervention, could recall the themes and key message on pica that were presented in the NEP. Overall, 46.6% spontaneously recalled theme 6 that dealt with pica as a risk factor for ID, and 20.5% spontaneously recalled theme 7, which dealt with pica as a sign of ID.

Table 11.8: Recall of the pica theme and challenges of adherence to education messages in the intervention community (N=71)

Theme discussed	Percentage (%) of mothers who remembered the theme	Changes that mothers reported making	Challenges mothers faced when implementing messages
Pica is a risk factor for ID	46.6	Reduced clay intake (26%) Advised others to stop	"It's not easy to stop the practice" "Forgetfulness"
Pica practice may be a sign of ID; hence refer to health persons	20.5	Stayed away from practicing pica (9.6%)	"Community teases you saying 'you have become a doctor'" "Mothers are shy" "Forgetfulness"

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11.5 Discussion

In this manuscript, the effect of a component of a NEP to address the knowledge, attitudes, and practices regarding pica as both a cause and a sign of ID and anemia among low income, unschooled mothers with children six to 59 months, in an agrarian society, was evaluated. All types of pica decreased by 14.1% and 12.0%, respectively, among mothers and children in the intervention community. Conversely, it decreased by only 1.4% and 2.6%, respectively, among mothers and children in the control community. Overall, reported pica decreased in the intervention community compared to the control community. Post-intervention some mothers (7.0%) in the intervention community and 1.4% in the control community associated pica with anemia and ID. About half of the mothers could remember the themes discussed in the NEP. Mothers reported reduction in the quantities of pica and frequency, but indicated that they required time to change and also they need the community support to become peer educators.

Pica practice has been reported among all socio-economic communities (Young 2010; Hunter, 1993), but more often in the poor (Rose, 1995). Level of income does however seem to play a vital role in the choice of pica substances. Factors such as access to electricity and owning a fridge or access to clay are were associated with intake of ice and or frost (pagophagea) and clay/soil intake (geophagea) (Abu, 2015:225-246; Coetzee, 2011; Young *et al.*, 2010; Louw *et al.*, 2007). Thus, among our participants geophagea was more common compared to pagophagea and this did not change significantly in control and intervention communities' pre and post-intervention. This was not expected to change since the intervention did not involve an income generating component but rather focused on impart of knowledge and good practices regarding pica and other known risk factors for iron deficiency.

The triple A cycle approach indicates that to effectively use a project to address a problem in a setting, a thorough assessment and analysis of the causes of the problem must feed into the actions based on the results of the analysis and resources available (UNICEF, 1992). The current study which identified ID as a problem in this community, identified gaps in knowledge, attitude and practices regarding known risk factors (Abu *et al.*, 2013; Abu, 2015:193-246) also identified pica practice among mothers and their children (Abu *et al.*, 2013). Based on the findings a designed intervention considering the available resources was implemented among mothers (Abu, 2015:253-298). This intervention was seen to have positive effects on knowledge, attitudes, and practices regarding iron deficiency (Abu *et al.*, 2014) and some dietary risk factors (Abu, 2015:299-341).

Nutrition education is an important part of nutrition interventions due to its component of bringing about change voluntarily (Contento, 2008). The nutrition education programmer focused on educating mothers on the risk of clay and other non-food substance and on the risk associated with pica for food substances. Mothers however reported an increase in pica for food substances. This was seen among both mothers and their children. Some previous studies which addressed pica used behavioural approaches (Williams and McAdams, 2012; Williams *et al.*, 2009) especially for children with autism and other developmental disabilities. Food aversions and substitutes have also been used as interventions on pica practices (Ferreri *et al.*, 2006). Some studies showed that raw and uncooked foods might have more nutrients in their raw forms than when cooked. Hence eating them in their uncooked form may help mothers meet their nutrient requirements. This however, has not been tested on rice. Though the risk of uncooked rice harbouring eggs of hookworms in their uncooked form has been discounted due to its dry nature (Young *et al.*, 2010), other disease causing agents such as weevil infested rice may pose health risk.

The methods of implementation should take into consideration the participants deficiencies. In thisintervention; mothers were not formally educated, this barrier was overcome with pictures and real food samples during sessions (Abu, 2015: 253-298). Pictorial images (Nisa *et al.*, 2008) and other participatory learning approaches have shown to be effective in other health education interventions (Mahr *et al.*, 2005). Though the physiological process and the development of anemia are complicated, this was simplified with the use of scenarios and preambles among low literate mothers. This approach may be applied to educate mothers on other complicated health issues.

The knowledge of the association of iron deficiency and pica may help in early identification of ID. This may work effectively when community-based health care staffs themselves are educated on the strength of this observed association. For early identification of ID, mothers can help other community members to recognize that people practicing pica may be exhibiting signs of iron deficiency. According to mothers, this may be challenging to do, especially when practices are seen among other people in the community. This is because they may be shy to express themselves or that others may see them as a “know it all”. The environment should be enabling for change (Lytle, 2005). Mothers may find it difficult to educate other people in the community because the community is a polygamous setting and many women are more private and less expressional. More education may improve the confidence of mothers through provision of information to induce change in health choices (Snetselaar, 2008).

The environment of an individual may be a barrier to change. Studies have shown that the influence of grandmothers on breastfeeding practices and other child nutrition-related practices (Aubel, 2012). Other members of the family (mostly an extended family) such as fathers and mothers in-law may be the major decision maker in the households. These family members should be targeted for education to improve adherence. The follow-up component of the intervention addressed this challenge of including other significant members of the family. However, not all household members were met during follow-ups because it was the farming season. Apart from the environments, the inability to change may also be due to some barriers within an individual in the form of lack of self-confidence or self-efficacy (Lytle, 2005). However, more education and understanding could be a motivator. Two studies found this to be true for breast cancer, where increased knowledge was seen to relate to having regular mammograms (Reimer *et al.*, 1991) and knowledge about cervical cancer to having regular pap smear tests (O'Brien and Lee, 1990).

The observed changes in both community's pre and post-intervention were self-reported, and this may make it difficult to determine the true change. However, if mothers were still practicing pica and did not report it, it may be because they know it is not a good practice or they know the possible health effects of pica thus increase in awareness of the health effects of pica and iron deficiency was realized.

11.6 Limitations

Three months may be a short period to realize changes in behaviour, which has been formed over many years. Changes realized were self-reported practices and this may not be the actual case.

11.7 Conclusions and recommendations

A nutritional education intervention increased awareness among mothers regarding the relationship between pica practices and iron deficiency, and decreased the reported consumption of non-food substances among mothers and children. Though few, some mothers were able to associate pica with iron deficiency, thus the risks associated with pica practice and pica as a possible sign of iron deficiency.There was also a high number of mothers who reported they did not practice pica before but did after the intervention. Yet some misconceptions prevailed; possibly more time post-intervention could improve pica related attitudes and practices.

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CHAPTER 12:

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

12 CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

12.1 Introduction

In 2008 the prevalence of anemia in the Northern Region of Ghana was 81.0% among children and 59.0% among WRA (GDHS, 2008). The GDHS reports (GDHS, 2008; 2003) suggested inadequate dietary intake, malaria and worm infestation as possible contributing factors, but no specific causes for the anemia epidemic in these regions have been documented. Studies have, however, shown that 50% of anemia worldwide is attributable to ID (WHO, 2001:15). Based on analysis of the NHANES 1976-80 data, it was further suggested that, if the overall anemia prevalence in a population is above 40%, it may be assumed that the entire population suffers from some degree of ID (Maclean *et al.,* 2007: Asobayire *et al.,* 2001).

This was the first study to explore the dietary patterns and intakes of nutrients that are relevant to ID and IDA, of mothers of young children in the Northern Region of Ghana with the purpose of designing a nutrition education programme (NEP).

This study aimed, firstly to establish and describe the baseline socio-demographics, nutritional status, KAP regarding known risk factors for iron deficiency and anemia, and the prevalence of pica, among mothers and their children six to 59 months old, in two randomly selected communities in two randomly selected districts of the Northern Region. This part of the study was a cross-sectional descriptive baseline survey conducted in April 2012 among 81 mothers and their index children in Gbullung in the Tolon-Kumbumgu district and 80 mothers Tugu in the Tamale metropolis.

The second aim was to design and implement a NEP to address the risk factors for ID identified in the baseline, and to evaluate the impact thereof in this study population. The NEP was implemented in July 2013 in Gbullung, and the baseline assessments were repeated in both communities in October 2013 to allow enough time for mothers to adopt to education information.

12.2 Conclusions

The conclusion drawn from this study are presented for the baseline survey and NEP seperately.

12.2.1 Conclusions regarding the baseline findings

This study group represented a low socio-economic rural agrarian community in a developing country. These women were mostly Muslims from the Dagomba ethnic group. Most were married and, as polygamy is the norm in this society, the mothers lived with a husband and their children (mean of four), as well as several other wives and their children, in mud huts. The mean household size was 13 people. About 80% had electricity, but only a third had piped water and many households drew water from rivers/dams/ponds. The mean age of the mothers was 33.0 ± 8.3 years. Most of the mothers had no formal education and none were formally employed. All were engaged in manual subsistence farming, earning a living through petty trading and sale of food crop production or livestock. Almost all food for household use was self-produced, utilising crops which included cereals and legumes. Women kept vegetable gardens and the communities kept fruit trees. Animals raised, were not generally utilised for households use. The women produced their own flour from maize and other cereals, as well their own shea butter/oil. Mothers reported spending a mean of ₵10.5 (±$5) per week on food.

Food production was, however, seasonal. The area has a dry season from November to April during which half of the households reported experiencing food shortages lasting a mean of around three months (about a quarter of households reported shortages lasting more than 12 weeks). Most households ran out of fruit (87%) and vegetables (60%) during the dry season and 20% ran out of crops (which included the maize staple, as well as legumes). About half of the households indicated that they can out of food/money to buy food in the year prior to the study. Food insecurity in this population was therefore just more than 50%, which is much higher than the national average of 5% reported in others studies (Quaye, 2008). .

The FFQ indicated that the staple was unfortified and unrefined maize flour, supplemented with some other unrefined cereal crops, unrefined legumes, and nuts, as well as some fruits and vegetables. Tea was commonly brewed, and consumed with meals. Heme sources were consumed infrequently and in small quantities. Overall the bioavailability of iron from such a diet may be seriously impaired by very high levels of fibre, phytates and tannin, the low intakes of MFP factor and the seasonality of vitamins C-rich and A-rich fruits and vegetables which enhances iron absorption and/or supports iron status and prevents other types of anemia (WHO/FAO, 2004). If it was assumed that only 5% of iron in the diet was bioavailability (Gibson & Ferguson, 2008; Allen *et al.*, 2006), 80.8% of mothers and 67.3% of the index children were estimated to have inadequate iron intakes. Both mothers and children had high prevalence of inadequate intakes of protein; vitamin A, folate and particularly vitamin B12.

As these mothers are already exposed to ID through menstruation, pregnancy, and lactation; these risk factors may contribute to the high anemia prevalence in the area. As the primary caregivers in charge of food, preparation in their households, their knowledge, attitudes and practices translates to the feeding practices of their young children, thus putting children at similar risk for ID and anemia. This was reflected in the current study by the dietary risk for children in this population, which were very similar to that of their mothers. There were also a significant correlations ($p<0.05$) between the nutrient intake of a mother and that of her child for all nutrients except for vitamin B12.

Despite breastfeeding practices that were generally very good, complementary feeding with the unmodified family diet described above, put the children at risk for IDA. Their diets translated to similar intake inadequacies as for the mothers. Mothers require education on these practices and their role in addressing ID among themselves and in children. About half of children (47.3%) were moderately-to-severely stunted, 38.0% moderately-to-severely underweight and 17.2% moderately-to-severely wasted. This indicates high levels of both acute and chronic malnutrition compared to the national average (GDHS, 2008), which was significantly associated with food security levels. Furthermore, the children were already at risk for ID, having been subjected to their mothers probable ID during pregnancy, followed by unassisted home deliveries which may not follow the guidelines regarding cord clamping to enhance the newborn’s iron stores.

An important contribution of this survey, was the finding that, because they almost exclusively consumed their own crops, these populations most at risk for ID and anemia, were not benefitting (at all) from the national fortification programme in Ghana. The programme universally fortifies wheat flour with among other nutrients, iron, vitamin A, folic acid, niacin and vitamin B12; and shea butter with vitamin A. Besides the implications for ID and IDA, almost the entire study population of mothers and children had inadequate intakes of vitamin B12, which could lead to nerve damage. Although not assessed in the study, the high consumption of unfortified maize in the absence of meat, may also predispose the population to niacin deficiency due to the presence of niacytin which inhibits the absorption of niacin from the diet.

Responses to open-ended questions, and poor to moderate scores on the test statements, revealed misperceptions and inaccuracies regarding the prevention, causes and symptoms of ID and anemia. Most could not identify the highest risk groups for ID/anemia. Only about half, indicated that they learned what they knew about ID/anemia, from health professionals. Myths regarding health risk and interventions may lead to low patronage of available health interventions (Galloway *et al.*, 2002; Galloway & McGuire, 1994). The frequencies of inaccurate answers or "do not know" answers were high, indicating the need for education, to prevent these knowledge gaps being filled with inaccurate information by peers, mothers and mother-in-laws (Aubel, 2012) or the untrained TBA. It was also noteworthy that most TBA in these communities were actually listed as 'untrained' in the district health reports.

This study also identified pica as an education need in the study population in terms of apparent gaps on KAP regarding the causes and risks associated with the practice. Though a strong conclusion cannot be drawn based on a cross sectional survey, a relationship between the mothers pica practice during pregnancy and the later pica practice of her child ($p<0.05$) was observed. This calls for further research with a larger sample size in this regard, since a third of mothers reported having practiced pica while pregnant with the index children. Pica has the potential to be used as a risk marker for ID in anemia endemic communities with poor access to fully furnished health facilities. This potential should be explored, since the strong relationship is already established in meta-analysis (Miao *et al.*, 2015).

The Tamil Nadu Integrated Nutrition Project in India indicated that an emphasis on NEPs is likely to influence nutrition-related KAP to such an extent that the need for intervention can be significantly reduced (WHO 2006; Balachander 1991). Education targeting the gaps identified in this baseline study may therefore empower mothers with more accurate information on the causes and prevention of anemia/ID, which may influence knowledge and attitudes to an extent that practices may change. If successful, such a NEP may be used to reduce the need for more costly intervention and treatment of IDA in this community and similar high risk areas.

12.2.2 Conclusions on the intervention design, implementation and evaluation after three months

From the baseline survey, major contextual gaps were grouped into ten themes. Each theme addressed the risk factors identified in the context of the community, using the existing resources in the community. The conclusions on the design, implementation and evaluation of this NEP are presented in this section.

12.2.2.1 Design of the NEP

The adaptation of nutrition messages and nutrition interventions according to the context and the specific needs of communities, is in line with the recommendation for urgent global interventions for maternal and child nutrition (Locks *et al.*, 2014; Black *et al.*, 2008). Context relevance is essential in addressing community problems, compared to theoretical and pre-determined solutions to problems within communities. The recommendation for context-specific adaptions to global public health challenges may be more costly and require more capacity in designing less generic interventions (Adu-Afarwuah & Dewey, 2008). However, this cost may be comparatively less than the cost of implementing ineffective interventions and the consequence of persistent nutrient and health problems and concomitant morbidity, mortality and high DALYs (WHO, 2001:11). Supplementation (Adu-Afarwauh *et al.*, 2008) and fortifications (GAIN, 2007:online) interventions are dominant in the intervention addressing anemia/ID. High rates of anemia make both supplementation and fortification necessary for the immediate curbing of anemia in Ghana, however, the most affected by ID are the rural communities where these approaches are either inaccessible as found by this study or not sustainable as seen in the baseline survey in these communities in the Northern Region. In the long-term, communities need to be empowered to improve their own health. A food-based approach therefore is promising for its cultural acceptability and sustainability, while nutrition education is important to empower the community to make the most of their available resources to enhance iron status, within their culture and society.

