NUTRITIONAL STATUS OF PATIENTS WITH TUBERCULOSIS AND TB/HIV CO-INFECTION AT STANDERTON TB SPECIALISED HOSPITAL, MPUMALANGA

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DECLARATION

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Janke Wessels

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LIST OF ABBREVIATIONS

AIDS	-	acquired immune deficiency syndrome
ART	-	antiretroviral therapy
ASSAf	-	Academy of Science in South Africa
BCG	-	bacille Calmette–Guérin
BMI	-	Body Mass Index
CCHIP	-	Community Childhood Hunger Identification Project
CEO	-	Corporate Executive Officer
CI	-	confidence intervals
cm	-	centimetre
CRP	-	C-reactive protein
DOTS	-	Directly Observed Therapy, Short-course
E	-	Ethambutol
ECUFS	-	Ethics Committee of the Faculty of Health Sciences, University of the Free State
EPTB	-	extra-pulmonary tuberculosis
g/dl	-	gram per decilitre
g/kg	-	gram per kilogram
g/l	-	gram per litre
H	-	Isoniazid
HBCs	-	high burden countries
HIV	-	Human Immunodeficiency Virus
IUATLD	-	International Union against Tuberculosis and Lung Disease
kcal/kg	-	kilocalorie per kilogram
kg	-	kilogram

kg/m^2	-	kilogram per metre square
MCT	-	medium-chain triglycerides
MCV	-	mean corpuscular volume
MDR TB	-	multi-drug resistance tuberculosis
mm	-	millimetre
mm^3	-	cubic millimetre
mg/l	-	milligram per litre
ml/kg	-	millilitre per kilogram
M. tb	-	Mycobacterium tuberculosis
MUAC	-	Mid-upper arm circumference
MUST	-	Malnutrition Universal Screening Tool
NFCS	-	National Food Consumption Survey
NHNES	-	National Health and Nutrition Examination Survey
OR	-	odd ratio
PHREC	-	Provincial Health and Research Ethics Committee
PLHIV	-	people living with HIV/AIDS
ppr	-	person per room
R	-	Rifampicin
REE	-	resting energy expenditure
S	-	Streptomycin
SADoH	-	South African Department of Health
SANHANES	-	South African National Health and Nutrition Examination Survey
SANTA	-	South African National Tuberculosis Association
TB	-	Tuberculosis

TST	-	tubercle skin test
UDHR	-	Universal Declaration of Human Rights
UFS	-	University of the Free State
vs.	-	versus
WFP	-	World Food Programme
WHO	-	World Health Organization
XDR TB	-	extremely-drug resistance tuberculosis
Z	-	Pyrazinamide
%	-	percentage
>	-	greater than
<	-	less than
≥	-	equal to or greater than
≤	-	equal to or less than

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SUMMARY

Tuberculosis (TB) is a leading cause of morbidity and mortality, especially in middle- and low-income countries. Globally, an estimated 2 billion people are infected with TB, of which 1 billion are malnourished. TB is strongly influenced by nutritional status, with nutrition interventions being likely to impact on prevalence of active disease, response to drug therapy and quality of life.

The aim of this study was to determine the nutritional status of patients with TB and TB/HIV co-infection. A convenience sample of a 100 hospitalised patients in Standerton TB Specialised Hospital, Mpumalanga, were included (60 men and 40 women). Socio-economic status, nutritional status (focusing on eating related side effects, food security, anthropometric measurements, overall risk of malnutrition and biochemical parameters), and lifestyle behaviours (smoking habits and alcohol use), as well as associations between the above were determined.

Food security was determined by means of the Community Childhood Hunger Identification Project (CCHIP) tool (that includes questions related to food insecurity, food shortages, perceived food insufficienty or altered food intake due to constraints on resources). Weight and height were obtained to calculate body mass index (BMI), while mid-upper arm circumference (MUAC) and triceps skinfold were taken to determine malnutrition and muscle wasting. The overall risk of malnutrition was determined by means of the Malnutrition Universal Screening Tool (MUST) (which calculates the overall risk of malnutrition by making use of a BMI score, a weight loss score and an acute disease score). Biochemical parameters were recorded from patient files. Socio-economic status included gender, age, marital status, education level, employment status, household income and housing density. Lifestyle factors included smoking habits and alcohol use. These variables were determined by means of a questionnaire completed by the researcher in a structured interview with each participant.

The majority of participants (91%) did not complete matric and two thirds (66%) were unemployed. More than one out of ten participants (12%) indicated that they had no monthly income and in 64% of households, only one person contributed to the monthly income. Room density of more than 2.5 persons per room (crowded) was present in 29% of households. Only 26% of participants reported having a household vegetable garden. As far as household food security was concerned, only 3% were classified as food secure with 27% of households being at risk of hunger and 70% being food insecure (hungry).

The food related side effects reported most commonly included loss of appetite (59%) followed by dry mouth (48%). According to the MUST, the overall risk for malnutrition was as follows: 70% had a high risk, 22% had a medium risk and 8% had a low risk. Actual unplanned weight loss and percentage of unplanned weight loss were significantly higher in patients with TB and HIV co-infection than in patients with TB only (95%

CI [1.5%; 38.2%] and [5.3%; 51.0%] respectively). Median BMI was in the underweight category at 18.3 kg/m². Half of participants (51%) had a MUAC in the low category, while half (49.9%) had triceps skinfold measurements below the 15th percentile, indicating malnutrition. The majority of participants had albumin and haemoglobin values below the normal ranges (79% and 92% respectively).

Almost six out of ten participants (58%) indicated that they were former (44%) or current (14%) smokers. The average cigarettes, pipes or cigars smoked by the former and current smokers were 4 with a maximum of 20 per day. The average amount of years that the former or current smokers smoked was 9 years with a minimum of 1 year and a maximum of 30 years. Nearly half of participants (49%) reported that they did use alcohol with 25% drinking alcohol more than three times per week. Statistically significantly more females than males were non-smokers and more men drank alcohol three times or more per week than females. Participants that indicated that they were either former or current smokers had significantly lower levels of education than participants who were non-smokers (95% CI [-26.7%; -2.6%] and [-39.9%; -1.0%] respectively). There were no statistically significant differences in terms of BMI in smokers versus non-smokers.

In the present study, the nutritional status of patients with TB and TB/HIV co-infection was found to be poor. They were characterised by poor socio-economic status, high levels of food insecurity, malnutrition (underweight, anaemia and hypoalbuminaemia) and poor lifestyle habits (smoking and alcohol use).

Recommendations to address the poor nutritional status of patients with TB and TB/HIV co-infection should include relief of poverty in communities, a focus on relevant and culturally acceptable nutrition education and the establishment of sustainable support networks.

OPSOMMING

Tuberkulose (TB) is ‘n hoofoorsaak van siekte en sterftes, veral in middel en lae inkomste lande. Wêreldwyd het ongeveer 2 biljoen mense TB, waarvan 1 biljoen wangevoed is. TB word sterk beïnvloed deur voedingstatus, dus speel voedingsintervensies heel moontlik ‘n belangrike rol in die voorkoms van aktiewe TB, die reaksie op medikasie en lewenskwaliteit.

Die doel van hierdie studie was om die voedingstatus van pasiënte met TB en TB/MIV ko-infeksie te bepaal. ‘n Gerieflikheidsteekproef van 100 gehospitaliseerde pasiënte by Standerton TB Hospitaal is ingesluit (60 mans en 40 vroue). Sosio-ekonomiese status, voedingsstatus (met fokus op newe effekte wat verband hou met voedselinname, voedselsekuriteit, antropometriese inligting, risiko vir wanvoeding en biochemiese merkers), en leefstyl veranderlikes (rookgewoontes en alkoholinname), asook verbande tussen veranderlikes is bepaal.

Voedselsekuriteit was bepaal deur middel van die *Community Childhood Hunger Identification Project* (CCHIP) (wat vrae insluit oor voedselsekuriteit, voedseltekorte, siening oor voedseltekort en verlaagde voedselinname as gevolg van beperkte voedselbronne). Massa en lengte was gemeet om liggaams-massa indeks (LMI) te bepaal en bo-arm omtrek en trisepsvelvou was geneem om wanvoeding en spierwegkwyning te bepaal. Die risiko vir wanvoeding was deur middel van die *Malnutrition Universal Screening Tool* (MUST) bepaal (bereken die totale risiko vir wanvoeding deur te kyk na die LMI, massaverlies en akute siekte). Biochemiese merkers was geneem vanuit die leêrs van pasiënte. Sosio-ekonomiese status het geslag, ouderdom, huweliksstatus, vlak van opvoeding, werkstatuss, huishouding se inkomste en kamerdigtheid ingesluit. Leefstylfaktore het rookgewoontes en alkoholinname ingesluit. Hierdie veranderlikes is bepaal deur middel van ‘n vraelys wat deur die navorser voltooi is in ‘n gestruktureerde onderhoud met elke deelnemer.

Die meerderheid van deelnemers (91%) het nie matriek voltooi nie en twee derdes (66%) was werkloos. Meer as een uit tien deelnemers (12%) het aangedui dat hulle geen maandelikse inkomste het nie en in 64% van huishoudings, dra slegs een persoon tot die maandelikse inkomste by. Kamerdigtheid van meer as 2.5 persone per kamer (oorbevolking) was teenwoordig in 29% van huishoudings. Slegs 26% van deelnemers het aangedui dat hulle ‘n groentetuin by die huis het. Met betrekking tot voedselsekuriteit, was slegs 3% van huishoudings geklassifiseer in die katogorie van voldoende voedselsekuriteit, 27% het ‘n risiko gehad vir swak voedselsekuritiet en 70% het geen voedselsekuriteit gehad nie (honger).

Die newe effekte wat veband hou met voedseliname wat die meeste gerapporteer was, was ‘n verlies aan aptyt (59%) gevolg deur ‘n droë mond (48%). Volgens die MUST, was die risiko vir wanvoeding soos volg: 70% het ‘n hoë risiko gehad, 22% ‘n medium risiko en 8% het ‘n lae risiko gehad. Onbeplande massaverlies

sowel as die persentasie van opbeplande massaverlies was betekenisvol hoër in pasiënte met TB en MIV ko-infeksie as wat dit in pasiënte met slegs TB was (95% VI [1.5%; 38.2%] en [5.3%; 51.0%] onderskeidelik). Mediaan LMI was in die ondergewig kategorie van 18.3 kg/m². Die helfte van deelnemers (51%) het lae bo-arm omterk afmeetings gehad terwyl die helfte (49.9%) trisepsvelvou-afmeetings van onder die 15de persentiel gehad, wat wanvoeding aandui. Die meerderheid van deelnemers het albumien en hemoglobien waardes onder die normale waardes gehad (79% en 92% onderskeidelik).

Naastenby ses uit elke tien deelnemers (58%) het aangedui dat hulle vorige (44%) of huidige (14%) rokers was. Die gemiddelde aantal sigarette of pype wat per dag deur die vorige of huidige rokers gerook was, was 4 met ‘n maksimum van 20. Die gemiddelde aantal jare wat die vorige of huidige rokers gerook het was 9 jaar met ‘n minimum van 1 jaar en’n maksimum van 30 jaar. Bykans die helfte van deelnemers (49%) het aangedui dat hulle alkohol inneem, met 25% wat alkohol meer as drie keer per week inneem. Statisties betekenisvol meer vroue as mans het nie gerook nie en meer mans het alkohol drie of meer keer per week ingeneem as vroue. Deelnemers wat aangedui het dat hulle vorige of huidige rokers was, het betekenisvolle laer vlakke van opvoeding gehad as deelnemers wat aangedui het dat hulle nie rook nie (95% VI [-26.7%; -2.6%] en [-39.9%; -1.0%] onderskeidelik). Daar was geen statistiese betekenisvolle verskil in terme van LMI tussen rokers en nie-rokers nie.

Die voedingstatus van pasiënte met TB en TB/MIV ko-infeksie in hierdie studie was oor die algemeen swak. Hulle was gekenmerk deur swak sosio-ekonomiese status, hoë vlakke van swak voedselsekuriteit, wanvoeding (ondermassa, anemie, hipoalbumienemie) en swak leefstylgewoontes (rookgewoontes en alkoholinname).

Aanbevelings om die swak voedsingstatus van pasiënte met TB en TB/MIV ko-infeksie aan te spreek sluit verligting van armoede in gemeenskappe, fokus op toepaslike en kulturele aanvaarbaarde voedingsonderrig en die stig van volhoubare ondersteuningsnetwerke in.

KEYWORDS

Tuberculosis

Nutritional status

Poverty

Food security

Malnutrition

Lifestyle habits

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Contents

CHAPTER 1

INTRODUCTION

1.1 Background

"Interventions and innovations, scientific discoveries, incredible advances in technology – even with all this, there are still more than 2 billion people infected with TB in the world, 9 million new TB cases every year and 1.3 million die every year. Sadly, 3 million are missed by health systems and they do not have access to proper diagnosis, treatment, follow up and the care that they deserve and need". This statement was made by Dr. Lucica Ditiu, Executive Secretary of the Stop TB Partnership in 2014. It is almost impossible to comprehend that a disease that has existed for more than 2000 years is still a major health challenge in 2016.

Tuberculosis (TB) is an infectious disease by when the *Mycobacterium tuberculosis (M. tb)* organism entering the lungs. TB can also spread through the bloodstream manifesting as extra-pulmonary TB that affects almost any organ, including: the genitourinary tract, lymph nodes, bones, brain etc. (Lombardo *et al*., 2012: 132; Escott-Stump, 2008: 303; Spencer, 2005: 107).

The World Health Organization (WHO) estimates that globally 33% of people are infected with *M. tb*. However, only 10% of those infected with *M. tb* will develop active TB disease (WHO, 2013a). Certain risk factors can increase an individual's chances of developing active TB. These factors include poor nutritional status, diabetes, smoking, alcohol abuse, human immunodeficiency virus (HIV) infection, cancer or renal disease (Lombardo *et al.,* 2012: 180; Mueller, 2012: 782; Frieden *et al*., 2003: 887).

Symptomatic patients most commonly present with fever, a productive cough in the case of pulmonary TB (lasting longer than two weeks), and night sweats. Other symptoms may include chest pain, haemoptysis, enlargement of the lymph nodes, chills, shortness of breath, exhaustion, loss of appetite, anorexia, pallor and weakness. Weight loss is common and is most likely caused by a combination of a reduction in appetite and increased energy expenditure as part of the inflammatory and immune response (Escott-Stump, 2008: 304; Oldewage-Theron & Fuller, 2008: 659; Hopewell *et al.*, 2006: 710; Williams, 2006: 51; Spencer, 2005: 109; Frieden *et al.,* 2003: 888).