The approach to the intervention design, took into consideration the resources, culture, and literacy of the community and particularly addressing the identified gaps.

12.2.2.2 Implementation of the NEP

Keeping messages focused, simple, practical, innovative and targeted to the profile of the mothers of young children in this community may have contributed to attaining high levels of participation in an educational intervention. Mothers understood the concept of ID and exhibited this during the scenarios and preambles; where they were able to identify who is vulnerable to ID. The theory on adult learning principles and different learning styles, were applied in the design and implementation process. These were used in innovative ways to improve the interaction process, which may translate to better success of micronutrient education interventions. Follow-up visits to the mothers in their households after the intervention, were targeted to help individual participants in managing challenges while implementing education messages – a component often lacking in education interventions.

12.2.2.3 Evaluation of the impact after three months

Except for electricity, the intervention and control communities were comparable regarding the socio-demographic characteristics. Post-intervention, food security levels were not significantly changed from baseline in either community. Recall of the relevant nutrition education themes and key messages covered in the NEP, was between 42% and 70% for different themes. This seemed to translate to more positive changes regarding the intake of sources of non-heme iron, as well as improved practices regarding tea consumption, which were observed for both mothers and children in the intervention community relative to the control. This confirmed that focused nutrition education messages have the potential to improve intake of iron rich foods (Adu-Afarwuah & Dewey, 2008).

Uptake of the messages imparted by a targeted 5-day NEP aimed at improving iron status by addressing dietary risk factors for ID among mothers with young children in an area of Ghana where anemia is a serious public health problem, as well as the translation of these practices to increased intakes of heme and non-heme iron sources, were apparently hampered by high levels of food insecurity, financial constraints and lack of social support. Involving men, who are the main decision makers and providers for the households in these communities, may be important to increase the success of interventions. Some positive trends were more apparent in the intervention community compared to the control community, and more time post-intervention, may have been required to observe significant changes.

The most important barriers to the uptake of the messages imparted by the targeted 5-day NEP as well as the translation of these practices to increased intakes of heme and non-heme iron sources, were persistent high levels of food insecurity, financial constraints and lack of social support. In these communities the seasonality of sources of non-heme iron and enhancers of non-heme iron absorption, are a major problem.

The intervention was effective in addressing some of the identified gaps on KAP related to risk factors for ID and anemia. There was a significant increase in mean scores of maternal knowledge on “iron sources or iron absorption enhancers” in both groups from baseline to post-intervention (intervention (2.324 ± 2.431SD; p=0.0001) and control (0.886 ± 2.262SD; p=0.001), with a significantly higher magnitude of change in the intervention compared to the control group.The observed changes may be due to the interaction with the research and the uestions in the questionnaire asked. More time and engagement of the mothers may have yielded a more positive impact. Though few, at least some mothers in the intervention group were able to associate pica with ID after the intervention, thus realizing the risks associated with pica practice and pica as a possible sign of ID. The community's views were also reported to have 'changed' after the intervention, although only mothers were part of the education. This may show the community view is more the reflection of the mother's perceptions than reality. However, mothers do make up the community and their knowledge does have the potential to change the views of the community. Yet, some misconceptions prevailed; possibly more time post-intervention could improve pica related attitudes and practices.

Challenges to implementing the recommended messages regarding risk factors for ID in this intervention group, were mostly financial, and lack of social support to improve adherence to education messages. Male involvement may be critical in interventions that have a food security component. To bring about sustainability in the nutrition education and messages, it is hoped that mothers will become agents of change within their community. They however had issues with self-confidence. This was seen with mothers refusing to educate other community members, because they did not want to be seen as a "know-it-all". Mothers have to be motivated to build their confidence in dealing with their peers and positively influencing them.

12.2.3 Summary

Numerous dietary practices, other risk factors, misconceptions and gaps in knowledge on ID and pica were identified at baseline. The intervention was successful in engaging rural women in addressing ID. It improved knowledge of good iron sources and risk factors. It also improved mothers' knowledge in pica and its practices. Mothers became more aware of pica in children. Generally, nutrient intake decreased in both groups, possibly related to food security and seasonality issues, with many mothers and children showing inadequate intake of iron and vitamin B12, among other nutrients.

12.3 Limitations of the study

The study had some inherent limitations and during the course of the study, some problems were encountered which may also limit the conclusions drawn from the findings.

- Communities were selected for their comparable nature as far as possible, yet some significant differences were found regarding electricity and safe water supply at baseline, which may have affected the outcomes of the study.

- Although the quantitative methods used, were appropriate for the evaluation of the nutrition education intervention, qualitative methods, which were not included, would have helped to gain a deeper understanding of the feelings and sentiments of mothers and their community regarding ID and pica.

- The relative small sample size, chosen for cost-effectiveness and logistical reasons, may have diminished the statistical power of some changes. There was, for example, an observed association between a child's pica practice and her mother's practice of pica during pregnancy; this needs further investigation a bigger sample size.

- Biochemical analysis would have helped make inferences with strength of association. However, the assumption made by Asobayire *et al.,* (2001) indicates that a high prevalence of ID can be assumed in this population. The association of child pica practice and the position of the child in the family could have an effect on the iron stores of the mother. Multiparous women are at higher risk of ID compared to primparous. This may be so because each pregnancy places nutritional demand on the mother. If nutrients used for the fetus were not replenished the mother may have an increased risk of ID and other nutrients in the preceding pregnancy. The position of the index child was, however not investigated.

- Within samples, dietary data collected for three non-consecutive days introduces variability. This variability is either intra-personal or inter-personal. This calls for the adjustment of this variability by using the variance ratio of the inter-person variability to the intra-person variability before an estimation/assessment of the nutrient intake is made. The process of adjustment can only be done however, for samples greater than 100. Intake values for the entire sample as a group in the baseline survey (N=161 mothers, and 175 children) was adjusted for this variability, but this could not be done for the post-intervention analysis, where the sample sizes of the two separate communities were smaller than 100 per group. The sample size of 80 per community was selected due to resource constraints and the ease of implementation and monitoring of the preceding intervention.

- Given the fact that the community was reported to frown upon the pica practice, these may have been underreported in the baseline survey. Furthermore, mothers may not have noticed pica before their encounter with the study and may have become more observant after the study. The encounter may also cause some to identify pica when it is in fact not there. This may have affected the evaluation of the intervention, however precautions to control this was put in place during data collection by encouraging women to answer honestly, providing the with privacy ducring interviews and assuring them of the confidenciatiality of the information provided.

- There is limited nutrient composition data on local foods in Ghana. This may be due to limited resources to carry food samples from the field to the laboratory and also to conduct chemical analysis on foods. This means that analysis of nutrient content of the diet often rely on composition data borrowed from other data bases which may not reflect the actual situation. Major significant differences were also found in this study when the same 24h recall data were analysed using the two available databases for Ghana as indicated in chapter 3.

12.4 Recommendations

In the course of this community intervention trial, some lessons were learned and are discussed below as suggestions.

12.4.1 Recommendations for the communities

Mothers involved in the study were encouraged to educate other women on messages they learn during the NEP. This may increase their confidence as peer educators, while helping to trickle NEP messages to mothers not directly involved in the study.

12.4.2 Recommendations for community-based health care

Some implications for research and practice were identified.

- ID is a complicated physiological process, however, the explaination of the development of anemia was simplified with the use of scenarios and preambles among low literate mothers. This means that innovative approaches could be used by health workers to educate mothers on complicated health issues. The methods of implementation should take into consideration the participants deficiencies. In this intervention the low education level was a barrier, which was addressed by using pictures, real food samples and food demonstrations.

- The use of education messages in songs, or jingles in the radio to reach other households could be explored for future interventions since radio was one of the main sources of information deceminaton in these communties

- The use of messages to engage men in discussions may be very valuable since they are the main providers of households' main foods. Male involvement has been shown to be benefical in breastfeeding issues (Brown & Davies, 2014).

- In this intervention the community volunteers, assembly men, nutrition officers and the community health workers were involved to ensure that the messages can be retained. Nutrition officers were encouraged to replicate the NEP in the communities to increase awareness on the known risk factors of ID and pica.

- Anti-natal care should be further addressed in these communities, but since most births occur at home, TBA should be trained regarding important preventative factors for ID such as the correct timing for cord clamping.

12.4.3 Recommendations for policy and programme implementation

- Programmes designers and implementers should adapt guidelines to the local setting of vulnerable communities to ensure effective spending of money. Education targeting the gaps identified in this baseline study may therefore empower mothers with more accurate information on the causes and prevention of anemia/ID, which may influence knowledge and attitudes to an extent that practices may change. The consideration of the context and the resources available with the community may encourage participation.

- Innovative ways to reach these vulnerable societies through food based approachesmust be promoted as these communities were found to be excluded, from benefitting from the national fortification programme due to their local context. Education on risk factors and processing methods among smallholder farmers will improve access to food nutrients and ID status.

- Male involvement may also be critical in interventions that have a food security component, since this affects food availability and consequently nutrient intake, similar to the identified role of men in promoting breast feeding (Brown & Davies, 2014).

- The effect of seasonality on vegetables and some foods could be addressed with initiatives that have been shown to work in other situations such as homestead gardens (Osei *et al.*, 2015; Talukder *et al.,* 2014) and irrigation farming (Abu *et al.,* 2010) which have shown to have positive effect on anemia/IDA in communities (Stiener-Asiedu *et al.,* 2012). The need to provide food all year round has to be addressed through sustainable interventions. Finding practical ways for households to process foods during the wet season and to keep it for the dry season may be another way of addressing the problem. Improving the outputs of the local industries such as "dawadawa" and shea butter production and other income generating activities may improve household incomes to enable them to buy food when the household runs out of food in the dry season.

12.4.4 Recommendations for research

- In the academic field, more research is needed in such agrarian communities, regarding the bioavailability of iron from mixed diets, and how to harness the indigenous knowledge to manage ID. Insufficient production to sustain the food supply throughout the dry seasons was the major cause of food insecurity in these communities, and may also have diluted the positive effects of the NEP. Ways to address these issues in the local context need to be further researched.

- Future research should focus on the etiology, risks to mother and child, as well as the management, of pica. The strength of the relationship between pica and IDA, as well as the potential use of pica as a risk marker for ID in anemia endemic communities with poor access to fully furnished health facilities, should also be explored. To design interventions targeted at individual and social behavioural change, a better understanding of knowledge, attitudes and practices should inform planning.

12.5 Summary

This study was the first contextualised community intervention trial which addressed KAP on ID and pica among mothers in a rural Ghanaian community. Identified dietary risk factors and gaps regarding KAP on pica and ID were addressed through the nutrition education key messages. There was improved knowledge on iron sources and some the ability of some mothers to associated pica with ID. Some inadequate intake in other nutrients related to ID and anemia were also seen. Inadequate intakes of vitamin B12 was found for almost the entire population and since this may have mayor health implications, it needs to be further investigated and addressed. Similarly, the potential risk for niacin deficiency in these populations should be investigated further.

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13 APPENDICES

Appendix 1: Consent Form (English)

Information Sheet

Topic of study: *Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Ghana.*

Investigator: Brenda Ariba Zarhari, Abu (PhD Candidate, University of the Free State, South Africa)

Promoters: Dr. VL Van Den Berg, Prof. VJ Louw and Prof. A Dannhauser (University of The Free State, South Africa)

Please do take your time to read and understand. Your decision to be part of this study is voluntary. Do ask questions should you have doubts at any time.

Introduction

The purpose of this study is to investigate the causes of anemia (not enough blood), associated pica (eating of funny substances) and food cravings among children (mothers) and assesses the knowledge, attitudes, practices regarding "inadequate blood" and excessive craving for food and non-food substances in northern Ghana. This is to help come out with an effective nutrition intervention on reducing anemia in the community and effective ways to address these excessive food cravings in children and women in Ghana.

Procedures

If you agree to be part of the study, you have agreed to be interviewed. Your body measurements and that of your child will be taken. The measurement will be used to evaluate you and your child's nutritional status. This will be done when we visit your home. We will also collect some information on your food intakes, medical history and then invite you to be part of a nutrition intervention program. In a case of any significant new findings developed during the course of the research related to your willingness to continue participation it will be communicated to you.

You may also be asked to take part in a community training session, which take place in three months time (if your community is selected), and be conducted over a period of three days, a few hours per day.

Risks

Your privacy may be invaded during the measurements of your body parts.

Benefits

Your child's measurement and yours will be made available to you. You will be provided with nutrition education during the intervention to help you and your child's health.

Cost

No fee is being charged for being part of this study. You will not be charged for your body measurements, or your participation in nutrition counseling.

Participant Right

The decision to join the study is entirely your own. You can decide not to be part of the study at any time and this will not attract any penalty.

Confidentiality

All information on your personal data will be kept confidential. Institutional review boards (IRB) however may inspect or copy your data to ensure the quality of the study and its findings. Some of these may be personal. The results will be used for publications but in all cases confidentiality be ensured, no names will be included in any publications or result presentations. All data will be locked and data on the computer locked with a password only available to study team members.

Questions

Should you have any questions at any time of the study do feel free to ask the following people:

Brenda Ariba Zarhari, Abu at +233244451726/+27794448211, abubrenda@yahoo.com (UFS, Ghana/South Africa)

Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS, at (+27-51-4052812) on your rights research participant.

Dr. VL Van Den Berg at +27833901808, vdbergvl@ufs.ac.za (UFS, South Africa)

You may also contact the chairman of the IRB-NMIMR, Rev. Dr. Ayete-Nyampong through mobile numbe 0208152360 when necessary.

The benefits, risks and procedures for "*Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Ghana* ." have been read to me. I have been made to understand and was given the opportunity to ask questions, which were all answered to my satisfaction. I volunteer to be part of the study.

Subjects Name………………………………………………..

Subjects signature/Thumb print…………………………… Date……………………………..

Signing this portion means that you are voluntarily allowing your child to be part of the study.

Childs name……………………………………………………………………………………….

Parent/Guardian Signature/thumb print……………………….. Date …………………………….

INVESTIGATOR'S STATEMENT

I certify that the participant has been made to read and understand the purpose, benefits, risk, and procedures of the study. I have given the participant enough time to read and voluntarily decided to join.

……………………………………………. ……………………………

(Signature of the Researcher/Research Assistant) Date

Appendix 2: Consent Form (Dagbani)

Bɔhimbu Yɛlizuɣu: Bɔhimbu din nyɛ tuhi nyaŋ kpante barigu behigu, baŋsim, behigu mini niŋsim zaŋ kpa bindira barina mini ningbiŋ yaa kalinsi paɣaba mini bipolo ni tudu polo ŋɔ na Ghana tiŋgbɔŋ ni.

Vihigu Baŋda: Brenda Ariba Zarhari, Abu (PhD Candidate University karimbia ŋun yi Free State, South Africa la na.)

Ban tabiri o n-nyɛ (Promoters): Dr. VL Van Den Berg, ni Prof. VJ Louw ni Prof. A Dannhauser (University of The Free State, South Africa)

M mabia, maami amaŋa n karim ka baŋ gbaŋ ŋɔ gbini. A yi saɣi ni a ni pahi n tum tuuni ŋɔ a suhuyubu zuɣu ka di pala muɣisigu puuni. A yi ti bi baŋ shɛli gbinni, a mali soli ka a bɔhi bɔhigu saha shɛli kam.