Anti-tuberculosis medications (Isoniazid, Rifampicin, Pyrazinamide, and Ethambutol) were introduced in the 1940's and 1950's (Marra *et al.,* 2004: 58). However, despite the availability of treatment, WHO declared TB as a "global health emergency" in 1993 (MacPherson *et al.,* 2014: 126; McConnell & Hargreaves, 2013: 285). In 2000 Karyadi *et al.* (2000: 720) stated that TB is on the increase throughout the world. In the year 2000 there were an estimated 8-9 million new cases of TB and in 2002 the figure was 8.8 million (Villamor *et al.,* 2006: 163). Two decades later, TB is still a major challenge and is ranked as the second leading cause

of death from an infectious disease after HIV infection, killing approximately two million people per year. In 2011, the WHO estimated that there were 8.7 million new cases of TB and 1.4 million deaths due to TB disease (Frediani *et al.*, 2013: 1024; Miyata *et al*., 2013; Gill *et al*., 2013: 984; Frieden *et al*., 2003: 889; Karyadi *et al*., 2000: 2954). In 2013, the WHO estimated that there were 9 million new cases of TB and 1.5 million deaths due to TB disease (WHO, 2013). Frieden *et al*. (2003: 889) stated that unless TB is controlled throughout the world, it will continue to be a major cause of death in developing countries and it will remain a threat in developed countries.

The impact of TB cannot be isolated from the HIV epidemic, since the two diseases fuel each other (Bloem & Saadeh, 2010). The incidence of TB in Africa has increased mostly as a result of HIV infection (Frieden *et al*., 2003: 888; Semba *et al*., 2010). The WHO estimates that 66% of people with TB disease in South Africa are co-infected with HIV (SANTA, 2014; WHO, 2013). Nelson Mandela's words on July 15, 2004 were: *"We cannot win the battle against AIDS if we do not also fight TB. TB is too often a death sentence for people with AIDS. It does not have to be this way. We have known how to cure TB for more than 50 years. What we have lacked is the will and the resources to quickly diagnose people with TB and get them the treatment they need."*

TB and HIV are both diseases causing wasting amongst the infected and co-infection has severe negative consequences on the nutritional status (Friis, 2006: 1849; Paton *et al.*, 2003: 321). In certain developing countries like South Africa, Botswana, Zambia and Zimbabwe, the prevalence of TB and TB/HIV co-infection exceeds 60%. TB is also the most frequent opportunistic infection in patients with HIV living in developing countries (Escott-Stump, 2008; Marra *et al*., 2004:58; Paton *et al*., 2003: 322). Co-infection with TB and HIV has had a significant impact on global health as well as on, social, political and economic outcomes (ADA, 2010).

The consequences of TB on the individual level and on the public health sector cannot be ignored. Against the background of malnutrition, TB could contribute to serious public health setbacks. These setbacks can have a tremendous impact on individual, community and national well-being (Wallis *et al*., 2013: 366; Escott-stump, 2008; Naude *et al.*, 2008). The necessity for governments of countries experiencing a high TB burden to increase financial, political and social commitment is greater than ever (Mwaba *et al*., 2011: 824). In addition to the many research gaps in the field of TB, the need for nutritional research is becoming more evident by the day (Cegielski & McMurray, 2004: 297; Van Lettow *et al.*, 2004: 61; Van Lettow *et al*., 2003: 87; Karyadi *et al*., 2000: 2926).

1.2 Prevalence of TB

1.2.1 TB: A global perspective

The WHO estimates that over 4 000 people die of TB every day and 3 million TB cases are missed by health care systems (WHO, 2015). The TB burden is most significant in developing countries, with developed countries having the lowest TB prevalence. The incidence of TB in Australia and Northern Italy, which are both developed countries, is among the lowest in the world, with respective rates of 6 and 7.6 cases per 100 000 of the population (Facinni *et al*., 2013: 486; Gill *et al*., 2013: 985).

TB is one of the top killers of women, with 300 000 global deaths among HIV-negative women and 200 000 deaths among HIV-positive women in 2011 (Miyata *et al*., 2013). TB is a major challenge in poor developing countries, contributing to as many as 95% of all deaths (WHO, 2013). India, Indonesia, Pakistan, China and Bangladesh together account for more than half of the global TB burden. According to a Household Health Survey that was undertaken in Indonesia in 1995, TB ranked second among the leading causes of death. India had an incidence of 185 cases per 100 000 of the population in 2010 (Bhargava *et al*., 2013). Globally there has been a 45% decrease in TB deaths since 1990. However, even with that progress, 1.3 million people died of TB and 8.6 million people were diagnosed with TB in 2012 (WHO, 2013). In 2014, even higher rates were reported with an estimated 9.6 million people diagnosed with TB and 1.5 million TB deaths (WHO, 2015).

1.2.2 TB in Africa

The African Region is the only region which is not on track with the WHO Millennium Development Goal that has set a target to reduce the incidence of death caused by TB by half between 1990 and 2015 (MacPherson *et al.*, 2014: 128). In 2012 27% of all TB cases were diagnosed in Africa (WHO, 2013). Sub-Saharan Africa has the highest incidence of TB with a 290 per 100 000 infection rate (Frieden *et al*., 2003: 891; Karyadi *et al*., 2002: 724). According to the WHO (2013) and the South African National Tuberculosis Association (SANTA) (2014), South Africa is one of the countries with the highest TB burden in the world. South Africa has the third highest incidence of TB with only India and China having higher figures (WHO, 2013). In 2004, South Africa had the highest incidence of TB in Africa with an estimated rate of 718 cases per 100 000 of the population. In 2009 the incidence rate increased to 971 cases per 100 000 of the population (Lombardo *et al*., 2012: 185). The figure increased to over a 1 000 cases per 100 000 of the populating in poor communities in the Western Cape of South Africa. Since 2010 there has been a slight reduction in the TB incidence per 100 000 people with 948 in 2010, 922 in 2011, 892 in 2012, and 860 in 2013.

In South Africa, the TB epidemic is also fuelled by the HIV pandemic, with almost 7 million people infected by HIV. Individuals infected with HIV have an increased risk of becoming infected with TB and an estimated 60% of patients with TB in South Africa are HIV-positive. In 2014 89 000 TB deaths were reported in South

Africa, of which 64 000 were HIV co-infected. South Africa also had a fourfold increase in TB case numbers over the last twenty years, mainly driven by the fast spread of HIV (Nieburg & Angelo, 2015: 5-6; Louwagie *et al*., 2014: 501).

Independent of the HIV burden in South Africa, the TB and TB/HIV co-infection situation is even more complex than that in most other lower- and middle-income countries. South Africa faces many other challenges including poverty, the stagnating economic situation, stigma and discrimination against people with TB disease, and the two class health system (state and private) that cannot adequately address the basic health needs of the larger more vulnerable population (Nieburg & Angelo, 2015).

1.3 Factors that impact on TB

1.3.1 Socio-economic status

Socioeconomic factors impact heavily on the rate of TB infection in a country. These include poverty, over crowding, unemployment, malnutrition, and inadequate health facilities. These factors do not only increase the incidence of TB, but also increase the chances of treatment failure. According to the SANTA, the incidence of TB is especially high amongst males, miners, migrants, prisoners, the elderly, refugees and internally displaced persons, substance users, homeless persons, the poor and the very young groups in South Africa (SANTA, 2014; Chee *et al.,* 2013: 205; Songpol *et al*., 2005: 221).

Food insecurity is a socio-economic factor that plays an important role in the progression of TB infection to active TB disease (Bloem & Saadeh, 2010). Rudolph *et al*. (2013) have reported that 96.5% of adult males and females with TB disease in South Africa experience food insecurity (defined according to Bloem & Saadeh (2010) as difficulties with food utilisation, availability or access). In an attempt to optimise nutritional status and health care for the community and the individual, food and nutritional security are essential factors to consider (ADA, 2010).

1.3.2 Nutritional status

Proper nutrition plays a vital role in supporting the health and quality of life of people with HIV and TB disease (ADA, 2010). The immune function and nutritional status are closely related (Macallan, 1999: 743). According to Rudolph *et al*. (2013) malnutrition is a serious global health problem that is often least addressed by public health programmes. Neither current WHO guidelines for treatment of TB, nor the 17 International Standards of Tuberculosis Care, address the importance of under-nutrition or nutritional support during treatment (Bhargava *et al*., 2013; Hopewell *et al*., 2006: 710-725).

According to the WHO, a low body mass index (BMI) (< 18.5 kg/m^2) is the best predictor of weight-related morbidity. The relationship between TB and BMI has been studied by several researchers (Bhargava *et al*., 2013; Rudolph *et al.,* 2013; Lombardo *et al*., 2012: 183; Lönnroth *et al*., 2010: 181; Semba *et al*., 2010;

Villamor *et al*., 2006: 168; Cegielski & McMurray, 2004: 288; van Lettow *et al*., 2003: 84; Karyadi *et al*., 2000: 725; Kennedy *et al*., 1996). A BMI below the lower cut off point (<18.5 kg/m²) is an established indicator for energy deficiency (Lönnroth *et al*., 2010). Systematic reviews by Lönnroth *et al.* (2010:181) and Cegielski & McMurray (2004: 288) have reported that malnutrition (defined using BMI) is an important risk factor for the progression of underlying TB infection to active TB disease. Rudolph *et al*. (2013) reported that the average BMI in adult South African males and females with TB is 19.2kg/m² (normal) and 23.3kg/m² (normal), respectively. Despite the fact that the BMI of South African females are within the normal range it is still lower than that of the general population, who are often overweight or obese. Villamor *et al*. (2006: 168) performed a cross-sectional study in adults with pulmonary TB co-infected with HIV and found that the lean body mass was low. Kennedy *et al*. (1996) used BMI to assess the nutritional status of 148 patients in Tanzania who presented with active TB. They found that malnutrition manifested before and after treatment for TB. Several cross-sectional studies have confirmed a lower BMI in adults with TB disease together with an increased risk for mortality and micronutrient deficiencies (Lombardo *et al*., 2012: 183; Semba *et al*., 2010; van Lettow *et al*., 2003: 84; Karyadi et al., 2000: 725).

In addition to BMI, mid-upper arm circumference (MUAC) is commonly used to determine the nutritional status of adults (Tang *et al*., 2013). Singla *et al*. (2010) and Karyadi *et al*. (2000: 725) found significantly higher proportions of patients with very low MUAC (<20cm) among TB-treated patients from India and Indonesia. A case control study that was conducted in Indonesia also reported that patients with TB had significantly lower skin fold measurements, which is an indication of malnutrition (Karyadi *et al*., 2000: 725).

The Academy of Science of Southern Africa (ASSAf) refers to malnutrition and TB as the so-called "chicken vs egg conundrum". This is because malnutrition may predispose to TB and TB also causes malnutrition. The ASSAf has identified the top three epidemics in 2007 as being HIV infection, TB infection and malnutrition and called it the "three concurrent epidemics". HIV and TB are caused by disease organisms, namely the human immunodeficiency virus and the Mycobacterium tuberculosis bacteria respectively. The third epidemic, malnutrition, is a consequence of these two disease states (ASSAf, 2007). Thus HIV, TB and malnutrition result in a vicious cycle, with the one epidemic exacerbating the other. Van Lettow *et al*. (2003: 81) refer to HIV, TB and malnutrition as "triple trouble".

Malnutrition has been described in patients with TB by several researchers (Bhargava *et al*., 2013 ; Frediani *et al*., 2013: 1026; Villamor *et al*., 2006: 169; van Lettow *et al*., 2004: 61; Frieden *et al*., 2003: 895; Karyadi *et al*., 2000). Both malnutrition and HIV infection are associated with an increased risk of progression from latent TB infection to active TB disease, because of the negative impact that dietary deficiencies have on cell-mediated immune response (Lönnroth *et al*., 2010: 152; Semba *et al*., 2010; Cegielski & McMurray, 2004:

296). TB very often results in poor dietary intake, nutrient deficiencies, malnutrition and wasting (Cegielski & McMurray, 2004: 296; van Lettow *et al.*, 2004: 61; Paton *et al.*, 2003: 322).

1.3.3 Lifestyle behaviours

Lifestyle factors that are strongly associated with the development of TB infection and progression to TB disease, include the use of tobacco and alcohol. Smoking is associated with underweight in the general population (Wack & Rodin, 1982). PrayGod *et al.* (2013) found that patients with TB that smoke, weighed less and had more fat mass than fat-free mass compared to those that did not smoke. Cigarette smoking is also associated with an increased lifetime risk for TB infection (Saad & Tirkey, 2013). Peltzer (2014) found that factors such as male gender, a high incidence of poverty and lower level of education, were strongly associated with tobacco and alcohol use among patients with TB. Coetzee *et al*. (1988: 353) found that households reported problematic alcohol consumption were more likely to develop TB.

1.4 Problem statement

South Africa is one of the countries in Africa with the highest burden of TB and HIV co-infection. It is a well-known fact that TB infection is associated with wasting and micronutrient deficiencies, however, information about the impact of nutritional status on increase TB risk and manifestation of the disease is still limited. Treating hospitalised TB patients may be challenging due to the increased rates of MDR TB, which may also be part of the disease-malnutrition viscious cycle. For this reason, the current study will aim to evaluate the nutritional status of patients with TB at Standerton TB Specialised Hospital, Mpumalanga, South Africa. Information gathered from this study will contribute to the identification of specific areas that need to be focused on in nutrition interventions. This might ultimately play a vital role in improving the outcome, quality of life and prognosis of patients with TB.

1.5 Aims and objectives

1.5.1 Aims

The main aim of the study was to determine the nutritional status of adult patients with TB and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga.

1.5.2 Objectives

In order to achieve the aim, the following objectives were determined:

1. Socio-economic status (gender, age, marital status, education level, employment status, household income and housing density)
2. Nutritional status:
    2.1 Eating related side effects and food security

2.2 Anthropometric measurements (body mass index (BMI), mid-upper arm circumference (MUAC), Triceps skinfold)

2.3 Overall risk of malnutrition

2.4 Biochemical parameters (total protein, albumin, C-reactive protein (CRP), CD 4 cell count, mean corpuscular volume (MCV), haemoglobin)

3 Lifestyle behaviours (smoking habits and alcohol use).

4 Associations among variables listed in sub-aims 1- 3.

1.6 Outline of thesis

Chapter 1: Introduction. Chapter 2: TB and TB/HIV co-infection. Chapter 3: Methodology. Chapter 4: Socio-demographic profile and household food security of patients with TB, and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga. Chapter 5: Nutritional status of patients with TB, and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga. Chapter 6: Smoking habits and alcohol use of patients with TB, and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga. Chapter 7: Conclusions and Recommendations.

CHAPTER 2
TB AND TB/HIV CO-INFECTION

2.1 Introduction

TB affects many people globally, impacting on health, nutrition, food security and socioeconomic development. Even though TB is a curable disease, in 2014 alone there were 1.5 million TB related deaths worldwide (WHO, 2015). Chapter two highlights current literature on the aetiology, pathophysiology, clinical presentation, diagnosis, management (medical and nutritional) and prevention of TB and TB/HIV co-infection.