Piligu

Bɔhimbu ŋɔ daliri nyɛla ni ti vihi baŋ din tahili ka ningbin yaa kalinsi bee kpante barigu ni (pica food craving) kum bee bindirigu kalinsi n ti bia bee ma; ka lan bɔhi baŋ niŋsim shɛli din beni kpante barigu mini kum saha. Bɔhimbu ŋɔ nia nyɛla ni di yina ni alaafee bɔma so pala din yɛn filim kpante mini yaa kalinsi ti ;zinɛli ni ka lan zaŋ so shɛŋa n tuhu fa paɣaba mini bia Ghana zaa bahi.

Din yɛn tum doli shɛm:

A yi saɣi n zaŋ amaŋ pahi bɔhimbu ŋɔ zuɣu din ŋuna a saɣiya ni bɛ vihima. Bɛ ni buɣisi a waɣilim mini a bi' waɣilim. Buɣisibu ŋɔ ka bɛ yɛn zaŋ zahim ma ka lan zahim a bi' maa bindira. Ti yi ti kana a yiŋa ka dimbɔŋɔ yen niŋ. Ti ni lahi deei lahabali zaŋ kpa a bindira dibu polo, alaafee lahabali polo; dimbɔŋɔ nyaanŋa ka ti bola ka a pahi ninvuɣu shɛba ban bɔri alaafee bindirigu bɔma la zuɣu.

Barina

Waɣlim buɣisibu la shee, bɛn ti chɛ ka yihi a daliya ka be nya a niŋgbuŋ yaɣa.

Nyɔri

Bɛ ni ti kahigi a bia ni amaŋa ni tu ni a diri bindir' shɛŋa zaa wuhi a. Bɛ ni wuhi a bindira baŋsim dibu saha shɛli taɣibu bɔhimbu ŋɔ ni chana maa ka di sɔŋ a mini a bii alaafee.

Yɔbu

Di bi tu ni a yɔ shɛli a ni pahi ni a tum tuuni ŋɔ zuɣu. So bi yɛn deei liɣiri a niŋgbuŋ waɣlim buɣisibu la zuɣu bee bindira dibu saɣisigunim la zuɣu.

A yɛlimaŋli Zaligu

A suhuyubu soli n nyɛli ni a pahi sɔŋ ka vihigu ni. A tooi pii ni a ku pahi sɔŋ ka vihi ŋɔ niŋ saha shɛli kam a yi ti bɔra ni a che ka so bi yɛn niŋ a shɛli.

Ashili

A ni yɛn yɛli bee n niŋ shɛli kam zaa bɛ yɛn zaŋlimi n n-sɔɣi ashilo gbana ni. Karimba Kpamba Laɣingu Zuɣulananima ni vihili n nya di dariza ni din tu ni bɛ zaŋ tum shɛm. Lahabali maa shɛŋa ni tooi nyɛla a ko dini. The bɛ yi ti naai bɔhimbu ŋɔ zaa, bɛ ni zaŋ li sabi ka sokam karim amaa ashili kam ni liri. Bɛ bi yɛn boli so yuli sabu ŋɔ puuni bee din bi tu zama ni wumbu. Bɛ ni ti zaŋ yɛtɔɣa maa zaa kpari niŋ kompita ni ka bɔ ashili lirigu tili din ni che ka ban bɔhindi li ko m mi li.

Bɔhisi:

A yi ti mali bɔhisi ni a bɔhi saha shɛli kam zaŋ kpa bɔhimbu ŋɔ polo a ni tooi bɔhi ninvuɣu shɛb ban yuya dɔ gbinni ŋɔ:

Brenda Ariba Zarhari, Abu bolimi o taligalmia ŋɔ: +233244451726 bee +27794448211, ka o email nyɛ: abubreda@yahoo.com (UFS, Ghana/South Africa)

Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS, (Dudoŋni ban lihiri Alaafee Tabibi Yilinima bɛ tangalimia n-nyɛ): (+27-51-4052812) a suhuyubu pahibu vihigu tumayilinima.

Dr. VL Van Den Berg; o tangalimia n-nyɛ: +27833901801, ka o email nyɛ: vdbergvl@ufs.ac.za (UFS, South Africa)

IRB Chairperson. (GHS, Ghana)

Anfaani, ni barina mini so' shɛŋa din dola: Bɔhimbu nyɛla din yɛn sɔŋ lihi ka bindirigu din simdi ni daadam di ka mali alaafee nyɛ zaasheei zani ni di baŋsim, ka lan taɣi ti behigu mini ti tuma ni ti minlinsi zaŋ kpa alaafee bindira polo. Di ni lahi sɔŋ ka ti baŋ barina shɛŋa din tahiri ningbuŋ yaa kalinsi bihi mini manima sani ti tudu bɔbli ŋɔ na Ghana tiŋgbɔŋ ni.

Lala bɔhimbu niya ŋɔ maa ka bɛ karim ti ma. M baŋ di gbinni ka bɛ ti ma saha ka n tooi bɔhi ba bɔhisi ka bɛ labsi m bɔhisi maa ka n suhu maai. Lala zuɣu n ni pahi bɔhimbu ŋɔ maa ni.

A yuli: ....

(Name)

.... Dihimi a nubila: (Signature/Thumb Print) ....

Dabsili (Date) ....

A yi dihi a nuu di wuhimi ni a saɣiya ni a bii pahi bɔhimbu ŋɔ maa zuɣu.

A bii maa yuli:

Ma bee Bii-Lana .... Nuchee Dihibu .... Dabsili ....

(Parent/Guardian) (Signature/thumb print) (Date)

VIHIGU BAƉDA ƷILINKOM

N saɣiya ni ti karimi gbaŋ ŋɔ niya ni nyɛ shɛm ka o baŋ di gbinni, di anfaani, ni di barina mini so shɛli bɔhimbu ŋɔ ni dola. N tiba saha ka bɛ karim ka saɣi ni bɛ bɔri ni bɛ pahi bɔhimbu ŋɔ zuɣu.

....

(Vihigulan Nuchee/Vihigu Wulana) Date

Appendix 3: Child Assent Form

Introduction

My name is Brenda Ariba Zarhari, Abu and I am from the *department of Nutrition and Dietetics* at University of the Free State, South Africa. I am doing a research study entitled "*Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to risk factors for iron deficiency among mothers and their young children in Northern Ghana.*" I am asking you to take part in this research study because I am trying to learn more about how the food you eat affect you blood and health. This research will take two (2) years.

General Information

If you agree to be in this study, you and your mother will be asked to take part in a face-to-face interview where you with the help of your mother will recall your food intake, your body parts be measured, as in weight  and also your height 

. You will also be physically examined on signs of inadequate blood.

Possible Benefits.

Your participation in this study will result in you knowing about your health. You and your mother will be given a small token to say thank you for taking part in the research.

Possible Risks and Discomforts

However, the risks are that, you may not feel comfortable during body parts measurements and talking about the foods you have already eaten.

Voluntary Participation and Right to Leave the Research

You can stop participating at any time if you feel uncomfortable. No one will be angry with you if you do not want to participate.

Confidentiality

Your information will be kept confidential. No one will be able to know how you responded to the questions and your information will not be linked to your name.

Contacts for Additional Information

You may ask me any questions about this study. You can call me at any time on my cell phone number +233-244451726 or talk to me the next time you see me.

Please talk about this study with your parents before you decide whether or not to participate. I will also ask permission from your parents before you are enrolled into the study. Even if your parents say "yes" you can still decide not to participate.

Voluntary agreement

By making a mark or thumb printing below, it means that you understand and know the issues concerning this research study. If you do not want to participate in this study, please do not sign this assent form. You and your parents will be given a copy of this form after you have signed it.

This assent form which describes the how the study go, the good and bad of the research titled "*Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Ghana."* has been read and or explained to me. I have been allowed to ask any questions about the research and they answered to my satisfaction. I agree to participate.

Child's Name:………………………………… Researcher's Name:…………..…

Child's Mark/Thumbprint……………………….. Researcher's Signature:………..…

Date: ……………………………Time……… Date: ……………………………..

Appendix 4: Ethics Approval Letters

Ethical approval letter by University of the Free State, South Africa

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

Research Division
Internal Post Box G40
☎(051) 4052812
Fax (051) 4444359

E-mail address: StraussHS@ufs.ac.za

Ms H Strauss/hv

2012-03-07

REC Reference nr 230408-011
IRB nr 00006240

MS BAZ ABU
c/o DR L VAN DEN BERG
DEPT OF NUTRITIONAL DIETETICS
CR DE WET BUILDING
UFS

Dear Ms Abu

ECUFS NR 24/2012
MS BAZ ABU **DEPT OF NUTRITIONAL DIETETICS**
PROJECT TITLE: IMPACT OF AN EDUCATION INTERVENTION ADDRESSING RISK FACTORS FOR IRON DEFICIENCY AMONG MOTHERS AND THEIR YOUNG CHILDREN IN NORTHERN GHANA.

- You are hereby kindly informed that the Ethics Committee approved the above project at the meeting held on 6 March 2012 on condition that:
  - ***The signed permission letters from the health authorities have to be submitted to the Ethics Committee before the study may be conducted***
- Committee guidance documents: Declaration of Helsinki, ICH, GCP and MRC Guidelines on Bio Medical Research. Clinical Trial Guidelines 2000 Department of Health RSA; Ethics in Health Research: Principles Structure and Processes Department of Health RSA 2004; Guidelines for Good Practice in the Conduct of Clinical Trials with Human Participants in South Africa, Second Edition (2006); the Constitution of the Ethics Committee of the Faculty of Health Sciences and the Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines.
- Any amendment, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.
- The Committee must be informed of any serious adverse event and/or termination of the study.
- A progress report should be submitted within one year of approval of long term studies and a final report at completion of both short term and long term studies.
- Kindly refer to the ECUFS reference number in correspondence to the Ethics Committee secretariat.

Yours faithfully

For CHAIR: ETHICS COMMITTEE

cc Ms BAZ Abu

205 Nelson Mandela Drive/Rylaan, Park West/Parkwes, Bloemfontein 9301, South Africa/Suid-Afrika
P.O. Box/Posbus 339, Bloemfontein 9300, South Africa/Suid-Afrika, T: +27(0)51 401 9111, www.ufs.ac.za

Ethical approval letter from the Noguchi Memorial Institute of Medical Research of the University of Ghana, Ghana (NMIMR) (2012-2013)

NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH

Established 1979

A Constituent of the College of Health Sciences
University of Ghana

INSTITUTIONAL REVIEW BOARD

Phone: +233-302-916438 (Direct)
+233-289-522574
Fax: +233-302-502182/513202
E-mail: nirb@noguchi.mimcom.org
Telex No: 2556 UGL GH

Post Office Box LG 581
Legon, Accra
Ghana

My Ref. No: DF.22
Your Ref. No:

7th March, 2012

ETHICAL CLEARANCE

FEDERALWIDE ASSURANCE FWA 00001824 **IRB 00001276**

NMIMR-IRB CPN 064/11-12 **IORG 0000908**

On 7th March, 2012, the Noguchi Memorial Institute for Medical Research (NMIMR) Institutional Review Board (IRB) at a full board meeting reviewed and approved your protocol titled:

TITLE OF PROTOCOL	:	**Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Ghana**
PRINCIPAL INVESTIGATOR	:	**Brenda Ariba Zarhari Abu (PhD Candidate)**
CO-PIs	:	**Dr. Van Den Berg, PhD, Prof. A. Dannhauser, PhD, Prof. V. J. Louw, PhD**

Please note that a final review report must be submitted to the Board at the completion of the study. Your research records may be audited at any time during or after the implementation.

Any modification of this research project must be submitted to the IRB for review and approval prior to implementation.

Please report all serious adverse events related to this study to NMIMR-IRB within seven days verbally and fourteen days in writing.

This certificate is valid till 6th March, 2013. You are to submit annual reports for continuing review.

Signature of Chairman: for ....
Rev. Dr. Samuel Ayete-Nyampong
(NMIMR – IRB, Chairman)

cc: Professor Alexander K. Nyarko
Director, Noguchi Memorial Institute
for Medical Research, University of Ghana, Legon

Application letter to the Regional Health directorate

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

13th March, 2012

The Regional Director
Northern Regional Health Directorate
Northern Region, Ghana

Dear Sir/Madam

APPLICATION FOR PERMISSION TO CONDUCT RESEARCH IN NORTHERN REGION

I am Ms Brenda Ariba Zarhari, Abu a student with the above institution and pursuing a course in Human Nutrition. I am applying for your permission to conduct a research titled; ***"Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Ghana."***.

This study is to investigate the high rates of anemia at baseline within your region, as well as evaluate the affectivity of an intervention programme designed to address these factors. The study will engage selected participants through interviews, and subsequent enrollment into a three-day intervention, with subsequent repeat interviews after a further three months. A total of 150 mothers and all their children between six months to 59 months will be recruited into the study.

The study has been granted ethical clearance by the Noguchi Medical Research, Ethical Review Committee of the University of Ghana and the ethics committee of the Faculty of Health Sciences in University of the Free State, South Africa. Please find attached approval letters. I will ensure that all ethical considerations are observed and hope to contribute positively to the nutritional health and anemia status of the region. Results of the study in the form of publications will also be shared with the directorate. The study is expected to be conducted in 21 months. Please find attached copies of the ethics approval letters.

I hope my application is considered.

Thank you.

Yours Faithfully,

(Brenda Ariba Zarhari, Abu)

Skool vir Aanvullende Gesondheidsberoepe / School for Allied Health Professions
Fakulteit Gesondheidswetenskappe / Faculty of Health Sciences
Departement Voeding en Dieetkunde/ Department of Nutrition and Dietetics
T: (051) 401 2894 / (+2751) 401 2894, F: (051) 401 2869 / (+2751) 401 2869, E: dietetics@ufs.ac.za / nutrition@ufs.ac.za
205 Nelson Mandela Drive/Rylaan, Park West/Parkwes, Bloemfontein 9301, South Africa/Suid-Afrika
P.O. Box/Posbus 339 (G24), Bloemfontein 9300, South Africa/Suid-Afrika, www.ufs.ac.za

Approval Letters from the Regional Health Directorate, Northern Region of Ghana.

GHANA HEALTH SERVICE

OUR CORE VALUES:
1. People-centered
2. Professionalism
3. Team work
4. Innovation
5. Discipline
6. Integrity

GHANA HEALTH SERVICE
Your Health - Our Concern

Regional Health Directorate
Ghana Health Service
P.O. BOX 99
Tamale

Tel: (233) (71) 22912, 22710, 22146
Fax: (233) (71) 22941
Email: moh-nr@africaonline.com.gh

My Ref No: GHS/NR/118–093

Monday, 16 April 2012

Your Ref No: ....

PERMISSION TO CONDUCT RESEARCH
MS. BRENDA ARIBA ZARHARI ABU

This is to introduce to you the above named second year student from the **University of the Free State-South Africa.**

She has applied to conduct a research on '***Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Region".***

I would be most grateful if you could use your good offices to assist her with the research.

Please find attached a letter from the school for your consideration.

Thank you and counting on your usual cooperation.

DR. J.Y MAHAMA
DEP. DIR. PUBLIC HEALTH
FOR: REG. DIR. OF HEALTH SERVICE

THE METRO DIR. OF HEALTH SERVICE
METRO HEALTH DIRECTORATE
TAMALE.

THE DIST. DIR. OF HEALTH SERVICES
DISTRICT HEALTH DIRECTORATE
TOLON/KUMBUGU

GHANA HEALTH SERVICE

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Regional Health Directorate
Ghana Health Service
P.O. BOX 99
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Fax: (233) (71) 22941
Email: moh-nr@africaonline.com.gh

GHANA HEALTH SERVICE
Your Health - Our Concern

My Ref No: GHS/NR/18-0/23

Monday, 16 April 2012

Your Ref No: ……………

PERMISSION TO CONDUCT RESEARCH
MS. BRENDA ARIBA ZARHARI ABU

This is to introduce to you the above named second year student from the **University of the Free State-South Africa.**

She has applied to conduct a research on '***Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Region".***

I would be most grateful if you could use your good offices to assist her with the research.