2.2 Epidemiology of TB and TB/HIV co-infection

Mycobacterium tuberculosis (*M. tb*) was first discovered in 1882 by Dr. Robert Koch. At that time, TB was responsible for the death of every one out of seven persons living in Europe and the United States. A century later, in 1982, the first World TB Day was announced and sponsored by the WHO and the International Union against Tuberculosis and Lung Disease (IUATLD) (GBTI, 2015).

Globally, TB is the leading cause of death and the second leading cause of death from infections after HIV (UNAIDS, 2014). Approximately one-third of the world population, an estimation of more than 2 billion people, are infected with *M. tb*. TB prevalence and mortality rates have dropped with 40% and 47% respectively since 1990 (WHO, 2015). The global incidence of TB was the highest in 2003 with a mortality rate that peaked at 1.8 million people (Horsburgh *et al*., 2012; Frieden *et al*., 2003: 887). An estimated 1.6 million deaths occurred from TB disease in 2005 (USAID, 2008). In 2014, an estimated 9.6 million people worldwide were diagnosed with TB disease, but only two-thirds (63%) were reported to the WHO (WHO, 2015). Mortality rates due to active TB disease are expected to increase to five million by the year 2050. The main reasons for this increase include increasing poverty, the spread of HIV/acquired immune deficiency syndrome (AIDS), population growth, poor health care systems and TB management, socioeconomic factors, TB drug resistance and unreliable funding of TB prevention and treatment programmes (USAID, 2008; ASSAf, 2007).

The epidemiology of TB differs greatly around the world. The highest rates of TB (100 per 100 000 population or higher) occur in sub-Saharan Africa, India, China, and the islands of Southeast Asia and Micronesia. It is estimated that fifty percent of adults in sub-Saharan African and South and South-East Asia are infected with TB. Moderate rates of TB (26 to 100 cases per 100 000 population) occur in Central and South America, Eastern Europe, and northern Africa. Low rates (less than 25 cases per 100 000 population) occur in the United States, Western Europe, Canada, Japan, and Australia (USAID, 2014; Horsburgh *et al*., 2012). *Figure 2.1* illustrates the estimated new cases of TB per 100 000 population globally. This figure clearly indicates that Africa and more specifically South-Africa has a high burden of TB.

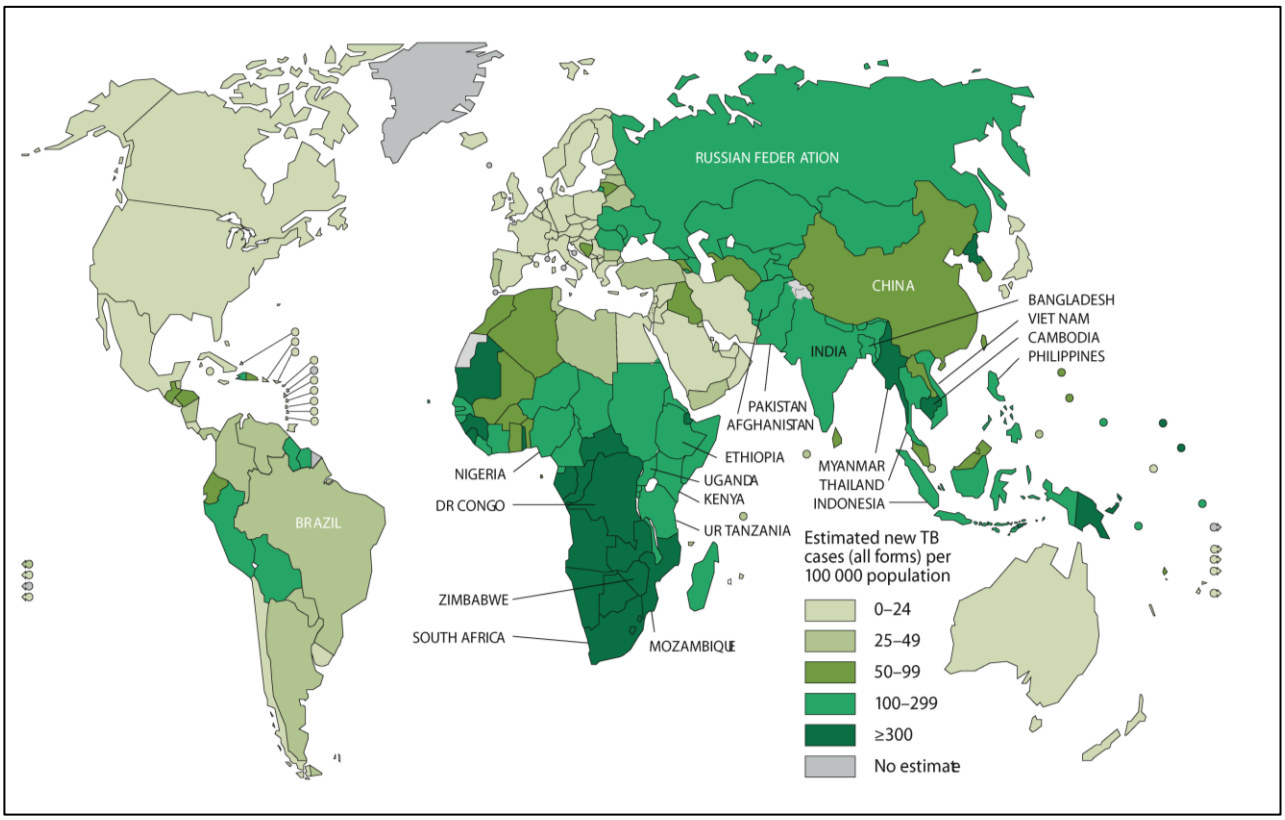

Figure 2.1 Estimated new TB cases globally during 2010 (WHO, 2011)

An estimated 70% of persons with TB disease are co-infected with HIV (Amollo, 2009). Worldwide, an estimated 12% of new adult TB cases in 2014 were infected with HIV. Sub-Saharan Africa has the highest incidence rate of 290 cases per 100 000 population. An estimated 8% of new TB cases occur in 22 high-burden countries (HBCs) (WHO, 2015; Frieden *et al*., 2003: 887).

The estimated TB burden in South Africa during 2014 is shown in *Table 2.*1, while the TB/HIV co-infection statistics are shown in *Table 2.2*. Among the HBCs, South Africa has the third highest reported incidence and fifth highest estimated prevalence (undiagnosed) TB cases. When adjusting for population size, South Africa does not only have the highest number of HIV-associated TB cases but also the highest incidence and prevalence of TB among the HBCs (Churchyard *et al*., 2014: 244).

Table 2.1: Estimated TB burden in South Africa during 2014 (WHO, 2015)

	Number (thousands)	**Rate (per 100, 000 population)**
Mortality (excludes HIV+TB)	24 (22-26)	44 (41-48)
Mortality (HIV+TB only)	72 (58-89)	134 (107-164)
Prevalence (includes HIV+TB)	380 (210-590)	696 (390-1088)
Incidence (includes HIV+TB)	450 (400-510)	834 (737-936)
Incidence (HIV+TB only)	270 (240-310)	509 (439-584)
Case detection, all forms (%)	68 (61-77)	

Table 2.2: Estimated TB/HIV co-infection burden in South Africa during 2014 (WHO, 2015)

	Number	**Percentage**
TB patients with known HIV status	295 136	93
HIV-positive TB patient	179 756	61
HIV-positive people screened for TB	1148 477	

Drug resistance is also a major contributor to the growing TB epidemic. In 2014 there were a total of 480 000 MDR-TB cases, but only 123 000 were detected and reported. Globally 20% of previously treated TB cases and 3.3% of new TB cases had MDR TB. In 2014 alone, 190 000 people died from MDR TB and 14% more patients started on MDR-TB treatment than in 2013. Globally only 50% of MDR TB patients were successfully treated in 2014 (WHO, 2015). In many parts of the world, multi-drug resistant TB (MDR TB) is increasing, especially in Asia and Africa. MDR TB is difficult to treat and the cure rate for MDR TB patients is less than 50% (Evian, 2003: 257). According to Nieburg & Angelo (2015), South Africa is at risk of becoming a country in which the TB pandemic becomes dominated by MDR TB.

2.3 Aetiology and pathophysiology of TB

Risk factors for becoming infected with TB disease may be divided into an impaired immune status and increased exposure to infection (Horsburgh *et al*., 2012). The risk of acquiring TB in poor developing countries, such as South Africa, is often high due to socio-economic factors such as poverty and food insecurity (ASSAf, 2007), while the most commonly reported risk factor in developed countries, such as the United States, is substance abuse (Horsburgh *et al*., 2012).

The genetic factors that make some people more susceptible to *M. tb* are poorly understood. A receptor on human dendritic cells, called DC-SIGN, has common polymorphisms that are less common in African than

in Eurasian populations. This receptor seems to be associated with significant protection against the development of active TB disease (ASSAf, 2007). Even though associations between TB susceptibility and genetic polymorphisms differ vastly according to ethnic origin, the extent to which genetic polymorphisms contribute to the global TB burden is unclear because of the difficulty of separating genetics from environmental influences (Frieden *et al*., 2003: 889).

M. tb belongs to the genus Mycobacterium that includes more than 50 other species. TB is defined as a disease caused by members of the *M. tb* complex. One unique feature of this organism is the presence of the cell envelope, which differs from the gram negative bacteria. Mycobacterium has no true outer membrane, but is composed of a core of three macromolecules linked to each other and a lypopolysaccharide, which is thought to be attached to the plasma membrane (Riley *et al*., 2012).

The easiest way for TB to enter the body is through inhalation of a very small number of droplet nuclei containing virulent tubercle bacilli. As mycobacteria require an environment high in oxygen, the lungs and kidneys are good examples of target organs. In healthy individuals, the bacilli are inhaled, but the organism may be inactivated before an immune response is induced. The immune response controls the replication of the bacilli and the individuals remain disease free until some immunosuppressive event (e.g. HIV) later in life induces the reactivation of TB (ASSAf, 2007: 98). Thus, disease progression depends on a person's health status, immune system and the number of infected bacilli. The larger the number of infected bacilli and the weaker the immune system, the more likely it is that a person will develop active TB (Shi & Sugawara, 2013: 128).

Four stages of clinical manifestation can be identified, including; latency, primary disease, primary progressive disease, and extrapulmonary disease (Shi & Sugawara, 2013: 128; Frieden *et al*., 2003: 888). Sites apart from the lungs that can also be infected include the lymph nodes, pleural cavities, pericardium, peritoneum, meninges, vertebral bodies and synovial tissue of other joints. Multi-organ involvement including the liver, spleen, lungs and bone marrow may also occur (Churchyard & Corbet, 2008: 438).

Extra-pulmonary TB (EPTB) occurs in more than twenty percent of patients. Lymphatic TB is the most common EPTB (Leeds *et al*., 2012). The most serious location for EPTB is the central nervous system, where infection may result in meningitis which is often fatal. Mycobacterial infection of the blood stream may also be fatal (Shi & Sugawara, 2013:129). TB can affect any joint or bone. The spine is the most common bony structure involved, with the thoracic location in the spine most often affected (Frieden *et al*., 2003: 889). Patients with lower CD_4 cell counts (<100 cells/µl) are more likely to develop EPTB than pulmonary TB. Sutariya *et al*. (2015: 75) found that peripheral lymph node TB was more common in females than in males, and the mortality rate among individuals with EPTB was higher than in individuals with pulmonary TB.

The tubercle bacilli begin to multiply in the alveolus and are attacked and ingested by alveolar macrophages at the same time. This is known as the initial phase of primary infection. Although some tubercle bacilli will be destroyed, the macrophages are non-specifically activated and some tubercle bacilli will survive and replicate within the macrophages. Usually, the infection is later brought under control by activated macrophages and T-lymphocytes (Pratt, 2003: 128). Phagocytosis of *M. tb* can occur through alveolar macrophages, epithelial cells, dendritic cells and neutrophils (Shi & Sugawara, 2013: 129). Cytokines are responsible for the high fever, weight loss and acute phase response that are commonly seen in patients with active TB disease. Malnutrition and nutrient deficiencies may affect immunity, leading to increased susceptibility to active infection (Frieden *et al*., 2003: 888).

Latent infection with *M. tb* is defined by the presence of an *M. tb* specific immune response in the absence of active TB (Chee *et al*., 2013: 205). Active TB develops in only 5-10% of individuals exposed to the *M. tb* (Shi & Sugawara, 2013: 129). Several factors can trigger the development of active TB infection to reactive TB disease. While HIV is the greatest single risk factor, other medical conditions may also compromise the immune system and predispose to development of active disease. These include poorly controlled diabetes mellitus, renal failure, underlying malignant disease, chemotherapy, extensive corticosteroid therapy, malnutrition and vitamin D or A deficiency. When individuals with active TB cough, sneeze, sing, or speak they can generate infectious droplets that transmit the TB infection (Nunes-Alves *et al*., 2014; Shi & Sugawara, 2013; ASSAf, 2007: 97; Frieden *et al*., 2003: 888). *Figure 2.2* illustrates the pathogenesis of TB.

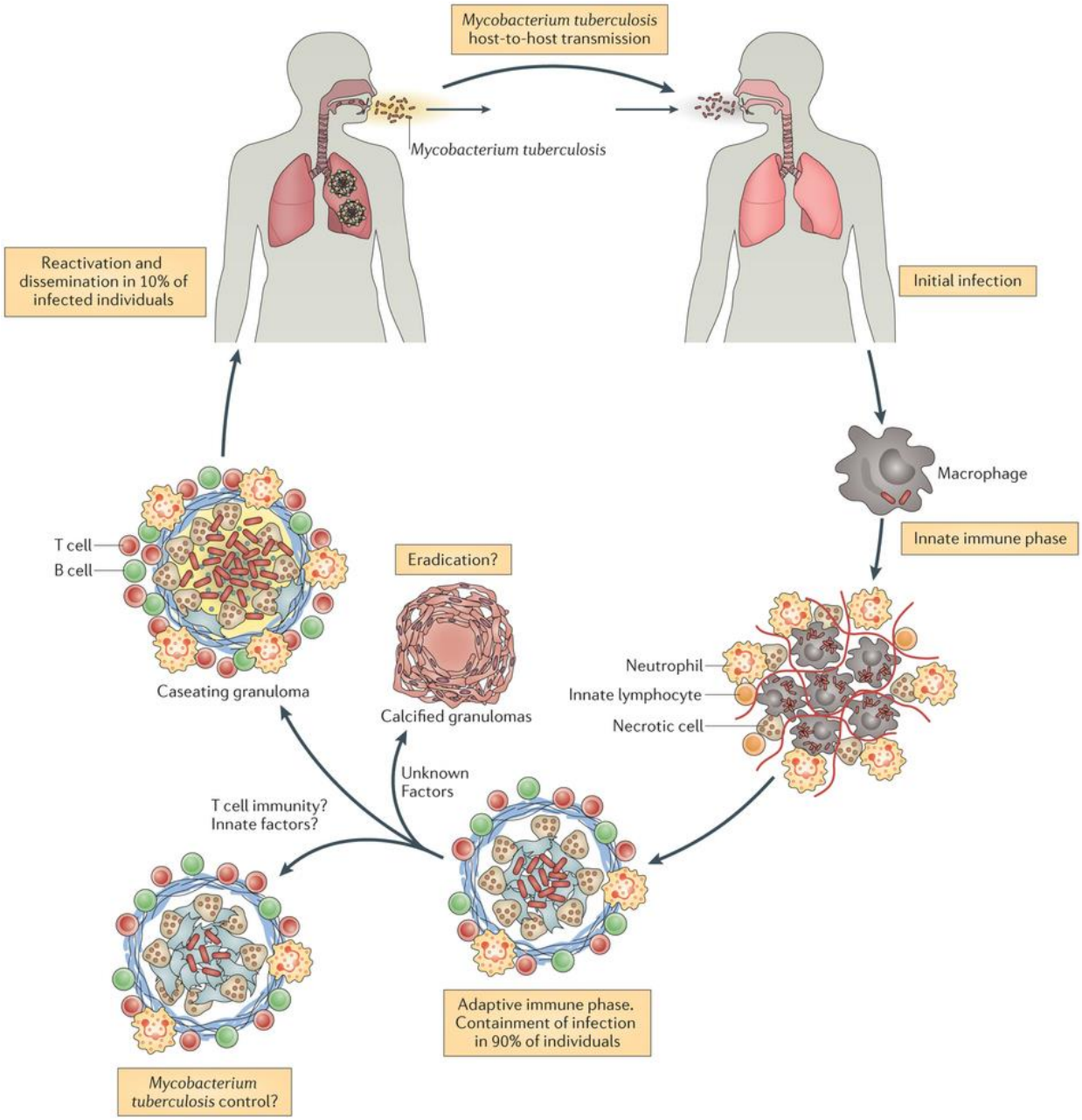

Figure 2.2: Pathogenesis of TB (Nunes-Alves *et al*., 2014)

Within three to eight months of the primary infection, primary TB may develop. Post-primary TB or reactivation may develop when the tubercle bacilli remain inactive for years and then start to multiply. Active TB can be caused by re-infection and HIV positive individuals are pre-disposed because of their immune-deficiency. It is difficult to differentiate between latent infection and re-infection; a general guideline is that more people develop active TB due to re-infection (Pratt, 2003: 133).

The transmission of TB is illustrated in *Figure 2.3.* Macrophages are crucial components in the killing of either mycobacterial or in the prevention of bacterial multiplication. Dendritic cells circulate to the lymph nodes and T cells, and return to the lungs to control the infection. The antibacterial activity of macrophages

is enhanced by the T cells that release cytokines. The infection is then cleared by the macrophages. Most individuals develop a T-cell response in the absence of any clinical symptoms, which is defined as a latent infection. The moment that the T cells response is insufficient to control the initial infection, clinical symptoms start to develop (Shi & Sugawara, 2013; Young *et al*., 2008; ASSAf, 2007). These clinical symptoms are discussed in a later section.

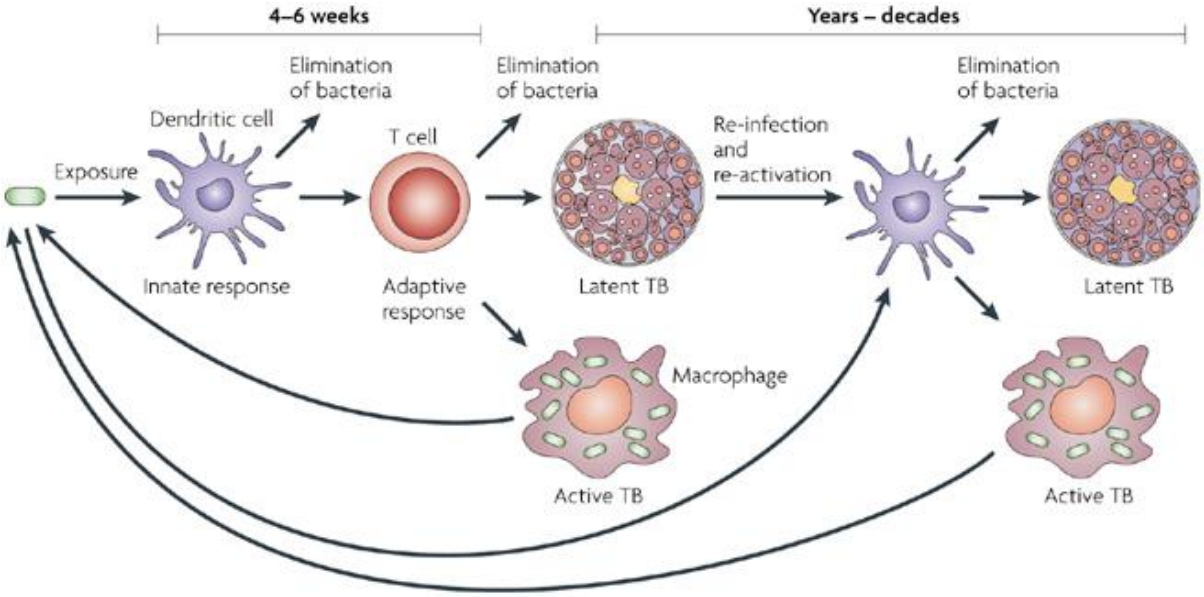

Figure 2.3: TB Transmission (Young *et al*., 2008)

2.4 HIV-associated TB

As mentioned previously, healthy individuals have a 10% lifetime risk of developing TB compared to HIV-infected patients that have a 10% annual risk (Shi & Sugawara, 2013:129; ASSAf, 2007). The risk of contracting TB is estimated to be 26 to 31 times greater in HIV positive individuals than in uninfected people (Sutariya *et al*., 2015: 75). Approximately one third of all HIV-infected Africans die in hospitals because of TB, and only half of them are diagnosed with TB during their lifetime (Churchyard & Corbet, 2008: 438). People with HIV-related TB are four times more likely to die than those who are infected with TB and are HIV-negative. In 2015, one third of all HIV deaths were due to TB (WHO, 2016). According to Semba *et al*. (2010: S353) HIV co-infection seems to be a much stronger risk factor for mortality in adults with TB than is malnutrition alone.

TB with HIV/AIDS co-infection has a major impact on the infected person (Pratt, 2003: 134). Though there is little evidence suggesting that HIV infection predisposes an individual to primary infection, it clearly increases the risk of progression from infection to disease. The effects of HIV on CD_4 cell counts (which are essential in the control of mycobacterial growth) are the most likely reason for this. HIV-infected patients

with TB also have a worse prognosis than HIV-infected persons who remain free of TB disease (ASSAf, 2007: 100).

TB can occur at any level or stage of HIV infection, but the weaker the immune system, the more likely it is that an HIV-infected person will develop TB (Churchyard & Corbet, 2008: 439). Thus, nutrition is important during all stages of HIV and TB infection. *Figure 2.4* illustrates the vicious cycle of malnutrition and HIV, which also applies to TB.

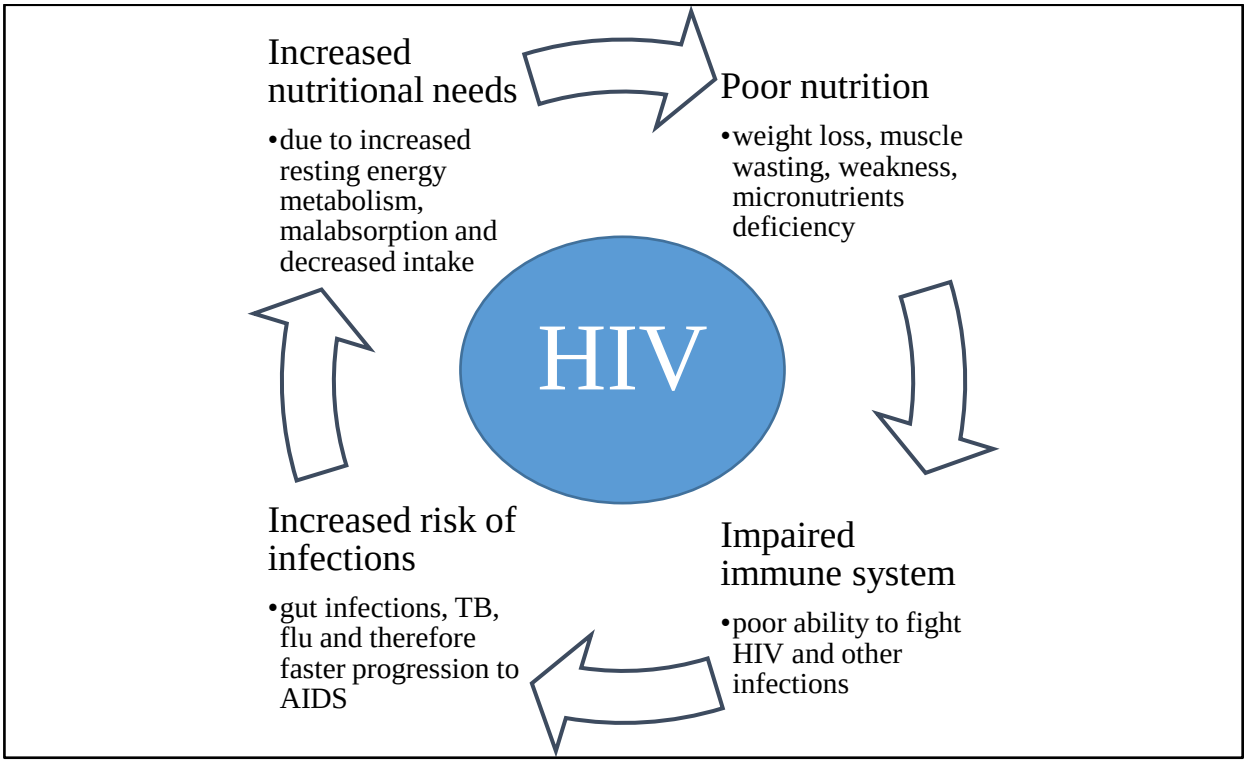

Figure 2.4 The vicious cycle involving HIV infection and malnutrition (Adapted from Regional Centre for Quality and Healthcare, 2003)

The extent of immunosuppression also changes the features of TB. TB that develops at an early stage of HIV-infection resembles HIV-negative TB, which involves pulmonary disease in the upper zones and cavities as well as smear-positive disease. HIV-infected individuals with advanced immunosuppression are more likely to present with hilar adenopathy and smear-negative disease. Extrapulmonary TB may also occur more commonly in the highly immunosuppressed patients (Churchyard & Corbet, 2008: 439).

It is difficult to diagnose TB in HIV infected patients and currently there is no rapid accurate diagnostic test for this. The clinical presentation is not very specific and the sensitivity towards microscopy is poor. The immunological recovery after the initiation of antiretroviral therapy (ART) increases the inflammatory response against the high mycobacterial organism load that is present in HIV infected patients with TB,

unmasking the TB infection and increasing the risk of death due to the strong inflammatory reaction (Alvarez-Uria *et al*., 2013: 123).

The burden of TB is growing globally, largely due to the spread of HIV/AIDS (Churchyard & Corbet, 2008: 434). HIV-infected people are more difficult to diagnose, more susceptible to TB and more difficult to treat. Furthermore, HIV-infected persons have a higher mortality following TB treatment. Thirty per cent of all HIV-infected persons with diagnosed TB die within a year of diagnosis and treatment (ASSAf, 2007: 34). Thus all persons with TB should be tested for HIV and all persons living with HIV should be screened for TB (Amollo, 2009). A better understanding on how TB and HIV interact is critical (Bloem & Saadeh, 2010: S289).

2.5 Screening and diagnosis

Symptoms of TB disease include fever, involuntary weight loss, night sweats, persistent cough (lasting two weeks or longer), chest pain, shortness of breath, haemoptysis, fatigue, loss of appetite, and localised pain or swelling. The WHO recommends four-symptoms for TB screening in HIV infected patients namely: the presence of fever, weight loss, night sweats or cough of any duration. This four-symptoms screening is not, however, specific or optimally sensitive (Williams, 2006: 50; Frieden *et al*., 2003: 889). Recently the WHO has recommended the implementation of the GeneXpert MTB/RIF assay in developing countries for national TB programmes. When comparing the smear microscopy, the GeneXpert MTB/RIF assay increases the diagnosis of TB by 13-38%, but it is a much more expensive test. Since, it is crucial to exclude TB in all patients who become eligible for HIV treatment before the initiation of ART, this expensive test may be warranted (Alvarez-Uria *et al*., 2013: 123; Churchyard & Corbet, 2008: 438).

There are several steps required before the final diagnosis of TB disease can be made. *Figure 2.5* summarises the process of TB diagnosis (SADoH, 2014).