Please find attached a letter from the school for your consideration.

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THE METRO DIR. OF HEALTH SERVICE
METRO HEALTH DIRECTORATE
TAMALE.

✓THE DIST. DIR. OF HEALTH SERVICES
DISTRICT HEALTH DIRECTORATE
TOLON/KUMBUGU

Permit Renewel for 2013-2014 from the Noguchi Memorial Institute of Medical Research of the University of Ghana, Ghana (NMIMR)

NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH
Established 1979 A Constituent of the College of Health Sciences
University of Ghana

Phone: +233-302-916438 (Direct)
+233-289-522574
Fax: +233-21-502182/513202
E-mail: nirb@noguchi.mimcom.org

NMIMR-IRB
P. O. Box LG 581
Legon, Accra
Ghana

My Reference: DF 22

April 30, 2014
Brenda Ariba Zarhari Abu Ms

RE: Our Study # 064/11-12 **At:** NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH-IRB

Dear Brenda Ariba Zarhari Abu:

Meeting Date: 3/7/2013 **At:** NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH-IRB
Protocol Title:

Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Ghana.

This is to advise you that the above referenced Study has been presented to the Institutional Review Board, and the following action taken subject to the conditions and explanation provided below.

Internal #: 422
Expiration Date: 3/6/2014
On Agenda For: Renewal
Reason 1: Progress Report **Reason 2:**
Description:
IRB ACTION: Renewed
Condition 1:
Action Explanation:

Yours Sincerely,

Helena Baidoo
IRB Administrator
NMIMR-IRB
cc: VL Van Berg Den, PhD, University of the Free State, Prof Dannhauser A., PhD , University of Free State, Prof VJ Louw , University of Free State

Permit Renewel for 2014-2015 from the Noguchi Memorial Institute of Medical Research of the University of Ghana, Ghana (NMIMR)

NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH
Established 1979 A Constituent of the College of Health Sciences
University of Ghana

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Fax: +233-21-502182/513202
E-mail: nirb@noguchi.mimcom.org

NMIMR-IRB
P. O. Box LG 581
Legon, Accra
Ghana

My Reference: DF 22

April 30, 2014
Brenda A. Z. Abu, PhD Can
University of the Free State, Department of Nutrition and Dietetics
Bloemfontein

RE: Our Study # 064/11-12 **At:** NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH-IRB

Dear Brenda A. Z. Abu, PhD Can:

Meeting Date: 3/5/2014 **At:** NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH-IRB
Protocol Title:

Impact of an education intervention addressing nutritional status, knowledge, attitudes and practices related to known risk factors for iron deficiency among mothers and their young children in Northern Ghana.

This is to advise you that the above referenced Study has been presented to the Institutional Review Board, and the following action taken subject to the conditions and explanation provided below.

Internal #: 598
Expiration Date: 3/4/2015
On Agenda For: Procedure
Reason 1: Amendment/Renewal **Reason 2:**
Description: The PI is proposing to increase the number of times for evaluation from the 3rd month to the 6th and 12th months after intervention.
IRB ACTION: Renewed
Condition 1:
Action
Explanation: The amendments to the protocol was approved.

Yours Sincerely,

Helena Baidoo
IRB Administrator
NMIMR-IRB

Appendix 5: Table 13.1: List of Participants

Serial Number	Mother's name	Mother's Code	Child Number	Children's name	Child Code
			CHD1		
			CHD2		
			CHD3		
			CHD4		
			CHD5		
			CHD6		

Appendix 6: Questionnaire

Main questionnaire

For Office Use

Participant ID [|] — 1-3

Section A: Sociodemographic Characteristics

1. Name of community …………………………………………… — 4-5

2. Mother's reference code [| |] — 6-8

3. Index child's reference code

CHD1 [| |] — 9-11

CHD2 [| |] — 12-14

CHD3 [| |] — 15-17

CHD 4	[ ][ ][ ]	[ ][ ][ ]	18-20
CHD 5	[ ][ ][ ]	[ ][ ][ ]	21-23
CHD 6	[ ][ ][ ]	[ ][ ][ ]	24-26

4. What is mothers' birth date? ……/…./19..... [ ][ ][ ][ ][ ][ ] 27-32

5. If date not known how old is mother in years? [ ][ ] [ ][ ] 33-34

6. Date of birth of index child (dd/mm/yy)

				d d m m y y	
CHD1	……/……/…	Unknown	[ ]	[ ][ ][ ][ ][ ][ ]	35-40
CHD2	……/……/…	Unknown	[ ]	[ ][ ][ ][ ][ ][ ]	41-46
CHD3	……/……/…	Unknown	[ ]	[ ][ ][ ][ ][ ][ ]	47-52
CHD4	……/……/.	Unknown	[ ]	[ ][ ][ ][ ][ ][ ]	53-58
CHD5	……/……/…	Unknown	[ ]	[ ][ ][ ][ ][ ][ ]	59-64
CHD6	……/……/	Unknown	[ ]	[ ][ ][ ][ ][ ][ ]	65-70

7. What is the gender of the index child?

1	Male	2	Female

CHD1			71
CHD2			72
CHD3			73
CHD4			74
CHD5			75
CHD6			76

8. What is the mother's highest level of education?

1	None (0years)		
2	Primary (1-6years)		
3	JSS level(7-10years)		77
4	SSS/Vocational school (11-14years)		
5	Tertiary level (15 and more years)		

9. What religion is the mother?

1	Christian	4	Other religion specify ……………………
2	Muslim		
3	Traditionalist		

78

1-2

10. Which ethnic group does the mother belong to?

………….………………………

3-4

11. Is/how is the mother employed?

1	Self employed	4	Remittances
2	Unemployed	5	Others specify ………………..
3	Government / Salary worker		

5

6-7

12. If the mother is employed, how many hours per day is she working?

………

8-10

13. If the mother is working, who takes care of the index child when the mother is at work?

CHD1

11-12

1	Mother takes child along	CHD2		13-14
2	Child in school	CHD3		15-16
3	Leaves the child with older siblings	CHD4		17-18
4	A paid carer	CHD5		19-20
5	Others please specify …………………..	CHD6		21-22

14. Marital status of the mother?

1	Married	4	Cohabiting	23
2	Single	5	Widowed	
3	Divorced/separated			

15. How is the father involved with index child?

1	Not at all	CHD1		24
2	Makes only financial contribution	CHD2		25
3	Helps to physically and financially care for child	CHD3		26
		CHD4		27
		CHD5		28
		CHD6		29

16. How old (years) was the mother when she got married? 30-31

17. Who is the head of household? 32

1	Mother	3	Grandparent
2	Husband/partner	4	Other members of household. Specify

……………...……………… 33-34

18. What is the educational level of the household head? 35

1	None
2	Primary level
3	JSS level
4	SSS/Vocational school
5	Tertiary level

Housing

19. How many people are living in the household?

	36-37

≤ 18years ≥ 18years — 38-41

20. How many rooms are in the house? — 42-43

21. What is the material used for roofing of the house?

1	Iron sheet	3	Thatch	44
2	Mud	4	Others specify…………..	45-46

22. What is the floor made of?

1	Mud	3	Tiles	47
2	Cement	4	Other, specify……………………	48-49

23. What is the monthly income of the household?

GH¢ — 50-53

24. Does household have electricity?

1	Yes	2	No		54

25. What is the household's main source of drinking water?

1	Bore hole	4	River/pond		55
2	Pipe borne	5	Well		56-57
3	Sachet/bottled/filtered water				
6	Others, specify …………………………………				

26. What is the household main source of fuel for cooking?

1	Firewood	3	Gas	5	Other, specify	58
2	Charcoal	4	Electricity		……………..	59-60

27. Does the household have cooling facilities?

1	Refrigerator	61
2	Freezer	62
3	Other, specify…………………	63-64

Section B :Medical History

28. When was the last time the mother had malaria?

1	Less than a week ago	5	Longer than three months	65
2	Longer than two weeks ago	6	Don't remember	
3	Longer than a month ago	7	Never	
4	Longer than two months ago			

29. How did she treat it? (More than one choice)

1	Did nothing	66
2	Used OTC medicine	67
3	Used prescribed drugs	68
4	Used a herbal treatment	69
5	Others specify …………………………	70
		71-72

30. When was the last time that the index child had malaria?

1	Less than a week	CHD1	73

2	Two weeks ago	CHD2		74
3	A month ago	CHD3		75
4	Three months	CHD4		76
5	More than three months	CHD5		77
6	Never	CHD6		78
7	Don't remember			

31. How did the mother treat it? (More than one choice)

		CHD1	CHD2	CHD3	CHD4	CHD5	CHD6							
1	Did nothing													79-84
2	Used OTC medicine													1-6
3	Used prescribed drugs													7-12
4	Used a herbal treatment													13-18
5	Others specify …													19-24

32. Has the mother been dewormed in the last three months?

1	Yes	2	No		25

33. Has the index child been dewormed in the last three months?

1	Yes	2	No	CHD1			26
				CHD2			27
				CHD3			28
				CHD4			29
				CHD5			30
				CHD6			31

34. Has the index child had any other sickness in the last two weeks prior to the study?

				CHD1			32
1	Yes	2	No	CHD2			33
				CHD3			34
				CHD4			35
				CHD5			36
				CHD6			37

35. What type of sickness was it? (more than one choice)

		CHD1	CHD2	CHD3	CHD4	CHD5	CHD6							
1	Fever													
2	Cough													38-43
3	Injury													44-49
4	Anemia													50-55
5	Others Specify…………													56-61
														62-67

36. Has the mother had any other form of symtoms of sickness in the last two weeks prior to the study.

1 Yes 2 No — 68

37. What symptoms or illness was it? (More than one choice)

1	Fever			69
2	Anemia			70
3	Injury			71

4	Other please specify ………………………		72-73

38. At what age did mother start menstruation? 74-75

39. When was the last time the mother had her menstrual flow? 76

1	Still menstruating
2	A week ago
3	2 – 3 weeks
4	A month ago
5	More than a months ago
6	Others, Specify ………………………………

77-78

40. How often does the mother change her sanitary pad/tampon during peak flow days? 79-80

41. How many pads/tampons does the mother use over a single menstrual period? 81-82

42. Does mother need to change her pads/tampons during the night?

1 Yes 2 No

1

43. How large are any clots that are passed?

2-3

44. Has the mother been told by a medical provider that she is anemic?

1 Yes 2 No

4

45. How long does the mother usually have her menstrual flow?

1	1-3days
2	4-7days
3	≥ 7days

5

46. How old (years) was the mother when she first got pregnant?

6-7

47. How many times have the mother been pregnant? 8

48. How many miscarriages has the mother had? 9-10

49. How many stillbirths has the mother had? 11-12

50. How many live births did the mother have? 13-14

51. How many live children does the mother currently have in total? 15-16

52. What was the birth weight of the index child? ………………Kg

CHD1		.				.			17-19
CHD2		.				.			20-22

CHD3		.					.			23-25
CHD4		.					.			26-28
CHD5		.					.			29-31
CHD6		.					.			32-34

53. How many weeks was the mother pregnant before the delivery

of the index child?

CHD1					35-36
CHD2					37-38
CHD3					39-40
CHD4					41-42
CHD5					43-44
CHD6					45-46

54. Does the mother smoke?

1 Yes   2 No   47

55.Was the mother given Iron (Fe) tablets when she was pregnant with the index child?

1	Yes	2	No

CHD1			48
CHD2			49
CHD3			50
CHD4			51
CHD5			52
CHD6			53

56. Did mother take all the iron tablets as instructed?

1	Took all as instructed	CHD1			54
2	Missed only a few times (occasionally)	CHD2			55
3	Missed many times (frequently)	CHD3			56
4	Only took it when she remembered	CHD4			57
5	Never took it	CHD5			58
		CHD6			59

57. If not taken daily as instructed, what was the reason? Please state

CHD1…..………………………………………………… 60-61

CHD2...………………………………………………… 62-63

CHD3…………………………………………………… 64-65

CHD4………………………………………………… 66-67

CHD5………………………………………………… 68-69

CHD6………………………………………………… 70-71

58. Is the mother currently using contraceptives?

1	Yes	2	No	72

59. What type of contraceptives is the mother using? (More than one choice)

1	IUD	73
2	Pills	74
3	Barrier method (condoms/diaphragm/cervical cap)	75
4	Other hormonal methods	76
5	Other methods, specify……………………………….	77
		78-79

60. If the mother is using pills or hormonal method, please name the product:

…………………………………………………… 80-81

Nutritional Status

Section A: Anthropometry and Physical signs of ID

Section B: Dietary Assessment

Section C: Household food Security

Section A: Anthropometry and Physical signs of ID

1. Mother; Weight (kg)

			.		

			.		1-5

2. Mother Height (m)

	.		

	.			6-8

3. Index child's; Weight ……………(kg)

CHD1			.		
CHD2			.		
CHD3			.		
CHD4			.		
CHD5			.		
CHD6			.		

		.			9-12
		.			13-16
		.			17-20
		.			21-24
		.			25-28
		.			29-32

4. Index child's height/length ……….(m)

CHD1		.					.			33-35
CHD2		.					.			36-38
CHD3		.					.			39-41
CHD4		.					.			42-44
CHD5		.					.			45-47
CHD6		.					.			48-50
							.			51-53

Physical Signs of ID

5. Does the mother or index child have any of the following symptoms?

(More than one choice)

i	Koilonychia	1	Yes	2	No
ii	Angular stomatitis	1	Yes	2	No
iii	Atrophic glossitis	1	Yes	2	No

	i	ii	iii				
Mother							54-56
CHD1							57-59
CHD2							60-62

CHD3							63-65
CHD4							66-68
CHD5							69-71
CHD6							72-74

C**: Household Food Security**

6. How much money is spent on food for the household weekly?

				GH¢						1-4

7. What is the mother's main source of income? (Indicate all sources of income)

1	Wages and salaries from formal employment		5
2	Self-employment (including home enterprises)		6
3	Casual employment (agricultural or non agricultural)		7
4	Crop production and livestock sales		8

5	Sale of assets	9
6	Land/ flats /equipment rental	10
7	Old age pension or state grant	11
8	Domestic work	12
9	Other: specify ______________________________	13
		14-15

Food production, preservation and Availability

8. Does the household grow vegetables?

1	Yes	2	No	16

9. If yes, which vegetables do they grow? (More than one choice)

1	Cabbage	17
2	Carrots	18
3	Green, leafy vegetables	19
4	Pumpkin	20
5	Beans	21
6	Groundnut	22
7	Other: specify ________________________	23

24-25

10. Does the household grow crops?

1	Yes	2	No	26

11. If yes, which crops does the household grow?

1	Maize	27
2	Wheat	28
3	Sorghum	29
4	Potatoes	30
5	Other: specify ________________________	31
		32-33

12. What % of the annual agricultural yield is sold? ________________ 34-35

13. Does the household own fruit trees?

1	Yes	2	No	36

14. If yes, which fruits does the household grow?

____

1	Mangoes		37
2	Oranges		38
3	Cashew		39
4	Guava		40
5	Sour sob		41
6	Other: specify ________________________		42
			43-44

15. Does the household own livestock?

1	Yes	2	No	45

16. If yes, which animals does household own and how many?

1	Beef cattle, specify how many		46-48
2	Dairy cattle , specify how many		49-51
3	Sheep, specify how many		52-54
4	Goats, specify how many		55-57
5	Pigs, specify how many		58-60
6	Chickens, specify how many		61-63
7	Other: specify_____________		64-66

17. If yes, which food usually lasts until the next harvest?

1 Yes   2 No

1	Vegetables	67
2	Crops	68
3	Fruits	69
4	Other: specify ______________________________	70
		71-72

18. If not, what are the reasons

1	Not enough land	73
2	Not enough money to buy seeds and other equipment	74
3	Other: specify ______________________________________	75
		76-77

19. Which preservation method does the mother mostly use?

1	Sun drying	
2	Canning	
3	Freezing	78
4	Other: specify____	79-80

20. What is the household main reason for producing food?

1	Consumption by family members
2	To sell
3	To exchange for clothes and household equipment
4	Other: specify___________________________

1

2-3

HUNGER SCALE

21. Does the household ever run out of money to buy food?

1 Yes 2 No

4

22. Does the household ever rely on a limited number of foods to feed children?

1 Yes 2 No

5

22b. If yes, how do they manage?

…………………………………………………………………….

……………………………………………………………………

23. Does the household ever cut the size of meals or skip any because there is not enough food in house?

[1] Yes [2] No — 6

24. Does the household ever eat less than they should because there is not enough money for food?

[1] Yes [2] No — 7

24b. How do you define eating "enough food".

…………………………………………………………

…………………………………………………………

8-10

25. Does the children in the household ever eat less than they feel they should because there is not enough money for food?

[1] Yes [2] No — 11

26. Does the children in the household ever say they are hungry because there is not enough food in the house?

[1] Yes [2] No — 12

27. Does the household ever cut the size of the children's meals or do they ever skip meals because there is not enough money to buy food?

1 Yes   2 No   13

28. Does any of the children in the household ever go to bed hungry because there is not enough money to buy food?

1 Yes   2 No   14

29. Has the household ever experienced periods of food shortage?

1 Yes   2 No   15

29b. How long did the food shortage take?   16-17

30. If yes, how did the household cope during this period? (more than one choice)

1	Found other/additional sources of income	18
2	Asked family/relatives/ neighbors for help (money/food)	19
3	Family members went to live elsewhere	20

4	Sold assets			21
5	Worked for payment in kind			22
6	Depended on charity/welfare			23
7	Borrowed money/food			24
8	Increased production of food			25
9	Could not do anything			26
10	Other: specify ____________________________			27
				28-29

Section C. Dietary Assessment – 24hour recall sheet

24hour recall **Day** [ ] **Mother ID** [ ]

Interviewer:			**Participants ID:**		**Weight:**	
Interview date:			**Location:**		**Sex F/M**	
Interview day:			**Age:**			

MOTHER/CAREGIVER

Time	**Place eaten**	**Food/drink eaten**	**Description and cooking method**	**Amount eaten**	**Weight/equivalent(g)**	**Food Code**

Probe for alcohol :	Yes		Probe for sickness :	Yes	
	No			No	
			If yes, did sickness affect appetite:	Yes	
				No	
			If yes, how?	Increase	
				Decrease	
Was food intake usual?	Yes		Probe for tablets?	Iron	
	No			Other supplement	
If no, how unusual?				Anti-malaria	
				Vitamin	
Was it a feast day?	Yes				
	No				
Was it a market day?	Yes				
	No				
Was it a fasting day?	Yes				
	No				

Day   **Child ID**

Interviewer:			**Participants ID:**		**Weight:**	
Interview date:			**Location:**		**Sex F/M**	
Interview day:			**Age:**			
CHILD						

Time	Place eaten	Food/drink eaten	Description and cooking method	Amount eaten	Weight/equivalent(g)	Food Code

Probe for alcohol :	Yes		Probe for sickness :	Yes	

	No			No	
			If yes, did sickness affect appetite:	Yes	
				No	
			If yes, how?	Increase	
				Decrease	
Was food intake usual?	Yes		Probe for tablets?	Iron	
	No			Other supplement	
If no, how unusual?				Anti-malaria	
				Vitamin	
Was it a feast day?	Yes				
	No				
Was it a market day?	Yes				
	No				
Was it a fasting day?	Yes				
	No				

Adopted and modified from Gibson and Ferguson, 2008: 48.

Food Frequency Questionnaire

Please indicate the frequency of the following foods **Mother's ID**

Question Number	**Food Group**	**Example**	**Within the 24 hours Yes= 1 No = 0**	**If yes, how often; Daily= 1 3-4 times a week = 2 Weekly = 3 2 – 3 times a month =4 Monthly = 5 Occasionally = 6 Never = 0**	**Seasonal = 1 All year = 2**
1	CEREALS	corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + *insert local foods e.g.ugali, nshima, porridge, TZ or paste*			
		Processes or whole grain			
		Maize porridge			
		Sour porridge			
		White bread			
		Brown bread			
		Millet Porridge			
		Pasta (macaroni, spaghetti)			
		Maize-meal TZ, Banku			
		Potatoes			
		Rice /mealie rice			
		Corn on cob			
		Popcorn			
		Butternut/squash/pumpkin			
		Others please specify			
2	WHITE	white potatoes, white			

	ROOTS AND TUBERS	yam, white cassava, or other foods made from roots			
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside + *other locally available vitamin A rich vegetables (e.g. red sweet pepper)*			
		Pumpkin			
		carrot			
		Sweet potatoes			
		Sweet pepper			
		Others			
	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + *locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach*			
		Amaranth			
		Cassava Leaves			
		Spinach/ Nkontomire			
		Bean leaves			
		Pumpkin leaves			
		Mellon leaves			
		Bitor leaves			
		Wild leafy vegetables			
		Mixed vegetables			
		Others			
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant) + *other locally available vegetables*			
		tomatoes			
		onions			

		Garden eggs			
		Others			
6	VITAMIN A RICH FRUITS	ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + *other locally available vitamin A rich fruits*			
		Ripe mango			
		100% juices form Cantaloupe /apricot			
		Ripe papaya			
		Dawadawa (condiment)			
		Others			
	VITAMIN C RICH FRUITS	Citrus fruits and juices, strawberries, berries			
		Oranges, tangerines, lime			
		Berries			
		Orange juices			
		Vitamin C fortified juices			
		Others			
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these			
8	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods			
		liver			
		kidney			
		heart			
		Blood-based foods			
		Others			

9	FLESH MEATS	beef, pork, lamb, goat, rabbit, game,			
		Beef			
		Pork			
		Lamp			
		Goat meat			
		Game			
		Chicken			
		Duck			
		Other birds			
		Insects/worms			
		Others			
10	EGGS	eggs from chicken, duck, guinea fowl or any other egg			
11	FISH AND SEAFOOD	fresh or dried fish or shellfish			
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)			
		Whole or processed			
		Dried beans			
		Dried peas			
		nuts			
		Peanut butter/seeds			
		Melon seeds			
		Others			
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products			
		Cow's milk			
		Yoghurt			
		Breast Milk (child)			
		Goat's milk			

14	OILS AND FATS	oil, fats or butter added to food or used for cooking			
15	SWEETS	sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes			
16	SPICES, CONDI MENTS, BEVER AGES	spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages			
		Soft drink			
		Soy products			
		Black pepper/chilli			
		Hot chocolate			
		Coffee			
		Tea			
		Milo			
		Green tea			
		Alcohol			
		Locally Brewed beers			
		Other			
Individ ual level	Did you eat anything (meal or snack) OUTSIDE the home yesterday?				

Adopted and modified from Kennedy *et al.*, 2011:8

<u>THANKYOU FOR YOUR TIME AND CONTRIBUTIONS</u>

Appendix 7: Reference Tables

Table 13.2: Table showing EAR calculated from FAO/WHO recommended nutrient intakes (RNI)

	Energy		**Protein**		**Folate/Folic acid**		**Vitamin A**		**Vitamin B12**		**Vitamin C**		**Total Water**	
UNITS	**Kcal /day**		**g/Kg/day**		**µg/day**		**µg/day (RAE)**				**Mg/Day**		**Liters/Day**	
Age	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**	**AI**	**UL**
Children														
6-12mo	95*	-	1*	-	80*	-	500*	600	0.5*	-	50*	-	0.8	-
12.01 - 36mo	1000	-	0.87	-	120	300	286	600	0.7	-	25*	400	1.3	-
36.01-72mo	1000	-	0.76	-	160	400	321	900	1.0	-	25*	650	1.7	-
Women														
19-50years	100	-	0.66	-	320	1000	357	3000	2.0	-	37*	1000	3.7	

The values for 6-12 month olds are adequate intakes since there are no ears for that age group. EAR is estimated average requirements, UL is the upper tolerable limits. Source Allen *et al.*, 2006:148, 149, FAO/WHO recommended nutrient intake (RNI).

Table 13.3: Reference table of calorie needs by age.

Age/Children (months	**Estimated Energy Requirements (kJ/kg/d** ***All children***	**Boys**	**Girls**	**Adults**
6-7	397			
7-8	395			
8-9	397			
9-10	414			
10-11	418			
11-12	437			
Children Age (years)				
1-2		439	439	
2-3		418	418	
3-4		397	497	
4-5		397	497	
Adults (Age years)				**173**
14-15				173
15-16				167
16-17				167
17-18				167
18-19				
BMI (18.5-24.5)				

20-30				267
30-40				267
40-50				268
BMI (25.0-29.5)				
20-30				213
30-40				218
40-50				204
Lactating mother (mean months of lactation EBF)				**Cost of Breast milk (KJ/day)**
1				1, 922
2				2,143
3				2,284
4				2,219
5				2,376
6				2,501

From: WHO/FAO, 1985.2002:16, 26, 28, 48, 65.

BMI is Body Mass Index.

Table 13.4: Requirement Estimates for Protein

Age (years)	Nutrient	Protein Requirement (g/kg body weight)		
		Growth	Maintenance	Total protein requirement
3-6months	Protein	0.43	0.56	0.99
6-12months		0.26	0.56	0.82
12-24months		0.16	0.56	0.72
24-60months		0.10	0.56	0.66
Adults		0.00	0.60	0.60

From Dewey *et al.*, 1996

Table 13.5: Requirement Estimates for Iron

Age (years)	**Nutrient**	**Estimated Requirement (mg)**	
		5percent Bioavailability	**10percent Bioavailability**
1-3year	**Iron**	10.8-12.2	5.4-6.1
4-8years		14.8-16.7	7.4-8.4
Women			
19-50		10.8	21.6
19-50menstruating		30.2-33.2	15.1-16.6
Lactation 0-3months		11.7	23.4

Source: From FAO/WHO, 2002, using the probability of anemia of 81% and 59.3% (GDHS, 2008:195, 203) among children and Women respectively in the Northern Region and 50 of anemia being attributed to ID, the probability of inadequate intake be 0.45 and 0.35

Table 13.6: Requirement Estimates for Folate /Folic Acid

Age (years)	Nutrient	Estimated Requirement (µg/kg)	
		Mean	**SD**
1-1.99year	**Folate**	2.5	0.13
2-5.99years		2.5	0.13
Women			
12-15		2.5	0.30
16-18.99		2.4	0.30
19-24		2.4	0.30
25+		2.4	0.30
Add for		ug/d	
Lactation 0-5.99 months		80	
Lactation, 6+ months		80	

Source; WHO/FAO, 1988; 2002; 2004.

Table 13.7: Requirement Estimates for Vitamin A

Age (years)	**Nutrient**	**Estimated Requirement (RE/kg,)**	
		Mean	**SD**
1-1.99year	**Vitamin A**	18.6	3.7
2-5.99years		18.6	3.7
Women			
12-15		8.1	1.6
16-18.99		6.6	1.3
19-24		6.6	1.3
25+		6.6	1.3
Add for		RE/d	
Lactation 0-5.99 months		250	
Lactation, 6+ months		250	

Source; WHO/FAO, 1988; 2002; 2004

Table 13.8: Requirement Estimates for Vitamin B12

Age (years)	Nutrient	Estimated Requirement (ug/kg,)	
		Mean	**SD**
1-1.99year	**Vitamin B12**	0.03	0.005
2-5.99years		0.03	0.005
Women			
12-15		0.77	0.12
16-18.99		0.77	0.12
19-24		0.77	0.12
25+		0.77	0.12
Add for			
Lactation 0-5.99 months		0.23	
Lactation, 6+ months		0.23	

Source: WHO/FAO, 1988; 2002; 2004.

Table 13.9: Requirement Estimates of Vitamin C

Age (years)	Nutrient	Estimated Requirement (ug/kg,)	
		Mean	**SD**
1-1.99year	**Vitamin C**	15	2.3
2-5.99years		15	2.3
Women			
12-15		23	3.5
16-18.99		23	3.5
19-24		23	3.5
25+		23	3.5
Add for			
Lactation 0-5.99 months		15	
Lactation, 6+ months		15	

Source: WHO/FAO, 1988; 2002; 2004.

Table 13.10: Table showing EAR calculated from FAO/WHO recommended nutrient intakes (RNI)

	Energy		**Protein**		**Folate/Folic acid**		**Vitamin A**		**Vitamin B12**		**Vitamin C**		**Total Water**	
UNITS	**Kcal /day**		**g/Kg/day**		**µg/day**		**µg/day (RAE)**		**µg/day**		**Mg/Day**		**Liters/Day**	
Age	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**	**EAR**	**UL**
Children														
6-12mo	*95*[*]	-	*1*[*]	-	*80*[*]	-	*500*[*]	*600*	*0.5*[*]	-	*50*[*]	-	*0.8*	-
12.01 - 36mo	1000	-	0.87	-	120	300	286	600	0.7	-	25[*]	400	*1.3*	-
36.01-72mo	1000	-	0.76	-	160	400	321	900	1.0	-	25[*]	650	*1.7*	-
Women														
19-50years	100	-	0.66	-	320	1000	357	3000	2.0	-	37[*]	1000	*3.7*	

The values for 6-12 month olds are adequate intakes since there are no EARs for that age group. EAR is Estimated Average Requirements (EAR), UL is the upper tolerable limits.

Source Allen *et al.*, 2006:148, 149, FAO/RNIs.

Table 13.11: The probability table for iron intake

Probability of inadequacy	**Usual intake of children 4-8 years consuming diet which the iron bioavailability is:**		**Usual intake of children 4-8 years consuming diet which the iron bioavailability is:**		**Usual intake of females 14-18 years consuming diet which are:**		**Usual intake of menstruating women years consuming diet from which the iron bioavailability is:**	
	5%	**10%**	**5%**	**10%**	**5%**	**10%**	**5%**	**10%**
1.00	<3.6	<1.8	<4.8	<2.4	<16.2	<8.1	<15.0	<7.5
0.96	3.6-4.5	1.8-2.3	4.8-5.9	2.4-3.0	1.6-17.7	8.1-8.8	5.4-16.7	7.5-8.4
0.93	4.5-5.5	2.3-2.8	5.9-7.4	3.0-3.7	17.7-19.6	8.8-9.8	16.7-18.7	8.4-9.4
0.85	5.5-7.1	2.8-3.6	7.4-9.5	3.7-4.8	19.6-22.1	9.8-11.1	18.7-21.4	9.4-10.7
0.75	7.1-8.3	3.6-4.2	9.5-11.3	4.8-5.7	22.1-24.1	11.1-12.0	21.4-23.6	10.7-11.8
0.65	8.3-9.6	4.2-4.8	11.3-13.0	5.7-6.5	24.1-26.0	12.0-13.0	23.6-25.7	11.8-12.9
0.55	9.6-10.8	4.8-5.4	13.0-14.8	6.5-7.4	26.0-27.8	13.0-13.9	25.7-27.8	12.9-13.9
0.45	10.8-12.2	5.4-6.1	14.8-16.7	7.4-8.4	27.8-29.7	13.9-14.8	27.8-30.2	13.9-15.1
0.35	12.2-13.8	6.1-6.9	16.7-19.0	8.4-9.5	29.7-32.1	14.8-16.1	30.2-33.2	15.1-16.6
0.25	13.8-15.8	6.9-7.9	19.0-21.9	9.5-11.0	32.1-35.2	16.1-17.6	33.2-37.3	16.6-18.7
0.15	15.8-18.9	7.9-9.5	21.9-26.3	11.0-13.2	35.2-40.4	17.6-20.2	37.3-45.0	18.7-22.5
0.08	18.9-21.8	9.5-10.9	26.3-30.4	13.2-15.2	40.4-45.9	20.2-23.0	45.0-53.5	22.5-26.7
0.04	21.8-24.5	10.9-12.3	30.4-34.3	15.2-17.2	45.9-51.8	23.0-25.9	53.5-63.0	26.7-31.5
0.0	>24.5	>8.2	>34.3	>17.2	>51.8	>25.9	>63.0	>31.5

Probability of 1 is assumed usual intakes below the 2.5th percentile and a probability of 0 is assumed for intakes above the 97.5th percentile.