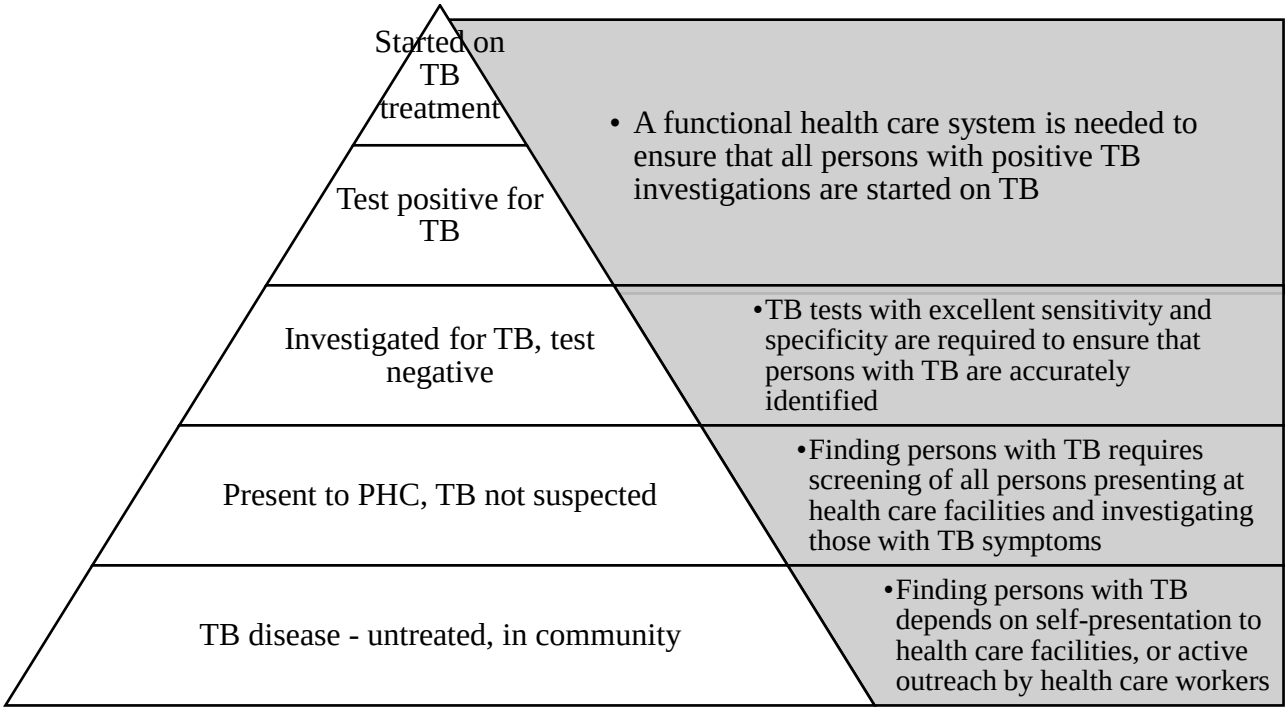

Figure 2.5: Steps required for the diagnosis of TB (SADoH, 2014)

The criteria for the diagnosis of active TB vary according to the setting. All patients that present with a persistent cough should be assessed for TB. Any patient that experiences three or more of these symptoms for three or more weeks should be screened for TB. Ideally, the diagnosis and treatment must occur as quickly as possible to minimise the damage that occurs in the infected tissues (Williams, 2006: 50). Diagnostic tests for TB vary in sensitivity, specificity, speed, and cost (Frieden *et al*., 2003: 890).

The tubercle skin test (TST) identifies previous TB-infection but does not distinguish between active TB and latent TB infection (Churchyard & Corbet, 2008: 441). The TST test is of little clinical value in the South-African setting because it is non-specific to latent and active TB. Immunosuppression, HIV and malnutrition may also lead to a decreased sensitivity of TST (Chee *et al*., 2013: 207; Ndjeka *et al*., 2008). Despite the questionable validity of the TST, it still remains a good predictor of future TB risk and the response to preventative therapy in HIV-infected individuals (Churchyard & Corbet, 2008: 441). Preventative chemotherapy might be a consideration, especially in persons with latent TB infection with an increased risk for progression to active TB (such as immunosuppressed individuals) (Chee *et al*., 2013: 209).

2.6 Assessment of nutritional status

The main objectives for nutritional assessment, counselling and support of patients with TB include; assessing their current nutritional status, identifying all the underlying causes of malnutrition, and improving nutritional

intake through any setting specific methods (education, counselling or food assistance) (UNAIDS, 2014; WHO, 2013).

One method to assess nutritional status is the "ABCDEF" approach, which involves assessment of the following aspects: anthropometry, biochemistry, clinical signs, dietary intake, exercise or physical activity and the family/household situation (UNAIDS, 2014). Each of these aspects will be discussed in more detail in the following section.

2.6.1 Anthropometry

Anthropometry includes measurements of body composition, weight, height, change in weight (involuntary weight loss), body mass index (BMI), mid-upper arm circumference (MUAC), and hand grip strength (UNAIDS, 2014).

Involuntary weight loss, wasting and cachexia are common findings in patients with TB. All of the above processes are most likely the result of a combination of factors, including increased nutrient losses, altered metabolism, and decreased appetite and food intake, which are all directly linked to a poor prognosis (Kirenga *et al*., 2015; Chang *et al*., 2013; Nezhad *et al*., 2012; USAID, 2010).

According to the WHO, a low BMI (< 18.5 kg/m^2) is the best predictor of weight-related morbidity. BMI is the indicator that is most commonly used to estimate the degree of fatness or thinness in adults over the age of 18 years (WHO, 2013). Several cross-sectional studies have confirmed a lower BMI in adults with TB (Lombardo *et al*., 2012: 183; Semba *et al*., 2010; Van Lettow *et al*., 2003: 84; Karyadi *et al*., 2000: 725). According to Hanrahan *et al*. (2010: 1507) BMI may be a useful surrogate marker of TB risk or mortality among HIV-positive individuals.

MUAC correlates well with BMI in the adult population. MUAC is often used to assess nutritional status and determine eligibility for nutrition support among adults in resource limited settings (Tang *et al*., 2013). Another measurement that is used to determine work capacity (lean body mass) in patients with TB is handgrip strength (PrayGod *et al*., 2012: 268).

2.6.2 Biochemistry

Although nutrient deficiencies can be identified through biochemistry, these tests are usually expensive, and they are seldom applied in nutritional assessment of persons from resource limited areas. More commonly measured biochemical assessments include haemoglobin, albumin, triglycerides, total cholesterol, low/high-density lipoproteins and iron (UNAIDS, 2014).

Serum protein concentrations can be useful in assessing protein status, to evaluate a patient's response to nutritional support, and to determine whether a patient is at risk of experiencing medical complications (Lee

& Nieman, 2013: 320) on condition that there is no acute phase response present due to metabolic stress that may affect the reliability of this indicator as a measure of nutritional status.

Serum albumin is an indicator of depleted protein status (Lee & Nieman, 2013: 320). Hypoalbuminaemia is an important marker of severe malnutrition (Matos & Moreira Lemos, 2006: 1363), but is not a reliable indicator of nutritional status when an infection is present, since it reacts as a negative phase protein (Litchford, 2012; Salgado *et al*., 2001). Low serum albumin levels are strongly associated with an increased risk of TB. This was confirmed in a study amongst adult patients in the United States (Cegielski *et al*., 2012: 409), confirming that serum albumin might be a useful diagnostic and prognostic marker for TB in HIV infected patients (Alvarez-Uria *et al*., 2013: 127). A study of hospitalised patients with TB in Brazil, found that the group of patients who died during hospitalisation had statistically significantly lower mean albumin levels that the group of patients that survived (26 g/l vs. 31 g/l) (Matos & Moreira Lemos, 2006: 1361). Alvarez-Uria *et al*. (2013: 127) found that a serum albumin value of >38 g/l was a negative predictor for TB even in settings with a high prevalence, whereas a serum albumin value of <32 g/l was associated with 85% TB specificity.

A study conducted in Pakistan amongst 127 patients with TB, reported that the median CRP was 11.21 mg/l in males and 13.82 mg/l in females respectively. The researchers concluded that a high CRP is noticeably associated with more severe TB disease (Shaikh *et al*., 2012: 144).

A number of studies in Gambia, India, the United States, Tanzania and Indonesia have confirmed that anaemia is particularly common in patients with TB (Minchella *et al*., 2015: 764; Boloor *et al*., 2014: 476; Cegielski *et al*., 2012: 412; Isanaka *et al*., 2012: 353; Karyadi *et al*., 2000: 2957) predominantly due to anaemia of inflammation (also known as anaemia of chronic disease) (Minchella *et al*., 2015: 771).

2.6.3 Clinical signs and symptoms

A clinical assessment or examination of a patient is useful to identify signs or symptoms of dehydration, oedema, malnutrition, ascites, taste changes or swallowing difficulties. The condition of certain body parts (fingernails, hairs, skin) is also examined (UNAIDS, 2014).

Clinical monitoring of possible side effects in patients with TB is important during treatment (WHO, 2004). It is unknown whether the food related side effects experienced by patients with TB, and TB/HIV co-infection are caused by the disease, the treatment or a combination of the two. Several food related side effects (gastro-intestinal irritation, nausea, vomiting, abdominal pain, constipation, anaemia, jaundice, pancreatitis, altered taste, anorexia, and fatigue) have been reported to be related to TB medications (Isoniazid and Rifampicin) (SADoH, 2014; Escott-Stump, 2012; WHO, 2004). Adverse side effects from medication are more common

in HIV positive than in HIV negative patients with TB (WHO, 2004). Drug related side effects are discussed in more detail in a later section.

Involuntary weight loss of more than 1.5 kg per month and wasting are some of the first clinical signs seen in patients with TB, and are most likely caused by a combination of reduction in appetite and increased energy expenditure as part of the inflammatory and immune response. Contact with a person with TB increases the likelihood of TB diagnosis and symptoms such as weight loss thus need to be investigated (SADoH, 2014; Escott-Stump, 2008: 304). When involuntary weight loss occurs, the risk of malnutrition increases (Bapen, 2003). Malnutrition, which is very common in patients with TB, is discussed in more detail in a later section.

2.6.4 Dietary intake

There are many tools that can be applied to assess dietary intake (24 hour recall, usual food intake, food frequency questionnaires, food records and diaries). The information gained through these approaches is aimed at providing data on the intake of particular foods, nutrients, herbal remedies and other supplements. Intake can either be determined in terms of the number of servings from each food group, or in terms of nutrient intake using food composition tables or dietary assessment computer programmes (UNAIDS, 2014).

The most frequent tool used to determine dietary intake of patients with TB seems to be the 24 hour recall method and has been used by several researchers. Karyadi *et al*. (2000) determined dietary intake of 82 subjects (41 TB patients and 41 controls) in Indonesia and found that intake of energy, protein, carbohydrates, fat, vitamin A and iron tend to be lower in patients with TB than in the healthy control group. Swaminathan *et al*. (2008) reported that energy and protein intake of patients with TB and TB/HIV co-infection were below the recommended daily allowance in India. More recently, Lombardo *et al*. (2012) determined dietary intake of 86 subjects (43 TB patients and 43 controls) in Cape Town and concluded that there were no significant difference between the two groups in terms of energy, protein, carbohydrate, fat, zinc and vitamin A intake. Lastly, Mupere *et al.* (2012) determined the dietary intake among patients with TB in Uganda and found that the average intake of energy, protein, carbohydrate, fat, calcium, folate and vitamin A were significantly lower among TB patients with moderate to severe disease compared to TB patients with mild disease. Nutrient deficiencies that are specific to TB are discussed in a later section.

2.6.5 Exercise or physical activity and other lifestyle factors

An assessment of physical activity and other lifestyle practices includes questions on activities of daily life, work and planned exercise as well as smoking and alcohol habits. A balance between energy expenditure and energy intake is required to maintain or reach a healthy weight (UNAIDS, 2014).

When determining the physical activity levels of patients, daily activities such as domestic work and gardening should be taken into consideration, since it requires energy to complete these tasks (McArdle *et*

al., 2001). Patients with TB and HIV co-infection are usually inactive, despite the beneficial role of exercise in patients with TB and TB/HIV co-infection (Jones, 2001). Malnutrition increases fatigue which in turn often leads to physical inactivity in immunocompromised patients (Piwoz & Preble, 2000).

Lifestyle factors that are strongly associated with the development of TB infection to TB disease include the use of tobacco and alcohol. Alcohol and smoking have been established to be risk factors for acquiring TB disease, and continued use of alcohol and tobacco products, once a person has contracted TB, decreases the chances of successful treatment (Louwagie *et al*., 2014: 501). Smoking is a risk factor for TB, independent of alcohol use or other socio-economic factors. Both passive and active exposure to tobacco smoke is associated with an increased risk for TB infection (SADoH, 2014; Saad & Tirkey, 2013). A high alcohol consumption (>40g alcohol per day) is associated with a threefold increased risk of developing TB (SADoH, 2014).

2.6.6 Family/household situation

During an assessment of nutritional status, it is important to assess poverty, illness or disability in the family, which may affect the family's capacity to obtain or prepare food. Nutritional knowledge, psychosocial factors, and food drug interactions also need to be assessed (UNAIDS, 2014).

Socioeconomic factors are closely related to TB infection. These include poverty, over crowding, unemployment, malnutrition, and inadequate access to efficient health facilities. These factors do not only increase the risk for developing TB, but also increase the chances of treatment failure. According to the South African National Tuberculosis Association (SANTA), the incidence of TB is especially high amongst males, miners, the poor and the very young in South Africa (SANTA, 2014; Chee *et al.*, 2013: 205; Songpol *et al*., 2005: 221). TB is mostly associated with specific population subgroups including immigrants from countries with high endemicity, ethnic minorities, refugees, and the homeless (Faccini *et al*., 2013: 485).

The quality of life of TB patients is negatively affected, since TB often leads to social isolation. It is important to evaluate the quality of life of patients with TB since it has an impact on treatment outcome and prognosis. Factors that negatively affect the quality of life of patients with TB include disease severity, use of drugs and the fear of dying (Awan *et al*., 2012: 330).

Mental health problems, such as anxiety and depression, are common in patients with TB and TB/HIV co-infected patients, and may be related to the psychological effects of dealing with a life-threatening disease. Patients who experience more economic hardship are more likely to display depressive symptoms (Louwagie *et al*., 2014: 501-508; Awan *et al*., 2012:330).

2.8 TB and Malnutrition

Very often, malnutrition in patients with TB is neither recognised nor addressed. This worsens disease, delays recovery and increases the length and frequency of hospital visits. Malnutrition affects an individual's health, wellbeing and ability to work or perform daily activities (Bapen, 2003).

In settings with limited resources, TB infection and the HIV epidemic are often highest where malnutrition is already present (UNAIDS, 2014). In 2007, the ASSAf identified the top three epidemics as HIV infection, TB infection and malnutrition and called it the "three concurrent epidemics". Although HIV and TB are caused by disease organisms, the third epidemic, malnutrition, is very often a consequence of these two disease states (ASSAf, 2007). Thus; HIV, TB and malnutrition result in a vicious cycle, with the one epidemic exacerbating the other.

Some important signs and symptoms of TB (e.g. wasting, anaemia, loss of lean and fat mass, etc.) are also signs of malnutrition (ASSAf, 2007:155-156). According to Cegielski & McMurray (2004) malnutrition is an important risk factor for the development of TB and for progression from latent to active disease. Poverty is mostly the common denominator, since population groups with an increased risk for poor nutritional status contribute to an elevated risk for developing TB. Even though there is a clear link between TB and malnutrition, the risk relative to the specific degrees and types of malnutrition are still unclear (Cegielski & McMurray, 2004: 294).

The presence of malnutrition has been described in patients with TB by several researchers (Bhargava *et al*., 2013; Frediani *et al*., 2013: 1026; Villamor *et al*., 2006: 169; van Lettow *et al*., 2004: 61; Frieden *et al*., 2003: 895; Karyadi *et al*., 2000). Both malnutrition and HIV infection are associated with an increased risk of progression from latent TB infection to active TB disease, because of the negative impact that dietary deficiencies have on cell-mediated immune response (Lönnroth *et al*., 2010: 152; Semba *et al*., 2010; Cegielski & McMurray, 2004: 296). TB very often results in poor dietary intake, nutrient deficiencies, malnutrition and wasting (Cegielski & McMurray, 2004: 296; Van Lettow *et al*., 2004: 61; Paton *et al*., 2003: 322).

TB may lead to prolonged fatigue, anorexia, nutrient malabsorption, altered metabolism, and weight loss (Dong & Imai, 2012: 876). The reasons for involuntary weight loss and wasting are multifactorial including increased energy expenditure, food insufficiency, decreased absorption or increased need for certain nutrients (Bloem & Saadeh, 2010: S290; ASSAf, 2007). Nutritional deficiencies are known to worsen immunological mechanisms that are crucial for successful control of mycobacteria, namely the functions of T-lymphocytes and a variety of phagocytic cells. Thus, nutrition deficiencies are generally associated with increased risk and severity of TB disease (ASSAf, 2007: 151).

The inflammatory state increases resting energy expenditure (REE) and also reduces appetite through effects on the hypothalamus. Thus, patients develop a negative energy balance, metabolise body stores of muscle tissue, and are at higher risk of wasting. Reduced food intake, as well as increased utilisation of energy and micronutrients, leads to weight loss and micronutrient deficiencies (Semba *et al*., 2010: S352)

The relationship between TB and malnutrition is illustrated in *Figure 2.6.* Through this illustration it is clear that nutrition and food security are directly related to the diagnosis, prognosis and mortality of a patient with TB. Thus, focusing on the nutritional status of people who are at risk of developing TB, may directly decrease the number of TB infections, improve treatment outcomes and reduce TB associated mortality (WFP, 2016).

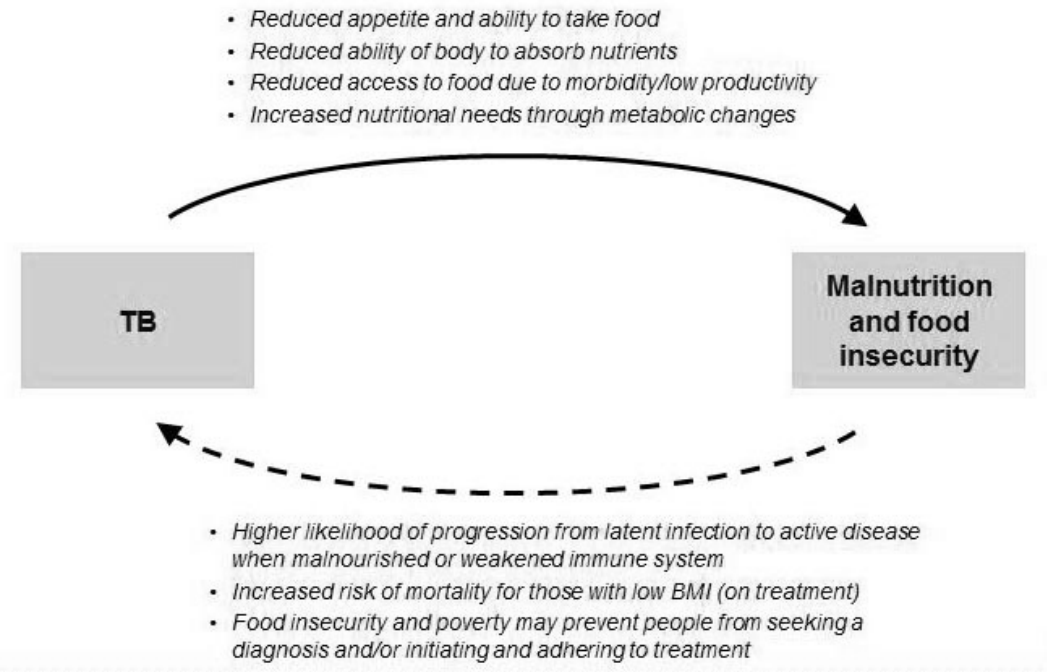

Figure 2.6: Relationship between TB and malnutrition (WFP, 2016)

2.9 Food security and food support

According to the National Food Consumption Survey (NFCS) of 1999, 33% of South African household were at risk of hunger and 52% of households experienced hunger at that time (Labadarios *et al*., 2005). According to the NFCS of 2005, similar results were found, with one out of three households at risk of hunger and 51.6% of households experiencing hunger (Labadarios *et al*., 2008). More recently, the South African National Health and Nutrition Examination Survey (SANHANES) of 2012 interviewed 5972 households and concluded that 39% of households do not have enough money for basic needs, like food (Shisana *et al*., 2013).

Even though food insecurity together with proper nutrition has long been recognised to play a vital role in TB infection, the HIV epidemic, and progression of TB infection to active disease, there is still very little understanding of their exact role (Bloem & Saadeh, 2010).

Food security is defined as "access to enough food at all times by all people for an active and healthy life" (Anderson, 1990; Keenan *et al*., 2001). According to Bloem & Saadeh (2010), food insecurity is defined as limited food utilisation, availability, or access. Households experience food insecurity in the most basic form when they do not have adequate resources to obtain enough food to meet their basic nutritional needs; resulting in hunger for all household members (Keenan *et al*., 2001). In an attempt to optimise nutritional status, food and nutrition security are essential factors to consider (ADA, 2010).

Globally poor household food security is a major concern. According to the global International Food Security Assessment for 2011 to 2021, the number of food-insecure people and the food gap are estimated to decline respectively by 16% and 7% during the ten year period. In Sub-Saharan African, however, the opposite is predicted, with an increase of 17 million in the number of food-insecure people and an increase of 20% in the food gap between 2011 and 2021 (USDA, 2011).

Between 1999 and 2008 the prevalence of food insecurity in South Africa appears to have been reduced by half (from 52.3% to 25.9%), but the percentage of people at risk of experiencing food insecurity remained almost unchanged, due to population growth together with high levels of unemployment (WHO, 2013; Labadarios *et al*., 2011). A major concern with regards to household food security, is that a household may be food secure overall, but a poor understanding of individual needs together with an unequal distribution among household members, may lead to food and nutrition insecurity for the more vulnerable household members, like persons infected with TB and/or HIV (Ogundiran *et al*., 2014; Bloem & Saadeh, 2010: S290).

"The Right to Food" is a basic human right enshrined in the South African constitution. The right to adequate food as a basic human right was first formally recognised by the United Nations in the Universal Declaration of Human Rights (UDHR), as a part of the right to a decent living standard (FAO, 2016). During 2009, the World Food programme (WFP) provided food assistance to 3 million people that were affected and infected with HIV and TB (Bloem & Saadeh, 2010: S291). As mentioned, food insecurity is a major risk factor for the development and prognosis of TB disease. According to Amollo (2009) food insecurity also increases the exposure to HIV in women as they may engage more easily in transactional sex in order to generate an income to provide food for their families.

Most nutrition support programmes for adults with TB and HIV provide food and nutrition support when treatment is initiated. Therapeutic food products are often prescribed to treat malnutrition based on strict anthropometric entry and exit criteria (low BMI and low MUAC). Food support for treatment initiation and adherence might require specific foods to manage side effects as illustrated in *Figure 2.7* (UNAIDS, 2014). The impact of food and nutrition support on treatment success depends on many factors (*Figure 2.7).*

However, the efficiency of food support programmes remains unclear, especially if some of these factors are ignored (De Pee & Semba, 2010).

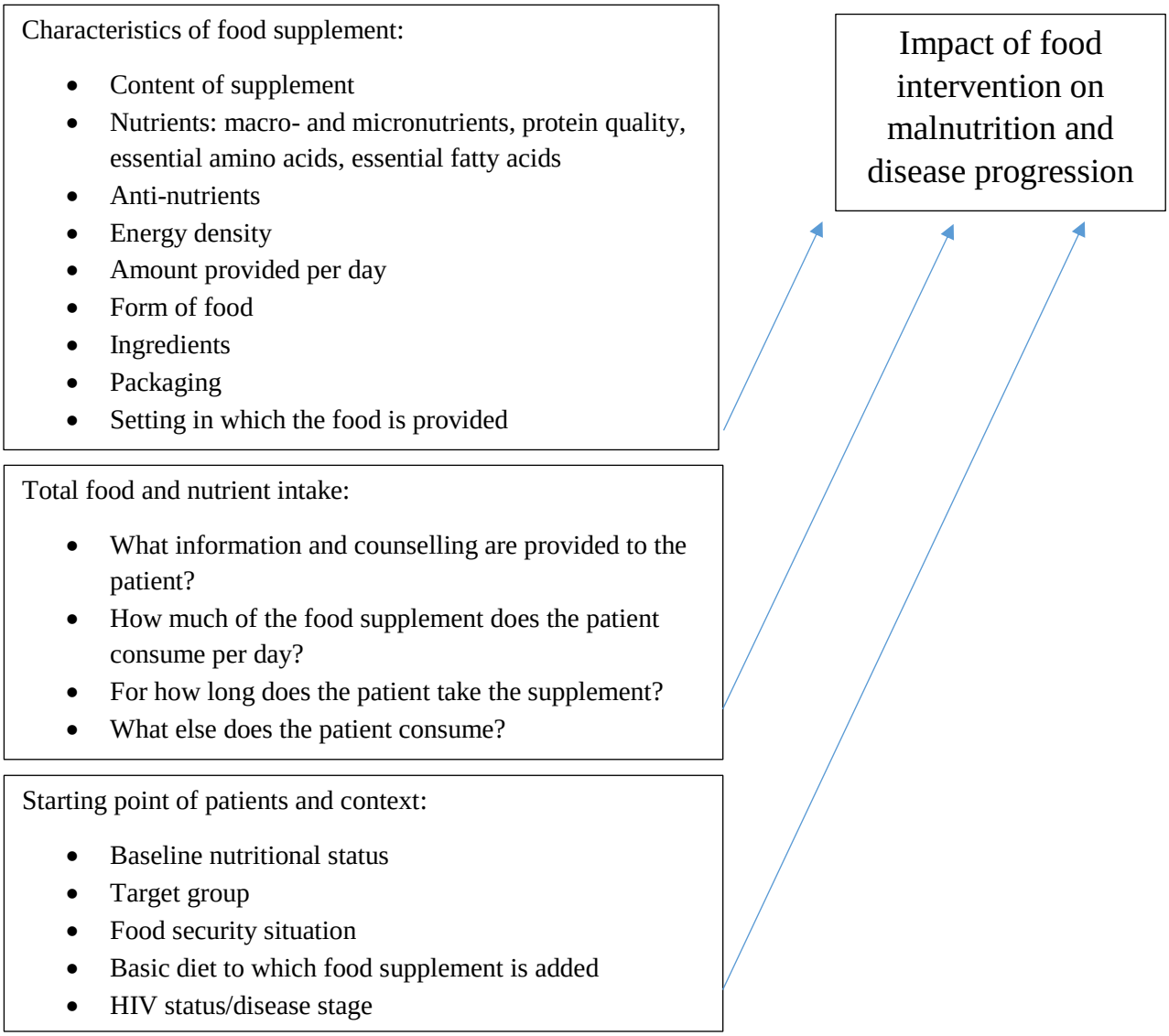

Figure 2.7: Factors affecting the impact of food support interventions on malnutrition and disease outcome (Adapted from De Pee & Semba, 2010)

2.10 Food safety

Food safety is very important in patients with TB and/or HIV co-infection. Patients with TB and/or HIV co-infection are more susceptible to foodborne illness due to a compromised immune system. Detailed guidelines on ensuring food safety are indicated in Addendum A (SADoH, 2007).

2.11 Management of TB

2.11.1 Medical treatment of TB

The primary goals of TB treatment are to eradicate *M. tb* infection, prevent development of drug resistance, and prevent relapse or death. In order to achieve these objectives, a combination of TB medicines should be

administered. Successful treatment of individual cases includes reducing the risk of transmission of TB to others in the community (Horsburgh *et al*., 2012; Frieden *et al*., 2003: 891). Medical treatment might improve the nutritional status of patients with TB, but treatment alone is probably not sufficient to ensure an optimal nutritional status in patients living in food insecure areas (WHO, 2013).

2.11.1.1 DOTS

In 1991 the World Health Assembly resolution recognized TB as a major global health problem and as a result, the WHO developed the five-element DOTS (Directly Observed Therapy, Short-course) strategy. The DOTS program is a method recommended by the WHO to improve compliance of patients with TB and thus to increase the cure rate of TB. The DOTS strategy was later implemented in 184 countries. According to the WHO (2011), 84% of patients that suffer from TB did not receive any DOTS support during 2010, since there are several challenges that are common in the implementation of the DOTS strategy.

The DOTS components include:

1. Government commitment to TB control;
2. Case detection among symptomatic patients;
3. Standardised chemotherapy for all sputum smear-positive cases under proper case management conditions;
4. Regular drug supply; and
5. Monitoring system for program supervision and evaluation (Horsburgh *et al*., 2012:2; Frieden *et al*., 2003: 891).

DOTS is recommended by the WHO and IUATLD. It is very important that treatment adherence and prevention of drug resistance are facilitated by trained individuals, since family members are usually not reliable (Frieden *et al*., 2003: 891). TB treatment is more likely to be successfully completed when there is a treatment supporter to administer the medication on a daily basis and to observe that the pills are swallowed. TB treatment outcomes are often poor due to poor compliance, treatment interruption or death. Other contributing factors such as inadequate healthcare, clinical and socio-economic factors, and substance use also prevent and interfere with successful completion of treatment (Louwagie *et al*., 2014: 501).

2.11.1.2 Vulnerability

Beyond medical treatment, factors that affect vulnerability to infection and progression of TB disease also need to be considered. *Table 2.3* summarises individual, household/community, and environmental vulnerabilities (USAID, 2008)

Table 2.3: Vulnerability factors related to progression to TB disease (USAID, 2008)

Individual	**Household/community**	**Environmental/institution**
Age	Socio-economic status	Geography/physical terrain
Sex	Migration	Availability of health services
Nutritional status	Access to treatment	Quality of health care
Immunity	Over crowding	Availability of appropriate treatment
Genetics		
Interactions with other diseases (HIV, diabetes)		Emergence of drug resistance
Behaviour		Development of infrastructure/ other service
Poverty		Public policy
Education		
Knowledge		
Diet		
Livelihood		

2.11.1.3 Standard regimens

The South Africa Department of Health (SADoH) have compiled recommendations for daily dosages of individual and combination drugs for adults and children over the age of 8 years. These recommendations are summarised in *Table 2.4* and *Table 2.5*.

Table 2.4: Recommended daily dosages of the individual drugs for adults and children >8yrs/ >30kg (SADoH, 2014: 41)

Essential TB drug	**Dose mg/kg**	**Dose range mg/kg**
Rifampicin (R)	10	8 – 12
Isoniazid (H)	5	4 – 6
Pyrazinamide (Z)	25	20 – 30
Ethambutol (E)	15	15 – 20
Streptomycin (S)	15	12 – 18

Table 2.5: Fixed dose combination tablets available for adults and children >8yrs/ >30kg (SADoH, 2014: 41)

Intensive Phase	**Continuation Phase**
RHZE (150,75,400,275mg)	RH (150,75mg)
	RH (300,150mg)

The standard treatment regimen for new and previously treated patients in South Africa is summarised in *Table 2.6*. For the first two months, treatment is with Rifampicin, Isoniazid, Pyrazinamide and Ethambutol (RHZE) in fixed dose combinations given every day of the week. If the patient is improving clinically and is also smear negative at the end of the second month, they are treated with RH in fixed dose combinations every day of the week for a period of four months (SADoH, 2014: 41).