Table 13.12: Dietary Reference Intakes (DRIs) of fiber: daily recommended intakes of dietary fiber for children and adults.

Age, gender, life stage group	**RDA Fiber (grams/day)**
Infants	
0–6 mo	Not determined
7–12 mo	Not determined
Children	
1–3 years	19
4–8 years	25
Adults	
Women	
9–13 years	26
14–18 years	26
19–30 years	25
31–50 years	25
51–70years	21
> 70 years	21
Pregnant Women	
14–18 years	28
19–30 years	28
31–50 years	28
Lactating Women	
14–18 years	29

19–30 years	29
31–50 years	29

Note: Daily Reference Intakes (DRI) has been developed, since 1996 by the Food and Nutrition Board, Commission on Life Sciences, National Research Council, to replace the Recommended Dietary Allowance (RDA).

Appendix 8: Check List for observations

<u>House Number…………………..., Mothers Name………………………………………..Childs Name………………………</u>

<u>Check list for household observation</u>

What time is food prepared?

1. What food is household cooking?
2. What are the three main ingredients?
3. Comment on the hygiene of the following;

The Mother…..

Environment….

Utensils……

Handling of food ……

4. What time does it take to cook?
5. Is there any special food prepared for the child?
6. How special was food prepared?
7. Does food contain the following? If yes please specify

Organ meat…….

Fish……………

Vegetables…………………..

Fruit …………

8. Do people eat in groups or are served each to plate?
9. How many people are shared per plate?
10. Do children eat with adults?
11. Is hand washing done before cooking?
    - After handling raw food? - Before eating?
12. Where is solid waste disposed off?
13. Where is liquid waste disposed off?

Appendix 9: Report from household observation

Introduction: A total of 40 households were visited and observed based on the checklist that was developed to observe food cooking practices, hygiene practices and also feeding behavior in households. Mothers were only told that the researcher and the RA would be visiting their households to observe how foods are prepared to learn their cooking methods to enable discussions later on how foods can be nutritionally improved. Mothers were encouraged to maintain their daily routines to enable a true realisation and relevant discussions.

Methods: A checklist was used to visit households. Each household was observed during one of the following, breakfast, lunch or supper preparations. The mother was observed from the beginning of the preparation of the meal to the end and the feeding time of the meal.

Food predations and quality

Most households prepare foods that were more carbohydrate based.

Ingredient such as dawadawa which is a bean- based condiment was usually added to soup and sauces. These may improve the protein content of the foods. Fish powder from anchovies was also a major part of soup and sauces. However, both were usually in small quantities but may be beneficial to improving iron absorption.

The water used in households was usually from the dam and were not treated in any other ways except to allow time to settle before using them for cooking and drinking. This was the same for children.

Meat was rarely cooked during meals and when done was only used to serve adult members.

Long period of cooking vegetables could affect the quality of nutrient in vegetables and heat labile nutrients. In addition, most times more water was added to vegetables during cooking or par boiling and after which it is draining of the water and the water the water discarded.

The use of iron cooking pots was used in all households visited and iron pots have a potential to improve iron content in foods.

Hygiene practices

Hygiene practices were observed in terms of hand washing, environment and utensils used for cooking. Hand washing was very rare, and was usually done without soap.

The environment was not always swept at the beginning of the cooking session but most women only swept while food was on fire and sometimes opened.

Utensils were mostly washed but allowed to dry on the floor or in an open basket while sweeping took place. Containers used to store cooking ingredients however were not kept clean.

Solid and liquid waste was damped in the outside of households and this may be breading grounds for mosquitoes.

Feeding behavior

Children in households ate together and adult members did the same. Though this may be a great opportunity for bonding among adults, among children, this may have both positive and negative impact on nutrition security for these children. The positive factor may be that children who do not like to eat by themselves may be encouraged to eat because all the other children in are eating.

On the other side, if a child does not like to eat, she may continuously no meet daily nutrient requirements thus leading to malnutrition. This practice has the probability to promote intera-household food and nutrition security.

In both communities, households served the carbohydrate food with very little soup or sauce. This was same for children and adults alike. This may be one of the practices that may affect iron-related nutrient adequacy. This is because most of the nutrients other than carbohydrate are in the soup or sauces. The education to increase quantities of soups and sauces may improve access to other nutrients.

Conclusion and Implications:

There are potentials that can be harnessed to improve the meal adequacy in these communities. Children feeding together, increasing soup quantities among others may improve nutrient adequacy.

Appendix 10: Key Messages Card

Key messages card
Nutrition Education Leaflet

DAY ONE (1)

Introduction; About iron deficiency (ID)

Healthy blood is needed to make you strong and able to do your work and play and also to think clearly and concentrate. For the body to form healthy blood and healthy brains it needs iron. Iron is from the food eaten. "Iron deficiency or "blood not enough" is caused by the low iron supply to the body, if;

- The body is not able to extract the iron due to a problem with the intestines.
- Malaria and worm infestation can also cause anemia make the" blood sick" or worms make the body lose blood.

Who is vulnerable?

Everyone can have anemia however, children, pregnant women and adolescents are the most common people to have ID.

Symptoms of ID;

Feels weak, tired and sleepy, inside of the lower eyelids appears pale; and pale palm and nail beds.

Prevention of ID

Foods rich in iron are meat, chicken, spinach, beans, fish, groundnuts and also fresh fruits both domestic and wild

Prevent infection of worms and malaria.

Effects of ID

CHILDREN- their brain may not develop well and they always feel tired and not do well in school.

WOMEN-feel tired and cannot work effectively, if they get pregnant the child may be smaller for the age during birth or both mother and child could die.

ADOLESCENTS GIRLS- not do well in school and when they are pregnant; they may have ID.

The following themes were identified as associated with ID but are problems within the community from the baseline survey.

Theme 1: Intake of fruits, organ and fleshy meat intake in ID

1A; Eat at least two fruits a day

1B; Organ meat in meals improve iron in food

1C; Red meat and fish improve iron in meals and help iron to be absorbed

Theme 2: Intake of tea and the timing of tea intake

- Tea should not be brewed or one bag should not be used several times.
- Drink tea at least an hour before or after meals to prevent it's interaction with food.

2A; Do not drink tea during meals

DAY TWO (2)

Theme 3: The role of contraception; spacing, use of IUD and pills in ID

- Visit the health center for advice on contraceptives
- Some of them contain iron (pills).
- The contraceptives may cause heavy menstrual flow. This may cause ID.

3A; Iron coated Pills can improve iron status in the blood.

Theme 4: Treatment of malaria; environment, personal hygiene and WASH

- Wash hands with soap to prevent the germs which cause diarrhea.
- Boil and filter water from dam and others sources before drinking
- Sleep in mosquito treated nets.
- Keep the environment clean.

4A; Wash hands with soap before cooking, eating and after you or child visit the toilet

4B; Avoid mosquito bites by sleeping in treated bed nets

Theme 5: Pica as an indicator for ID

When a person is iron deficient, they have an increased need to eat foods or sometimes things that are not food.

- When a child or an adult eats these foods, then one can suspect iron deficiency.
- Apart from the smooth (atrophied) tongue, sores at the corners of the mouth (angular stomatis) and spoon nails, pica is a good sign of ID

5A; Children and adults who eat soil and clay may be exposed to worms and ID

5B; Soil may contain worms or their eggs

DAY THREE (3)

Theme 6: Pica as a risk factor for ID

- Pica is the increased appetite for food and non-food substances.
- Clay, soil and some raw food may contain worms or germs.
- Pica can cause ID

During pregnancy, mothers should find other foods to satisfy their cravings like fruits and meat rather than the clay they eat.

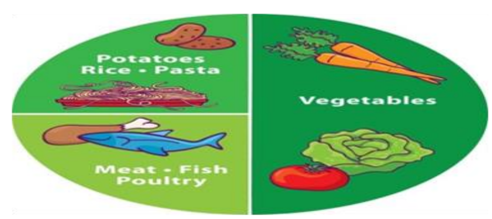
6A; An atrophied tongue may be a sign of ID

6B; Spoon fingers are a sign of ID

6C; Angular Stomatitis is a signs of ID

Theme 7: Complementary feeding in ID risk areas

- The plate model shows how the food should be represented in your plate.
- Fish enhance the body to get the iron in food.



7A: Plate model: How plate should look like

Use more fish, organ meat, meat, and beans based meals for complementary foods.

Theme 8: Other risk factors; (high antenatal attendance versus low hospital delivery)

- When a woman finds out that she is pregnant, she should report to the health center immediately.
- Deliver in the hospital since help is readily available in case of complications.

Report heavy menstrual bleeding to the health facility

DAY FOUR (4)

Theme 9: Addressing myths and misconceptions of ID and Pica.

Myths on iron deficiency
Causes
Cuts/injury leading to blood loss can cause anemia
Hard work does not cause anemia
Stress does not causes anemia
Some chronic sickness(fever) causes ID
Standing in the sun for long does not cause anemia
Regular visit alone to the clinic not reduce anemia
Anemia is disease condition not just God's
Drinking tea with meals has an effect on iron uptake
Signs
Edema is not a sign of anemia
Itching body is not a sign of anemia
Prevention
Malta drink and milk does not prevent anemia
Myths
Drinking tea with meals has effect on iron
Eating more eggs does not improves iron status
Taking supplements with milk and tea effect iron uptake
Cashew fruit-when taken with groundnut is not dangerous
Cowpea does not cause malaria
Fish does not makes child steal
Eggs does not makes children steal
Adult men who usually sit at one place cannot get ID

Myths on pica
Causes
People practice pica may have ID not due to personal Interest
People who practice pica are not insane
Pica is not a normal practice
Pregnancy or hormonal changes alone does not causes pica
Myths
People who practice pica are not foolish
Pica practice can be treated
Advice people alone may not stop pica
Cane child not to stop pica practice
Pica is not due to headaches
Ignoring cravings of pica may not treat it
Do away with the food / non food substance may not stop the craving
Getting a substitute/ chewing stick may not treat pica
Pica may not stop after delivery
Child
Beating /scaring the child to stop not stop pica
Training the child may not stop the child
Give them something else edible may reduce the pica practice but not treat the cause.
Children not stop pica when they grow

DAY FIVE (5)

Theme 10: Demonstration of cooking methods; plate model, protein foods, fish powder in complementary foods.

Food assembled from the various food groups according to the plate model

- Choose food with high iron when cooking for the entire household.
- Do not overcook vegetables

Appendix 11: Journal of Activities during Nutrition Intervention Programme

Preparation started with the printing, photocopying and laminating of 83copies of the key messages card (Appendix 10). Samples of foods and others materials were obtained to enhance learning. The programme began on 5th -9th July, 2013. In each day, three sessions were held, thus the early morning (8-10am), the late morning (11am -1pm) and the afternoon sessions (2-4pm). A total of 81 mothers were expected. A participant was expected to choose and attend one of these sessions in a day. The theme for the day is uniform in all sessions of the day hence mothers. New evolving discussions from each sessions were noted and discussed with the others sessions.

Intervention Day 1

The intervention started with mothers arriving late to the programme thought they were entreated to be on time in order not to spend more time waiting on others. Since they are not used to schedule times this could be the reason. The community volunteer went round to remind mothers again to report on time. The first session finally started at 9:15am instead of the scheduled 8 am with anthropometric measurement. The weight and height of both mother and child/ren pairs were repeated before the session finally started with 18 mothers. Any more mothers who came later were encouraged to stay around or go home to do their chores and return in 2hours since they had missed the introduction of the programme. This happened though mothers had earlier been divided into groups. Mothers were given an introduction of the entire programme. They were also made aware that it was a result sharing and intervention on issues identified during the baseline survey and household observation. Mothers were excited but wondered what it would look like. The team (researcher, research assistant and community volunteer) told the group that it would be a knowledge sharing experience hence; they themselves had some of the answers. It was also made known that most of the things they would hear were not new but were known issues that were often overlooked but have an effect on their ID and health. Only few issues would be new to them, this made mothers relax. The session then began with a prayer from one of the participants.

The key messages card was used as a guide on themes to be discussed. All mothers were given copies of this guide to enable them see the pictures and follow what was being discussed.

The introduction to ID was given as the concept of the blood being important for every function of the body but that iron is needed for the blood formation and iron is obtained from food. Any process that lead to blood loss (menstruation, injury, and worm infestation), spoiling of blood (malaria), or inadequate intake (vomiting, diarrhea, nutrient interaction, and inadequate iron in food or inadequate enhancers of iron absorption) lead to ID. The risk of tea intake and the importance of the timing of its intake in relation to meals were also discussed.

The second session continued right after the first session. It started with 28 mothers. Most mothers had already been to the venue and decided to wait; this made them looked more tired than the previous group. This session also started with anthropometry and then later and introduction to the training programme. It ended just around the time the call for prayers came in at 1pm. Most mothers were happy to close at this time so that they could go for prayers.

The third session started after the afternoon prayers (2pm). The mothers were 16 and their anthropometry and that of their children also repeated.

In all, 62 mothers where present for the first day training. A total of 10 mothers were reported to have travelled to Accra or Kumasi for the kayayie. Kayayie is an exodus of young/sometimes old people to the southern part of Ghana during the dry season (no farming activities take place) to work as porters and luggage carriers in order to obtain some money. In one (I) incident the child in the study died but the mother reported for the training, since the mother was already pregnant and had a child she was made to take part in order to use the knowledge to support her other children. In another case a mother in the study died but a carer who was an aunt to be the child came in with the child. Though this pair would not be considered for the evaluation of the study, they were told to sit in, so that the carer could help the child with the knowledge acquired from the intervention. One mother had relocated and 8mother were within the village but were not present for the days programme, the community volunteer said they had gone to the farm.

Each group nominated a group leader and this leader was responsible for coordinating the activities in the group.

Intervention Day 2

A total of 61mothers were present during the three sessions of the day. Each session began with a revision from the discussions of the previous day. Mothers who answered questions correctly were promised a gift the next day. The first theme to be discussed for the day was the need to report to the health center for advice on contraceptives. Most mothers were able to answer questions posed to them; however a few mothers were shy to express themselves during the sessions.

The session then began with discussions on contraceptives. The contraceptives that may improve ID like the pill and some that may cause excessive monthly menstrual bleeding like the intra-uterine device (IUD) were discussed. This phenomenon of heavy and/or prolonged bleeding may lead to ID if there is no replacement of iron lost. The other theme discussed was on the need for good hygiene, hand washing, especially during occasions like weddings and naming ceremonies. During these occasions, one bowl with water is used as the central hand washing site. Mothers were sensitized on the need to use running water so that the occasion does not become a "dirt/germ sharing" session. The proper hand washing technique was illustrated by the researcher by the washing of hands with soap and running water poured on from a cup. Hand washing was rarely done during household observation. This is to help make sure that the hand is thoroughly washed. When the hand is not thoroughly washed there is the risk of diarrhea which prevents access to iron in food among other nutrients. Malaria also lead to "death of blood cells" and so weeding over grown weeds around the house and emptying stagnant waters especially from the bathroom gutters reduce breeding of mosquitoes. For mothers who have mosquito treated bed nets, they were entreated to sleep in mosquito nets to reduce risk of malaria. Energizers (activities) were used to keep mothers active after the discussion of each theme.