Table 2.6: Standard treatment regimen for adults and children >8yrs/ >30kg (SADoH, 2014: 41)

Pre-treatment body weight	**Intensive Phase (2 months)**	**Continuation Phase (4 months)**	
	RHZE (150,75,400,275)	RH (150,75)	RH (300,150)
30 – 37 kg	2 tablets	2 tablets	
38 – 54 kg	3 tablets	3 tablets	
55 – 70 kg	4 tablets		2 tablets
>70 kg	5 tablets		2 tablets

2.11.1.4 Drug-nutrient interactions and food related side effects

TB is treated with multiple medications and antibiotics, which can all result in a number of food-drug interactions. Patients with TB require more vitamin B_6, vitamin D and mineral intake from supplements because medication (isoniazid) reduces levels of vitamin B_6 and interferes with vitamin D absorption which in turn can decrease absorption of calcium and phosphorus (Mueller, 2012: 796; Fenton & Silverman, 2009: 918; SADoH, 2007). Isoniazid and Rifampicin should preferably be taken 30 minutes to 1 hour before or 2 hours after a meal, due to reduced absorption when taken with food. TB medication should not be taken together with alcohol (Mueller, 2012: 796). *Table 2.7* indicates the medications commonly used in the management of TB together with possible food related side effects and/or nutrient interactions that may occur.

Table 2.7: Medications used for the management of TB (Escott-Stump, 2012: 305; Singla *et al*., 2010: 82; SADoH, 2007)

Medication	**Interactions/ Side effects**
Aminosalicylic acid	Interfere with vitamin B_{12} and folate absorption Nausea/vomiting
Chemotherapy	Increase serum calcium levels
Ethionamide	Requires vitamin B_6 supplementation Anorexia; metallic taste; nausea/vomiting; diarrhoea; weight loss and hypoglycaemia
Ethambutol	Gastrointestinal distress; nausea and anorexia Not to be used for >2 months, due to harmful effects on the eyes
Isoniazid (INH)	Depletes vitamin B_6 causes neuritis May decrease absorption of pyridoxine, calcium, and vitamin D. Increase requirements for pyridoxine, folate, niacin (vitamin B_3) and magnesium. May cause hepatitis, constipation, anaemia, and fatigue Tastes bad Nausea/vomiting; anorexia; stomach cramps and dry mouth Hepatotoxic Better absorbed in an acidic pH
Pyrazinamide	Anorexia and nausea/vomiting Hepatotoxic
Rifampicin	May interfere with folate and vitamin B_{12} Nausea/vomiting; diarrhoea; anorexia; gastrointestinal distress; anaemia; jaundice; pancreatitis and altered taste Hepatotoxic
Streptomycin	Hearing and balance affected when using for >3 months

Food related illnesses that are likely to occur in patients with TB and/or HIV co-infection together with specific dietary, prevention and treatment guidelines are listed in Addendum B (Republic of Ghana, 2013).

2.11.1.5 Place where TB patients are treated

There is controversy about whether patients with TB disease should be treated as in- or out-patients. The WHO suggests that hospitalisation is of no value in the management of patients with TB disease and the

British Thoracic Society agrees that most patients with TB disease can be treated as outpatients. The American Thoracic Society has no clear recommendation regarding this issue (WHO, 2013; Chu *et al*., 2001: 147).

In a rural setting in Uganda, home-based care and treatment for patients with MDR TB was found to be preferred by staff and patients over hospital-based care for three main reasons: it was more conductive to patient recovery; it enabled enhanced psychosocial support; and it allowed more free time for patients and caretakers for other activities (Horter *et al*., 2014). This approach (home-based care and treatment), however, is not realistic for patients with comorbidities or more severe TB disease, who should ideally be hospitalised (Chu *et al*., 2001: 148).

2.11.1.6 The "End TB Strategy"

According to the WHO, the most recent global goal is to end the TB epidemic through the implementation of the "End TB Strategy". The main objectives of this strategy is: to reduce the number of TB deaths by ninety percent by 2030, to cut new cases of TB by eighty percent by 2030, and to prevent families from being burdened with the high costs due to TB disease (WHO, 2015).

New vaccines, diagnostics, and drugs will be needed to achieve the targets set in the "End TB Strategy" (WHO, 2015). Even though new diagnostic methods have been developed, the main diagnostic methods are still the sputum smear and culture, both of which are over a hundred years old. No new first-line TB drugs have been developed since 1950; thus two thirds of people who develop TB disease are not effectively diagnosed, treated or monitored (Frieden *et al*., 2003: 896).

Currently, ten vaccines for TB prevention and two immunotherapeutic vaccines are in the process of being researched. In addition, nine new or repurposed TB drugs are in the late phases of clinical development for sensitive TB, drug-resistant TB and latent TB infection. There is an urgent need for short, effective and well-tolerated treatments for latent TB infection, a clear diagnostic test, and an effective post-exposure vaccine to end the global TB epidemic (WHO, 2016; WHO, 2013).

2.11.1.7 Drug resistance

MDR TB refers to TB which is resistant to one or more first-line anti-TB drugs (Pratt, 2003: 147). Drug resistance occurs as a result of inadequate treatment for TB, or poor treatment compliance (Evian, 2003: 257). Institutionally acquired MDR TB has a rapid progression to disease in HIV-infected patients and an extremely high mortality if not immediately diagnosed and treated with suitable MDR TB treatment. Patients who are thus suspected to have MDR TB should be kept separate from HIV-infected patients as far as possible (Churchyard & Corbet, 2008: 441).

Two types of drug resistance occur. Primary drug resistance refers to infection with resistant tubercle bacilli due to the exposure to a person who is drug-resistant. Secondary resistance occurs when an individual has poor adherence to therapy or inadequate treatment. Alcoholics, drug users, and the homeless often exhibit poor adherence, as well as those who are socially, economically and educationally deprived. Supervision of therapy is a key factor in the prevention of MDR and treatment completion and consistent adherence to the prescribed regimen are critical issues (Pratt, 2003: 148).

The main challenges of TB control in Africa are the unknown burden of drug resistant TB cases (which increase yearly), the unavailability of second-line drugs, inadequate infection control and poor drug-resistant TB monitoring and evaluating systems (Ndjeka *et al*., 2008).

2.11.2 Nutrition therapy for TB and TB/HIV co-infection

Nutrition, immune function and infection interact in complex ways (Cegielski & McMurray, 2004: 288). As previously mentioned, limited information is available about effective nutritional management for patients with TB (Rudolph *et al*., 2013). Nutritional care and management of persons with active TB (with or without malnutrition) are similar to other persons with moderate malnutrition. It includes assessing nutritional status, identifying and treating the underlying causes of malnutrition and improving nutrient intake through counselling, education, and/or food assistance (WHO, 2013).

The importance of proper nutrition in the treatment of TB and TB/HIV co-infection is tremendous, since any nutrient deficiency may impair resistance to infection (ASSAf, 2007: 117). Nutrients are required to regulate certain body processes and to build and repair tissues and thereby promote health and prevent illness. In some settings, macronutrients (carbohydrate, protein, and fat) are generally consumed in sufficient amounts. Carbohydrates and some fat are used as energy sources, while protein and some fat are used as structural and functional components in the body. In patients with TB, micronutrients (vitamins, minerals and phytochemicals) are usually consumed in insufficient amounts. Together, macro- and micronutrients are essential for metabolic processes, cellular integrity and tissue regeneration (WHO, 2013).

Although the relation between impaired immunity due to malnutrition and risk of acquiring TB has not been well described, it is generally understood that malnutrition is an important risk factor for TB. A balanced diet should provide macronutrients, micronutrients and energy required for optimal growth and development (ASSAf, 2007: 155). General nutrition recommendations for patient with TB and/or HIV are summarised in Addendum C (FANTA, 2013).

2.11.2.1 Macronutrients

There has been no published randomised, clinical trial to support macronutrient supplementation for people with TB and HIV co-infection. Thus, there is no specific guideline related to the macronutrient distribution

of the diet for patients with TB disease. A general recommendation is that all people consume around 45-65% of energy as carbohydrates, 15-30% as protein and 25-35% as fat for optimal growth and development (WHO, 2013). A balanced food or enteral supplement which contains 50-60 % carbohydrates, 15-30 % protein and 20 – 30 % fat may be beneficial to increase energy and protein intake (ASSAf, 2007: 135). Providing access to food and oral supplements high in energy and protein is a cost effective and practical option for patients with TB (Escott-Stump, 2012; Paton *et al*., 2004). Despite this recommendation, PrayGod *et al*. (2012: 270) have reported that energy and protein supplementation in patients with pulmonary TB and HIV co-infection in Tanzania, with high multi-micronutrient intake, had no direct effect on body composition or weight.

a. Energy

Maintaining a healthy weight and optimal lean body mass are two of the main objectives of nutrition management (Escott-Stump, 2012). Patients with TB have increased energy needs and when HIV/AIDS is present, energy requirements increase by 20-30% to maintain body weight (SAHoH, 2007). The energy and nutrient requirements for people living with HIV/AIDS (PLHIV) and/or TB, developed in Ghana, are summarised in *Table 2.8.*

Table 2.8: Energy and Nutrient requirements for PLHIV and/or TB (Republic of Ghana, 2013).

Age group	Healthy	HIV and/or TB-infection		
		Asymptomatic	Symptomatic	Severely acutely malnourished
Children				
		10% more energy	20% more energy	50%-100% more energy
6 – 11 months	680	760	830	150 – 200 kcal/kg of body weight/day
12 – 23 months	900	990	1080	150 – 200 kcal/kg of body weight/day
2 – 5 years	1260	1390	1510	150 – 200 kcal/kg of body weight/day
6 – 9 years	1650	1815	1980	75 – 100 kcal/kg of body weight/day
10 – 14 years	2020	2220	2420	60 - 90 kcal/kg of body weight/day
Adults				
Non-pregnant/lactating	2000 – 2580	10% more energy	20% more energy	
Pregnant/lactating women	2460 – 2580	(210 – 258 more kcal)	(420 more kcal)	

Insufficient research is currently available to ascertain whether routinely providing energy supplements at or above recommended daily amounts results in better TB treatment outcomes, improved quality of life, or has any clinical benefits (Sinclair *et al*., 2011). Surprisingly little data is available in the literature on habitual macronutrient and micronutrient intake in patients with TB. A recent Cochrane review on the quality of evidence of trails on nutrient supplementation in TB concluded that there is insufficient evidence to determine whether an increase in energy intake improves patient outcomes (Frediani *et al*., 2013: 1024).

When hypermetabolism and fever occur, energy requirements increase by 13% for every degree Celsius of temperature above normal (Fenton & Silverman, 2008: 1011). If an HIV-infected individual's REE is found to be increased, energy requirements increase by 10% above normal requirements. REE is increased

dramatically in persons with opportunistic infections and as a result, the appropriate amount and type of food should be prescribed (ASSAf, 2008: 134).

During HIV-infection, energy requirements can range from 35 – 45 kcal/kg current body weight depending on the health status of the individual and the progression of the disease. Improvement and reversal of HIV-wasting can be attained when prescribing 500 kcal above estimated energy needs, or 40 – 50 kcal/kg body weight (Fenton & Silverman, 2008:1011). It is important to note than when people are involved in physical labour, and if meeting normal energy requirements is already difficult, increasing energy intake by 10% is reasonable advice (UNAIDS, 2014).

b. Protein

Protein requirements for maintaining health in HIV can be estimated at 1.0 – 1.4 g protein per kilogram current body weight and 1.5 – 2.0 g/kg body weight for repletion. Protein restriction is only advisable in severe hepatic or renal disease**.** In order to prevent wasting, sufficient protein should be consumed. The protein recommendations for these patients are 1.6-1.8g per kg of current weight. Protein requirements can increase by 10% for every degree Celsius of temperature above normal. High-protein diets may help to improve a positive nitrogen balance and restore lean body mass, but the ability of a high-protein diet to reverse HIV-malnutrition remains controversial (Fenton & Silverman, 2008:1011). Body weight and fat-free body mass can be increased with the supplementation of a whole-protein diet (ASSAf, 2008:135). Furthermore, when treating malnutrition, it is important that enough essential amino acids are provided through protein sources, thus a variety of protein should be included in the diet (animal food products, soybeans, dairy) (UNAIDS, 2014). Experimental animal studies confirm that a protein deficiency can have negative consequences on vaccine-induced resistance against TB, but this finding has not been confirmed in humans (Cegielski & McMurray, 2004: 294).

c. Fat

Immune-compromised patients often struggle with diarrhoea and other abdominal symptoms. In the case of fat malabsorption or diarrhoea, a low-fat diet is advisable. Medium-chain triglyceride (MCT) oil can help to decrease stool fat and stool nitrogen content, as well as reducing the number of bowel movements and abdominal symptoms (Fenton & Silverman, 2008: 1011). MCT oil together with fish oil (omega-3 fatty acids) is less inflammatory than omega-6 fatty acids and may improve immune function. Omega 3 fatty acids are associated with increased food intake, less weight loss and improved effects on the function and quality of lean body mass (Escott-Stump, 2012). Unsaturated rather than saturated fats should be consumed (UNAIDS, 2014).

d. Fluids and electrolytes

Fluid requirements in TB and TB/HIV co-infected individuals are the same as for healthy individuals (30 – 35 ml/kg per day). Electrolytes (sodium, potassium and chloride) that are lost through fever, diarrhoea, vomiting and night sweats should be replaced (Fenton & Silverman, 2008:1011). However, Mueller (2012: 918) indicates that all patients with TB require increased fluid intake, unless it is contra-indicated, such as in renal insufficiency.

2.11.2.2 Micronutrients

Micronutrients are essential for optimal functioning of the immune system (ASSAf, 2007). However, the relationship between TB and micronutrients is considered to be complex (USAID, 2010: 18) and randomised, placebo-controlled clinical trials of multi-micronutrient supplementation for adults with pulmonary TB and HIV co-infection have shown conflicting results. A study in Malawi, with a sample size of 829 adult patients with TB and HIV co-infection, concluded that daily supplementation with a multi-vitamin and mineral supplement had no significant impact on mortality (Semba *et al*., 2007: 856). A study in Tanzania also concluded that there was no significant impact of micronutrient supplementation on mortality, but supplementation with micronutrient nutrients did reduce the risk of relapse of TB by 63% in patients with pulmonary TB and HIV co-infection (Villamor *et al*., 2008: 1504). In contrast to the results of the above studies, another study in Tanzania, including 213 adult patients with pulmonary TB and HIV co-infection, found that daily supplementation with a multi-vitamin that included zinc for a period of eight months, reduced mortality by 71% (Range *et al*., 2006: 769). A study in Indonesia, with a small sample size of 54 TB patients, found that supplementation with vitamin A and zinc improved the effectiveness of anti-TB treatment during the first two months (Karyadi *et al*., 2002: 726). According to Murpere *et al*. (2012) micronutrients may improve the outcome of TB treatment.