Intervention Day 3

A total of 64 mothers were present in all three sessions of the day. All sessions started with revisions from the past two days thus linking the food sources and causes of ID to the hygiene practices that affect ID. All mothers who answered their questions correctly were given a price of a cake of soap. This made mothers more excited about the session and promised to answer more questions during the next revision.

The session for the day began with the theme on pica as a risk factor and also as a sign of ID. Other risks of pica were shared with mothers such as constipations and lead poisoning. The craving of pica substances however is also a sign of ID. Mothers therefore had these two associations on pica to take home. Some other signs like angular stomatitis, koilonychias (spoon nails) and atrophied tongues were shared with mothers and sample pictures shown in their cards. The risk of worms in clay or the germs that may cause ID were used to illustrate the risk to ID.

Feeding the child using the plate model as a guideline was also discussed. For all three sessions in the day, the plate model was used to illustrate, variety and food proportions in meals. A plate was used to illustrate this by dividing it into two parts with a marker and the second half into two, thus half of the plate should be filled with vegetables stew or soup since the raw vegetable is not their typical diet and fruits. The first quarter of the others half should be used for TZ, Banku or rice all of which are carbohydrate food and the last quarter filled with meat, fish, organ meat or the meat replacers such as beans, soya beans and groundnut.

The last theme for each session was the discussion of the other risk factors that affect ID. Mothers were encouraged to report to the health centre when pregnant. The importance was to weigh mothers and to make sure everything is fine and to be advised on the right foods to eat to enhance a healthy pregnancy, especially regarding ID. It is also important to give birth in the hospital to manage bleeding, identify low birth weight (LBW) children, and also help with guidance on breast feeding. The universal food fortification information was discussed with mothers. Mothers were promised to be shown the logo for fortified foods on the last day. The mothers were encouraged to de-worm themselves and their children every three months to reduce exposure to worms. Each session ended with a summary of all three themes.

A discussion on the activities for day 5 with group leaders and the community volunteer was done after the last session of the day. All foods that required extensive preparation of the materials for cooking like the corn flour, wean mix for children, corn dough, groundnut/soya paste were divided among mothers to start preparing ahead in time. Money for the raw materials/ ingredients was provided for purchases to be made.

Intervention Day 4

The theme of day was to discuss the myths, misconceptions, and half-truths regarding ID and pica. These were collected during the baseline survey. A total of 62 mothers reported for the session 1, 11 and 111. In all 21 (11mothers gone to farms and 10 mothers gone on kayayie) mothers were absent for this days discussions.

One of the misconceptions that lead to a long discussion was the thought that hard work causes ID. Most mothers stressed this as a matter of fact. An invention to illustrate and help them discard this thought was done by putting a bottle with water and close tightly to represent the human body with blood, and then shaken vigorously this activity represented hard work, the mothers were asked whether the shaking of the water representing the blood affected the quantity or quality of the water. This illustration helped mothers understand the concept that hard work does not lead to ID.

Another misconception which mothers argued about was that eggs, milk and malt lead to improved iron status. This was discarded by one participant with a negative deviant attitude. She shared her experience with the other mothers that when she gave her child milk and malt drink it did not improve the ID but when she started putting dried fish powder in soup with green vegetables upon advice by a nurse; this improved the child iron status. Mothers thought the color of the malt drink meant it contained blood forming nutrients. Another mothers shared her experience on her malnourished child. According to her, she took the child to the health centre and was advised to give the child eggs, fish and vegetables, with time the child improved in weight and his hair color became darker. So she believes that the eggs “give blood”. The explanation on the role of variety was reiterated and mothers were told that the eggs contain protein which helps in the development of the hair, nails, muscle hence is important in the diet but it is not a good source of iron.

The thought that meat, fish and eggs are sweet according to the mothers made them think that if a child is used to eating them, when they go out they may beg for or steal if they find them, this they said is embarrassing. This analogy was thrown back to mothers to look at it from a different view. That the fear of embarrassment and the heath of the child which was more important to them. This helped mothers make an easy choice and agreed that it was more important for the child to grow healthily.

Also to test if mothers understood the concepts of ID and pica, three scenarios were given to them to identify who was more vulnerable to ID;

If a man and a woman both eat the same food, with inadequate iron, and are in the same conditions which of them would develop ID first and why?

This was to assess if the mothers understood the channels of iron losses and vulnerability to ID. Mothers were able to identify that the woman had monthly menstrual flow, so she would be the first to develop ID under the same conditions.

If two women are living in the same conditions, one is pregnant, and the other is not, which of them would be the first to have ID and why?

This question was to assess their understanding of the channels of iron losses or need. The discussion that ensued helped to understand that mothers had a better idea as to how ID developed. This was because some mothers chose the pregnant mother and their reason was that her need for ID increases with the development of her fetus. Another group also said the non-pregnant mother since she still had her monthly menstrual flow and the pregnant mother does not, hence the non-pregnant woman is more vulnerable. A consensus was reached that the pregnant mother be more vulnerable since she needs more iron but may be vomiting food she eats thus she may not be getting as much iron from the food she eats compared to her non-pregnant counterpart. This discussion was very encouraging to observe since mothers were discussing the concept of vulnerability, need of iron and iron losses as causes of ID.

If there are three children, one has malaria, the other has worms and the last does not eat iron rich food, which of them is more vulnerable to ID?

In this scenario, mothers were split in their choices and those who chose the child with worms explained that the worms suck blood; another group said malaria "spoil" the blood and the last groups chose the one who did not eat iron rich food. When asked who thought they were all right, over 50% said yes. At least every mother voted for one. This scenario was also to test if mothers understand the causes of ID.

The mothers enquired if raw eggs were rich in iron. The risk of diarrhea from raw eggs was discussed even when eggs is fried. They were told that cooked eggs are a good source of protein which helps the child or an individual to grow well. Another mother asked if contraceptives (pills) can cure infertility. This was answered on the negative, since the essence of contraceptives was rather to lead to infertility if taken well.

The mothers also asked if it is true that supplements given to pregnant women lead to big babies and difficulty in giving birth. Though this had been perceive in other areas where supplementation of pregnant women takes place, there is no scientific evidence as yet. The Team therefore implored mothers to take supplements when given. According to mothers this perception leads to women collecting supplements and throwing them away.

On the misconceptions regards pica

This discussion in itself was to help identify if mothers understood the previous days discussions on the causes of pica. The discussion theme was that pica should not be seen as an associated with among pregnant women but also as a disease condition which develops when ID is not treated was one of the themes. The mothers however still agreed that people who practice pica did it because of their own personal interest and that children should be caned to stop. The research team then likened pica to any disease condition; when one is sick, does canning take the sickness away? When a child is sick and is not treated, growing does not make the sickness go away either. Mothers themselves then nodded in agreement. A mother said a pregnant woman ate a lot of clay during pregnancy and when she gave birth there was clay in the child's eyes and nose or so they thought. This was refuted as it is not physiologically possible.

On the treatment of pica, one mother said the alternative treatment for pica was to burn the feces from a fowl with the clay (pica substance) and eat them together. According to the said mother, that was how her pica was treated. This practice was however discouraged since we earlier discussed the risk of diarrhea from feces of a foul on eggs due to the presents of staphylococcus, and that diarrhea deprives its patient from absorbing the iron from the food. This session ended on an exciting note. Mothers were encouraged to continue to ask questions if they had any even after the sessions.

Intervention Day 5

This was the day all theoretical discussions were made practical. A total of 68 mothers were present for this session Mothers were made to cook six types of foods with fortificants. The fortificants were iron rich food sources used to enrich foods to help mothers improve the iron quality of diets. The following foods from the table below were cooked by all three groups and all ingredients provided for by the researcher.

Mothers were also advised not to throw away stocks from vegetables but utilize them in food preparation or add little water to vegetables to avoid throwing away essential nutrients. Over cooking of vegetables was also discouraged. When vegetables (greens) are overcooked they turn brown which means that some of the nutrients are lost like the vitamin C which is needed for iron absorption from the food. The picture of the universal fortification of flour and oil was shown to mothers. Mothers were then divided into sub-groups (six in each group) to cook the various foods.

Table 13.13: Table showing foods that was prepared on Day 5

Meal	Fortificant	ingredients	Processing
Porridge Millet + fish powder Wean mix (maize+ beans+ groundnut) porridge	Groundnut Fish Beans	Maize, millet, spices, groundnut, fish, beans and salt	-Maize+ groundnut + beans roasted to brown in the ratio 2:1:1 and ground together into a powder. -Millets is ground when dry with spices and made into dough to ferment and then later, ground fish powder added when cooking in order to prepare the porridge.
Rice with stew -Rice and beans with tomato sauce -Rice and with Amaranth stew.	Amaranth (alefu) Fish powder Dawadawa (bean based condiment) Beans Meat	Rice, tomatoes, oil, onions, fish powder, Alefu, beans and meat	-Frying vegetables into a sauces serving it with plain rice or as a combination of rice and beans
Banku with groundnut soup	Groundnut, Soyabeans, fish powder, red meat, dawadawa (bean based condiment)	Maize (dough) Groundnuts Tomatoes Onions Soya beans, dawadawa	Maize (soaked overnight and ground wet and then made into a dough and allowed to ferment) Groundnut made into paste by roasting ground and soya beans (1:2) and grinding them together

Tuo-zaafi and vegetable soup -groundnut soup + bra - ayoyo soup	Ayoyo, Bra, Groundnut, Soyabeans, fish powder, red meat, Organ meant, Dawadawa	Maize (corn flour) Ayoyo, Bra, fish powder, organ mean, oil	Maize soaked overnight, ground wet and dried in the sun, when dry flour is grinded again in fine flour. Groundnut made into paste by roasting ground and soya beans (1:2) and grinding then together
Tubani with oil	Soya beans Cowpea Fish powder Groundnut powder	Beans flour Soya flour Fish powder Oil Groundnut cake flour	Beans/Soya de-whorled, dried and ground into powder Groundnut cake pounded into powder
Apaparansa (yama) Corn flour cooked in soup	Dawadawa (bean based condiment) Fish powder	Corn flour, tomatoes, oil, onions, and fish powder	Maize soaked overnight, ground wet and dried in the sun, when dry flour is grinded again in fine flour.

After the session the mothers were asked to describe the processing methods, foods prepared and then identify the fortificants in each meal. This was very exciting for both the mothers and the research team since they shared the preparation methods and identified the iron rich foods that they were taught. Foods were shared among mothers and a fruit (orange) each was added as a source of vitamin C. Mothers were congratulated on their participation with a file each to carry their key messages card, consent forms and other documents. The session ended in a joyous mood with every mother having at least three samples of food. Since the day was a market day for the community, mothers soon left to prepare for the market which usually starts at 3pm. They also had to prepare to start the 30-day Muslim fasting.

Attendance

The attendance was as follows;

53mothers from the sample participated fully thus were present for all 5 days

2mothers from the pilot wanted to be part and they participated actively.

8mothers attended for 4 days,

4mothers were present for only 3 days,

2mothers were present for 2 days.

2mothers were present for just 1day: 1 came on only the last day and the other on the first day.

2mothers never attended though they were present in the community.

10 mothers had travel of which 1 had relocated and 9 went for kayayie.

Follow-up

Follow-up were done in mothers households to help mother's fresher the intervention themes and help apply them to their individual household. This was done two weeks after the interaction using the follow up sheet in Appendix 12. This was also repeated two weeks later. During the visit, four mothers had returned from the kayayie trip. Mothers had more one-one interaction with the researcher since it was within their households. Mothers asked more questions during these sessions. They however could remember most of the themes discussed during the intervention. The most questions were asked on contraceptives, complementary feeds and the treatment of water.

Most mothers had been able to apply at least one theme within their household. The hygiene practices especially washing of hands was reported to be practiced more. Other family members were also involved since in some households others shared the changes the mothers had discussed with them.

The most reported challenge as reason why mothers did not implement some practices was financial constraints. One woman reported this during a visit to hers household as "*Now we know that fish can added to our children's food to give blood but we don't have the money to buy it every day. And the fish is so expensive.*" Mothers were reminded of other cheaper options like beans, soya beans, and groundnut to help improve the nutritional content of the food. They were also reminded that some of the discussed issues like hygiene practices, sanitations and sleeping in mosquito nets if they were provided with one, are not expensive. Mothers complained that vegetables during the dry season were very scarce and expensive. They proposed an irrigation dam to help them grow vegetables during the dry season. They think that this could even reduce their exodus to the south during this period. Full report of the follow-up household visitation is Appendix 13.

Conclusions

The mothers started the intervention with many questions in their heads on ID and ended with more answers on ID and the relationship between ID and pica. The discussions on the scenarios and misconceptions revealed that most mothers were better informed about ID then than before the intervention. However the individual assessments were a better assessment of the intervention since we could compare the baseline data to the mothers' characteristic after the intervention.

For the body to form healthy blood and healthy brains it needs iron. Healthy blood is needed to make you strong and able to do your work and play and also to think clearly and concentrate. Any blood loss steals iron from the body – which is why women who menstruate are vulnerable to ID, and why worms "steals blood from the body" and malaria that makes the blood "sick" all cause ID and later anemia. This is also why children whose blood and brains are still growing are vulnerable (mothers were asked the following; where would the body get iron that it needs from?). Iron is found in some foods that we eat (mothers gave examples).

"Iron deficiency or "blood not enough" is caused by the low iron supply to the body. This may be because there is either not enough iron in the food eaten, the body is not able to extract the iron due to a problem with the intestines, or because there are factors, nutrients or "chemicals" within the food that prevent iron from being taken up by the body. Therefore, when you eat food with iron, your body is not able to provide food that prevents your body from absorbing it. Malaria and worm infestation can also cause anemia and ID because they also make the blood sick or worms make the body lose blood."

Anyone can have anemia however, children, pregnant women and adolescents are the most common people to have ID. This is because they lose blood or need it to grow. Hence if they do not eat many of the foods to improve iron they not have enough.

In Ghana out of every 100 women who can have children, 59 of them have anemia and in the Northern region the number is the same. Among children, out of every 100 children in Ghana, 78 have anemia. Within the Northern region, for every 100 children, 81 of them are affected (GDHS, 2008). However, because ID takes a long time to be recognized, a lot more women and children may be affected (GDHS, 2008).

Symptoms of ID

How do we see that a mother or a child has ID? The person with ID feels:

Mostly feels weak, tired and sleepy most of the time.

The inside of the lower eyelids appear pale

The inside of the palm and nail beds is pale.

Prevention of ID

ID is preventable. In order to be protected from ID, foods rich in iron are meat, chicken, spinach, beans, fish, groundnuts and also fresh fruits both domestic and wild.

Prevent infection of worms and malaria.

Effects of ID

In children, their brain may not develop well and they always feel tired and hence they would not do well in school.

Among mothers, they feel tired and cannot work effectively, if they get pregnant the child maybe smaller for the age during birth or both mother and child could die.

If adolescents especially girls have ID, they would be less productive in school and when they get pregnant, they may have ID and pass it on to their children.

The following themes were identified as associated with ID but were problems within the community from the baseline survey. The effort is to help mothers know what is being done right and/or wrong and how to improve their health.

Appendix 12: Follow-up sheet

Follow-up Sheet
Name of Mother ……………………………………………………………………..……………….
Name of Child ……………………………………………………………………..……………….
Mothers ID……………………………………………………………………….…….…………..

DAY 1

1. What do you remember from discussions in the intervention?

Comment …………………………………………
……………………………………….……………
……………………………….……………………
……………………………………….……………

2. How have you been able to apply it?

Comment ………………………………………
…………………………..……………………
…………………………………..……………
…………………………………..……………

3. What challenges are you facing?

Comment ………………………………………
……………………………..…………………
…………………………………..……………
………………………………..………………

DAY 2

1. What do you remember from the discussions in the intervention?

Comment ……………………………………………………
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………………………………………….………………
………………………………………….………………

2. How have you been able to apply it?

Comment ……………………..………………………………
………………………………………….………………
……………………………………….…………………
……………………………………….…………………

3. What challenges are you facing?

Comment
……………………………….……………………………
…………………………..…………………………………
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Appendix 13: Report from household visits

Introduction

The household visitation was done two weeks after the 5-day education program was implemented. This stage was done two times for all 70 households who were present at the intervention. The visitations were also two weeks apart. Each mother was visited in her household asked three questions using a follow-up sheet in Appendix 12: The questions were to find out if mother remembered any of the education messages, if she was able to implement any message and if she encountered any challenges while implementing the messages any existing challenges that prevented her from practicing the education messages. All household visitations were done by the researcher and an assistant.

The mothers recall of education messages from intervention

In the first visit most of the mothers could remember the key messages on pica practice as a risk factor for ID, that tea intake may interfere with foods and so time should be allowed between tea intake and meal time. Most of the mothers could also remember that some contraceptives may enhance irons in the body especially some pill that are coated with iron to be taken on the days of menstruations. Though no mother could remember all ten messages each mother remembered at least three of the education message.

During the second round of visitations the mothers could still remember at least three of the education messages. Each visit lasted about 10-15 minutes.

Reported implemented messages

Compared to the number of messages recalled, fewer motihers reported having implemented messages. Some reported adoption included allowing time between tea intakes which was observed to be common with meals; increased frequency of hand washing with soap, reduce time of cooking vegetables compared to before the intervention; try to add more beans to their foods.

Some mothers also reported preventing their children form eating the clay unlike before. A mother reported preparing the weanix for the entire household and this was confirmed by other family remembers and the remaining flour was shown to the team who visited. Mothers were encouraged to implement the messages and the education messages were reiterated to the mother. Any questions the mother had regarding of implementation and further clarification of the messages were addressed during the visit. This was done during both visits.

Reported challenges in implementation

Some reported challenges included meat is expensive to provide for their large family sizes. Fish is also expensive for mothers. Another mentioned that the vegetables are easier to obtain but also seasonal. Others insist no changes though they did not report implementing any of the messages.

Observations

The mothers were excited about the visits and in most cases other family members showed interest in the recall process. Some re-echoed what she told them she learnt. This was however not universal. Men in some households also showed interest in the project since they asked questions like “you only talk to the women how about us.” There were also a few families were I could see they supported the mothers in the implementation of messages especially messages on environmental cleanliness, frequent hand washing and clearing all stagnant water around which may become breeding grounds for mosquitoes.

Conclusion

The household visitation served as refresher of education messages for the mothers. It helped mothers to personalize the messages in their own households and to ask questions which they were no able to ask during the general class.

Appendix 14: Report of nutrition education programme implementation in the control community

Introduction

After the implementation and of the designed intervention, an evaluation showed some positive effects on the KAP of mothers regarding pica and other known risk factors of ID. As stated in the protocol of this study, since both communities are in endemic communities, ethics requires that the control community is given some benefit of the research. The implementation of the intervention was therefore repeated in the control community to help improve the KAP on known risk factors identified in the selected communities.

Arrival

This community comprised of two villages; 56 in the Tugu and 24 in Tugu-yepala. Participants in the Tugu-yepala had to be transported to join participants in Tugu. In attendance were 70 mothers.

Venue and Logistics

By 10: am all the participants had gathered in the school in the communities. The group leaders chosen from a prior meeting with participants earlier in the week were given money to mobilize selected foodstuff for the program. Fresh vegetables were procured on the day of the intervention from an irrigation site (using stream water) between the two communities.

Before the session began all participants and their babies were weighed and their heights/lengths measured.

Implementation

Nutrition Education- the 4 page key messages cards were distributed to all mothers. The same facilitator who translated the intervention to Dagbani was present to translate all messages from English to Dagbani. The 5-day nutrition education programme was boxed into a days. The introduction to iron deficiency was given, the various themes in were discussed according to the following order;

1. *Intake of fruits, organ and fleshy meat intake in ID*
2. *Intake of tea and the timing of tea intake*
3. *The role of contraception; spacing, use of IUD and pills in ID*
4. *Treatment of malaria; environment, personal hygiene and washing*
5. *Pica as a risk factor for ID*
6. *Pica as an indicator for ID*
7. *Complementary feeding in ID risk areas*
8. *Other risk factors; home delivery (high antenatal visited and also high home deliveries)*
9. *Myths and misconceptions regarding ID and pica.*
10. *Demonstration of cooking methods; plate model, protein foods, and the use of fish powder in complementary foods.*

The importance of demonstration session was explained to the mothers and the mothers were divided into groups.

Practical Session

The groups were provided with the ingredients all obtained from the community to start the food preparation. There were six groups, each groups was responsible for the preparation of one of the six foods in the table used for the intervention community, shown in table 20. These foods included the following:

- Porridge using millet and porridge using combinations of roasted corn, beans and groundnut blend.
- Rice with soya- amaranth sauce and rice mixed with beans
- Banku with groundnut + okra soup
- Tuo-zaafi with groundnut soup
- Tubani with oil
- Appapransah/ yama

The cooking session took another 3 hours to complete. The mothers were made to re-converge as a group and each two mothers from each group presented the food prepared to the other participants stressing the iron food sources used to fortify the food prepared in order to increase iron consumption and bioavailability.

Conclusion

This group of mothers was eager to participate and learn. Time limitation was however a challenge. Three mothers who were no part of the study wanted to join the team and it was difficult to turn them away. Since this session was educational, they were allowed to join the team however, their data was not used. The intervention is better to be implemented in the five-day period to allow mothers to ask more questions and be allowed enough time for refresher of the course content.

SUMMARY OF THE STUDY

Impact of an education intervention addressing known risk factors for iron deficiency among mothers and their young children in Northern Ghana

When anemia prevalence in a population is above 40%, as is the case in Northern Ghana among children (81%) and women of reproductive age (59%), it may be assumed that the entire population suffers from some degree of iron deficiency (ID). This study aimed to assess the socio-demographic profile, nutritional status, and knowledge, attitude and practices (KAP), regarding known risk factors for ID/anemia and pica, among mothers and their children six to 59 months old in Northern Ghana; and to design, implement and evaluate a nutrition education programme (NEP) to address the gaps identified at baseline.

A questionnaire on socio-demographics, household food production, food frequencies, household food security (CHIPP index), and three 24-hour recalls, KAP regarding pica (excessive craving/eating of food and/or non-food substances) and ID were administered via structured interviews; and BMI and Z-Scores were assessed among non-pregnant mothers with children (six to 59months) in Tolon-Kumbungu district (Gbullung (n=81 mothers; 85children) and Tamale metropolitan (Tugu & Tugu-yepala (n=80) mothers; 90 children). Dietary intakes were analysed with the *Ghana Nutrient Database*® (Version 6.02). Iron intakes were assessed by the probability method at 5% and 10% bioavailability, and vitamins A, B$_{12}$, folate and vitamin C intakes were evaluated in relation to estimated average requirements (EAR) cut-points. Data was analysed with SAS® version 16.0.

At baseline the mean age for mothers was 33.0 ± 8.3 years. Most were from the Dagomba ethnic group; practiced the Muslim religion (98.1%), and were married (97.5%) in polygamist marriages. Over 90.0% had no formal education. More than half the households were food insecure. A usual daily intakes consisted of (of maize meal (*tuo zaafi* (*TZ)*) (mostly whole) 96.2%), green leafy vegetables (7%) (mostly *amaranth* leaves), shea butter and tea. Legumes and nuts were included on a weekly basis and meat, eggs and citrus fruits occasionally. Children had basically the same

dietary patterns. Based on 24-hour recall, inadequate intakes of protein (30%), and vitamin B_{12} (94.4%) were observed. Similarly, inadequate intake of vitamin A (58.5%), vitamin B_{12} (98.2%), and vitamin C (21.3%) were observed for children. Mean fibre intakes were 47.8 ± 19.0 among mothers and 19.8 ± 13.9 g/day among children. At an assumed bioavailability of 5% , 80.3% of mothers and 67.3% of the children, had probable inadequate intakes of iron. A tenth of mothers were underweight and 11.3% overweight/obese. About half of children (47.3%) were stunted (≤-2SD), 38.0% (≤-2SD) underweight, and 17.2% (≤-2SD) wasted. The knowledge scores of the mothers were below average regarding sources of iron and enhancers of iron absorption. Pica practice was reported among 16.8% of mothers and 9.0% of children; and among 29.3% of pregnancies with the index children; mostly for clay, kola nuts and soil. A child's current pica practice was significantly associated (p=0.002) with his/her mother's pica practice when she was expecting him/her. Mother's views on pica were mostly negative and they thought it was untreatable.

Gaps identified from the baseline survey, were summarised into 10 themes, and translated into key messages presented in July, 2013, as a 5-day (90 minutes/day) NEP in the Tolon-Kumbungu district, while Tamale Metropolis was the control.

Three months after the intervention (attrition: 20 mothers, 23 children), the data collection were repeated in both the original groups of mothers. For both mother and children inadequate intakes of vitamins A, B_{12}, protein and iron persisted. BMI, HAZ and WHZ decreased from baseline in both groups with a significantly higher ($p<0.05$) decrease in the intervention group. A significant improvement in total score on knowledge of iron sources and iron absorption enhancers was observed in both the intervention ($p<0.0001$) and control ($P=0.0016$) groups. Hand washing was the most practiced key message. Financial constraint and lack of social support was the main challenges to behavioural change. Post-intervention 12.8% of mothers in the intervention group mentioned anemia/ID as a possible cause of pica, and 7.1% stated that when you treat ID/Anemia, pica may also be treated compared to 1.4% in the control group.

Conclusion: A context specific NEP on ID and pica improved the knowledge on iron sources, and mother's ability to associated pica with ID, but did not improve nutrient intake or anthropometry at three months post intervention.

OPSOMMING VAN DIE STUDIE

Impak van 'n opvoedkundige intervensie om bekend risikofaktore vir ystertekort onder moeders en hul jong kinders in Noord-Ghana aan te spreek.

Wanneer die voorkoms van anemie in 'n bevolking bo 40%, soos in Noord-Ghana die geval is onder kinders (81%) en vroue van reproduktiewe ouderdom (59%), kan dit aanvaar word dat die hele bevolking aan 'n mate van ystertekort ly. Hierdie studie het gepoog om die sosio-demografiese profiel, voedingstatus en kennis, houdings en praktyke (KHP), ten opsigte van bekende risikofaktore vir ID / bloedarmoede en pika te evalueer, onder moeders en hul kinders van ses tot 59 maande oud in Noord-Ghana; ‘n 'n voeding onderwys program te ontwerp, te implementer, en te evalueer om die die gapings geïdentifiseer by basislyn te spreek

'n Opname mbv ‘n gestruktureerde vraelys insluitende vrae mbt sosio-demografie, huishoudelike voedselproduksie, gewoontlike dieet, huishoudelike voedselsekuriteit (vlg CHIPP indeks), drie 24-uur herroepe, en KHP rakende pika (oormatige drang na / eet van nie-eetbare stowwe) en ystertekort; asook opnames van LMI en Z-tellings, is onder nie-swanger moeders met kinders (ses tot 59 maande) in die Tolon-Kumbungu distrik (in Gbullung (81 moeders, 85 kinders) en in die Tamale Metropool (in Tugu & Tugu-yepala (80 moeders; 90 kinders) uitgevoer. Dieetinnames is met die *Ghana Nutrient Database*® (weergawe 6.02) ontleed. Ysterinname is mbv die waarskynlikheidsmetode teen 5% en 10% biobeskikbaarheid geevalueer, en vitamiene A, $B_{12,}$ C, folaatinname is mbv geskatte gemiddelde vereistes (EAR) afsnypunte geëvalueer. Data is ontleed met SAS® weergawe 16.0.

By basislyn was die gemiddelde ouderdom vir moeders 33.0 ± 8.3 jaar. Die meeste was van die Dagomba etniese groep; het die Moslem-godsdiens (98,1%) beoefen, en was getroud (97,5%) in poligamiese huwelike. Meer as 90.0% het geen formele opleiding gehad nie. Meer as die helfte van die huishoudings het nie voedselsekuriteit gehad nie. Gewone daaglikse inname het meestal uit onverfynde mieliemeel (tuo zaafi (TZ)) (96.2%), groen blaargroentes (7%) (meestal amarantblare),

shea-botter en tee bestaan. Peulgewasse en neute is op 'n weeklikse basis ingesluit en vleis, eiers en sitrusvrugte slegs per geleentheid. Kinders het basies dieselfde dieetpatrone getoon. Gebaseer op 24-uur herroep, is onvoldoende inname van proteïen (30%) en vitamien B12 (94.4%) waargeneem. By kinders is onvoldoende inname van vitamien A (58,5%), vitamien B_{12} (98,2%), en vitamien C (21.3%) waargeneem. Gemiddelde veselinname was 47,8 ± 19.0 g/dag onder moeders en 19.8 ± 13.9 g/dag onder kinders. Met 'n veronderstelde biobeskikbaarheid van 5%, het 80,3% van die moeders en 67.3% van die kinders, waarskynlik onvoldoende yaterinname gehad. 'n Tiende van moeders was ondermassa en 11.3% oormassa / vetsugtig. Ongeveer die helfte van die kinders (47,3%) was groei-ingekort (≤-2SD), 38.0% (≤-2SD) ondermasssa, en 17.2% (≤-2SD) uitgeteer. Die kennistellings van die moeders was onder gemiddeld tov bronne van yster en faktore wat ysterabsorpsie bevorder. Pika is onder 16.8% van die moeders en 9.0% van kinders aangemeld; en onder 29.3% van swangerskappe met die indekskinders; meestal vir klei, kola neute en grond. 'n Kind se huidige pika-praktyk het beduidend verband gehou ($p = 0,002$) met sy / haar ma se pika-praktyk toe sy hom / haar verwag het. Moeder se standpunte oor pika was meestal negatiewe en hulle het gedink dit was onbehandelbare.

Gapings wat uit die basislynopname geïdentifiseer is, is opgesom in 10 temas, en tot sleutelboodskappe verwerk, wat in Julie 2013, as 'n 5-dag (90 minute/dag) voedingsonderrig-intervensie in die Tolon-Kumbungu distrik geimplimenteer is, met die Tamale Metropolis as kontrol. Drie maande na die intervensie (uitval: 20 moeders, 23 kinders), is die data-insameling in beide die oorspronklike groepe moeders herhaal. Vir beide die moeder en kinders, is onvoldoende inname van vitamiene A, B_{12}, proteïen en yster volgehou. BMI, HAZ en WHZ het vanaf basislyn afgeneem in beide groepe, maar die afname was beduidend hoër ($p <0.05$) in die intervensie groep. ‘n Beduidende verbetering in totale kennistelling mbt ysterbronne en faktore war ysterabsorpsie verbeter, is in beide die intervensie- ($p <0.0001$) en kontrole- ($p = 0,0016$) groepe waargeneem. Hande-was, was die sleutelboodskap wat die beste deur die intervensiegroep opgeneem is. Finansiële beperking en die gebrek aan sosiale ondersteuning was die belangrikste uitdagings vir gedragsverandering. Post-intervensie het 128% van die moeders in die intervensiegroep anemie /

ystertekort as 'n moontlike oorsaak van pika genoem, en 7.1% het gesê dat wanneer anemie / ystertekort behandel word, pika sal verdwyn.

Gevolgtrekking: 'n Konteks-spesifieke voedingsonderig-intervensie het kennis rakende ysterbronne en die moeder se vermoë om pika met ystertekort te assosieer, verbeter, maar het nie ‘n beteknisvolle affek op voedingstofinname of antropometrie teen drie maande post-intervensie gehad nie.