Studies undertaken over the last two decades have found that low serum levels of essential micronutrients; namely vitamins A, E and D and the minerals calcium, iron, zinc and selenium are common in patients with active TB starting on treatment (Rudolph *et al*., 2013; Moses *et al*., 2008; Ramachandran *et al*., 2004; Madebo *et al*., 2003; Mugusi *et al*., 2003; Karyadi *et al*., 2000; Coetzee, 1997). Rudolph *et al*. (2013) reported that almost 50% of adult patients with TB had levels of vitamin A, vitamin D, iron, zinc, and albumin below the normal range. Deficiencies of vitamin A, C and D and the minerals zinc and iron can lead to immune impairment, and thus deficiencies of these micronutrients may be significant determinants of TB disease. The increased energy expenditure and tissue breakdown associated with infection are thought to increase the requirements of micronutrients such as vitamin A, E, $B_{6,}$ C, D and folate (ASSAf, 2007; Van Lettow *et al*., 2004).

a. Vitamin A and antioxidants

Low levels of vitamin A and certain antioxidants in patients with TB have been reported by several researchers (Semba *et al*., 2010: S352; Moses *et al*., 2008: 211; Karyadi *et al*., 2002). This could be because of oxidative stress, high load of free radicals, decreased dietary intake, and impaired absorption, increased utilisation during infection, lipid peroxidation or abnormal losses in the urine. All of these processes either destroy the antioxidants or create a high demand for them (Semba *et al*., 2010: S352; USAIDS, 2008: 18; Moses *et al*., 2008: 211). Karyadi *et al*. (2002: 726) reported that the effectiveness of anti-TB treatment improved during the first two months of supplementation with vitamin A and zinc.

b. Vitamin D

Adding calcitriol (1,25(OH)2 vitamin D3) to cultured human macrophages enhances the ability of the cells to control replication of active *M. tb* (Semba *et al*., 2010: S352; Cegielski & McMurray, 2004: 293; ASSAf, 2007). Supplementation with vitamin D may be required where sunlight and diets are inadequate, although further research on the impact of vitamin D supplementation during TB treatment is needed (USAID, 2010: 21). Abnormalities in terms of calcium homeostasis have been reported in patients with TB, but the correlation of these abnormalities to vitamin D status is still uncertain (Semba *et al*., 2010: S352).

c. Iron and anaemia

Anaemia is common in patients with pulmonary TB, and it appears to be more common among TB/HIV co-infected patients. Karyadi *et al*. (2000) found that patients with TB were more anaemic and had lower plasma concentrations of zinc and retinol than controls, while low concentrations of haemoglobin, retinol and zinc were also more common in malnourished TB patients.

Reasons for anaemia may be related to an inadequate intake, increased blood loss from hemoptysis, bone marrow involvement, or anaemia of chronic inflammation. As with other infections, intake of iron with TB disease, beyond correcting iron deficiency, may have harmful effects and should be avoided (Karyadi *et al*., 2000: 2957). On the other hand, iron overload occurs in about 10% of individuals in rural African populations due to high dietary iron intake through the consumption of traditional fermented beverages brewed in iron pots. Iron overload may increase the growth of *M. tb* by weakening macrophage suppression of invading microorganisms (USAID, 2008: 22-23).

d. Other trace elements

Zinc and selenium status are affected during infection. Excessive zinc losses may occur through diarrhoea, which is common in patients with TB, and may lead to loss of gastrointestinal epithelial integrity and absorptive power. In animal studies, selenium deficiency is associated with reduced immune function (ASSAf, 2007: 145).

2.11.2.3 Micronutrient supplementation

As mentioned, a number of deficiencies can occur in TB/HIV co-infected patients (Coodley & Albertson, 2001: 155). There is convincing evidence suggesting the need for a multivitamin and mineral supplement, which should provide 100% of the recommended daily allowances (UNAIDS, 2014; Fenton & Silverman, 2008: 1011). Mupere *et al*. (2012) has recommended that nutrition supplementation, together with counselling, is required to improve TB treatment outcomes positively.

2.12 Prevention Programmes

As far as prevention is concerned, HIV testing, prevention, and protection programmes should be emphasised (Labadarios *et al*., 2008: 132). The high incidence of TB infection in South Africa is mainly due to the high rate of HIV co-infection (WHO, 2013) and although TB is curable, HIV cannot be cured. Thus, babies at increased risk for TB should be vaccinated with bacille Calmette–Guérin (BCG) before discharge from hospital or as soon as possible (at the 6 weeks postnatal checkup). The BCG vaccination and TB testing should be promoted in eligible groups (Hoppe *et al*., 2016). The BCG seems to be protective against serious forms of disease (meningitis) in children, but not so effective against TB in adults. Therefore there is a need for a more effective vaccine (Frieden, 2003: 896).

Since South Africa is currently facing an economic crisis, health departments need to identify the cheapest and most effective treatment for TB. Community support groups are one of the cheapest and most effective ways to manage TB treatment. Communities can play an important contributory role in reducing the burden of TB and HIV and in alleviating its impact, stigma and discrimination. Despite this, community resources in most settings are often inadequate and their role remains undefined (Zacharaih *et al*., 2006). The DOTS strategy is a good initiative to support the community, and has been shown to lower the indirect costs of TB to patients and family members. However, the current implementation of the DOTS strategy needs to be reassessed (Ahlburg, 2000).

Food support has the potential to have a positive impact on the quality of life of patients with TB and family members affected by TB (WHO, 2013). Food support at the start of treatment, when people are still recovering from opportunistic infections and malnutrition, is of major importance. Together with food assistance, household members should be informed of the different nutritional needs in the family and that more vulnerable individuals might have increased requirements. Intervention strategies cannot be generalised, but should be implemented according to what is most appropriate in the specific context (Bloem & Saadeh, 2010: S290-S291).

Nutrition education has the potential to play an important role in improving nutritional status and ensuring food security (Keenan *et al*., 2001). Poverty, however, makes TB education difficult, due to lower levels of literacy in poverty stricken communities and limited access to mass media and health education services,

especially in rural areas. Furthermore, people struggling with daily survival are less inclined to worry about the long-term implications of illness and therefore are less likely to take preventative measures (FAO, 2003).

2.13 Conclusion

TB is closely associated with poverty and has not received the attention that it deserves in terms of the development of diagnostics, drugs, treatment and vaccines. It is considered to be a "neglected disease", together with HIV/AIDS, malaria and other diseases in developing countries.

Some people refer to TB as "The Mother of Diseases" and there is a saying that goes "TB anywhere is TB everywhere". Annually nearly 3 million lives are claimed by the curable TB disease. In South Africa, TB affects 4 to 5 out of every 1 000 people and thus the TB problem in South Africa is one of the worst in the world. TB costs about 10 000 lives a year in South Africa and is the most deadly single infectious disease in this country (ASSAf, 2007).

A better understanding of latent TB infection can assist in focusing on preventative and protective mechanisms. TB is as much a social disease as an infectious disease, as poverty, stress, drug addiction, alcoholism, overcrowding and malnutrition are associated with TB. Successfully addressing TB requires increasing awareness of TB to ensure earlier and better detection, by addressing the fears and preconceptions that people will feel free to admit having the illness, by giving support to those who are taking treatment to complete the long course, and by removing unnecessary barriers to treatment.

Proper nutritional status is vital during all lifestyle stages. A person affected by TB disease, directly or indirectly, requires even more special attention in terms of nutrition. Nevertheless, this group of people are usually the most neglected and malnourished. In order to obtain an adequate nutritional profile of patients with TB and TB/HIV co-infection, more research in this field is of tremendous importance.

CHAPTER 3

METHODOLOGY

3.1 Introduction

A cross sectional study was conducted to achieve the main aim of the study, which was to determine the nutritional status of patients with TB, and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga.

To achieve the above mentioned aim, information related to socio-economic status, nutritional status, overall risk of malnutrition, biochemical parameters and lifestyle behaviours was collected as part of the objectives. Associations between various parameters were also established.

3.2 Ethical considerations

Ethics approval was obtained from all relevant parties, including the Provincial Health and Research Ethics Committee (PHREC) of Mpumalanga Department of Health (PHREC MP_2015RP38_556) (Addendum D & E) and the Health Sciences Research Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS 56/2015) (Addendum F). Prior to data collection, approval to undertake the study was obtained from Standerton TB Specialised Hospital (Addendum G & H). All participants completed informed consent (Addendum I) and an information document (Addendum J) was given to each patient. The information document explained procedures that would be followed during the study, as well as risks, benefits, voluntary participation and guaranteed confidentiality.

3.3 Sample selection

3.3.1 Population and sample selection

The study population included all patients with TB, and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga. There were a total of five wards in the hospital, of which three wards had patients with MDR TB. For the purpose of this study, patients with MDR TB were excluded (due to different medication regimens); thus only two of the five wards were included. The patients with drug sensitive TB (patients that are not resistant to any of the TB medications) in ward one and two were included.

3.3.2 Sample

A convenience sample of consecutive patients was included. The sample included 100 patients with TB and TB/HIV co-infection that met the inclusion criteria and were present over a period of one month (21/07/2015 – 17/08/2015). Inclusion and exclusion criteria were applied to select patients who were eligible to participate in the study.

3.3.2.1 Inclusion criteria

The following participants were included in the study:

- For the period of the study, all patients with TB and, TB/HIV co-infection admitted to wards 1 and 2 at Standerton TB Specialised Hospital
- Patients between 20 and 69 years (as this is within the age references of the anthropometric cut-off points for the Triceps skinfold measurement)

3.3.2.2 Exclusion criteria

The following participants were excluded from the study:

- Patients with additional diagnoses other than TB or TB/HIV co-infection
- Pregnant or lactating patients (anthropometric and biochemical cut-off points differ)
- Patients that were mentally disabled (unable to report accurate information)
- Patients that were physically disabled (anthropometric measures are affected)

3.4 Operational definitions

For the purpose of the study the following definitions were compiled and applied to achieve the objectives of the study.

3.4.1 Room density

For the purpose of this study, a room density of more than 2.5 persons per room (ppr), was an indication of crowding (Coetzee *et al*., 1988: 354).

3.4.2 Eating related side effects and food security

For the purpose of this study, eating related side effects referred to: loss of appetite, sore mouth, dry mouth, nausea, vomiting, constipation, diarrhoea and night sweats. Food security was assessed by means of the Community Childhood Hunger Identification Project (CCHIP) tool that included questions related to the availability of money in the household for food purchases (Wehler *et al*., 1992). The CCHIP hunger index is a scale composed of eight questions that investigates whether adults and/or children in the household are affected by food insecurity, food shortages, perceived food insufficiency or altered food intake due to constraints on resources (FRAC, 1991).

Food insecurity was categorised as follows (FRAC, 1991):

- A score of five or more positive responses (Yes answers) out of a maximum possible of eight indicated that the family is “hungry”.
- A score of one to four positive responses (Yes answers) indicated that the family is at “risk of hunger”.
- A negative response (No answer) assumed that the household is “food secure”.

3.4.3 Anthropometric measurements

For the purpose of this study anthropometric indicators of nutritional status included height, weight, MUAC and Triceps skinfold.

3.4.3.1 Body mass index (BMI)

BMI was calculated by dividing weight in kilograms (kg) by height in m^2. BMI was interpreted according to the World Health Organisation (WHO) categories of BMI as indicated in Table 1.

Table 3.1: Weight classifications by Body Mass Index (WHO, 2006)

BMI (kg/m²)	**WHO classification**
< 18.5	Underweight
18.5 – 24.9	Normal weight
25 – 29.9	Overweight / Pre-obese
30.0 – 34.9	Obese Class I
35 – 39.9	Obese Class II
≥ 40	Obese Class III

3.4.3.2 Mid-upper arm circumference (MUAC)

For the purpose of this study a MUAC of <22cm for females and <23cm for males indicated malnutrition as indicated by Table 2 (Tang *et al*., 2013).

Table 3.2: Cut-off points for classification of adult- malnutrition by mid-upper arm circumference

	Circumference (cm)	**Classification**
Females	≥ 22	Normal
	< 22	Malnourished
Males	≥ 23	Normal
	< 23	Malnourished

3.4.3.3 Triceps skinfold

For the purpose of this study a Triceps skinfold measurement was interpreted according to the Triceps skinfold norms from NHANES 2003 – 2006 as indicated by *Table 3.3* for females and *Table 3.4* for males (Lee & Nieman, 2013:459-460).

Table 3.3: Triceps skinfolds in millimetres for females 20 years of age and older

Race, ethnicity and age	Percentile (mm)								
All race and ethnicity groups	**5th**	**10th**	**15th**	**25th**	**50th**	**75th**	**85th**	**90th**	**95th**
20-29 years	10.4	11.9	13.2	15.5	21.1	27.3	30.3	32.4	34.7
30-39 years	12.1	14.7	15.8	18.2	23.9	30.2	32.9	35.3	37.4
40-49 years	12.1	14.1	15.9	19.5	25.6	30.9	33.6	35.2	36.9
50-59 years	13.3	16.1	17.5	20.5	25.9	31.0	33.2	34.9	36.5
60-69 years	13.4	16.6	18.1	20.3	25.4	30.2	32.8	34.2	36.0

Table 3.4: Triceps skinfolds in millimetres for males 20 years of age and older

Race, ethnicity and age	Percentile (mm)								
All race and ethnicity groups	**5th**	**10th**	**15th**	**25th**	**50th**	**75th**	**85th**	**90th**	**95th**
20-29 years	5.0	6.2	7.1	8.8	12.7	18.9	21.7	25.4	29.4
30-39 years	5.8	7.1	8.2	10.0	13.6	18.3	21.4	23.4	27.0
40-49 years	6.6	7.6	8.7	10.4	13.9	19.2	22.3	24.1	27.9
50-59 years	6.2	7.4	8.9	10.8	14.1	18.5	21.5	23.2	26.7
60-69 years	7.3	8.3	9.4	11.2	14.9	19.7	22.5	25.2	30.3

3.4.4 Overall risk of malnutrition

For the purpose of this study the overall risk of malnutrition was determined by making use of the Malnutrition Universal Screening Tool (MUST) (Bapen, 2003).

The four-step MUST screening tool to identify adults, who are malnourished or at risk of malnutrition is illustrated in Figure 3.1:

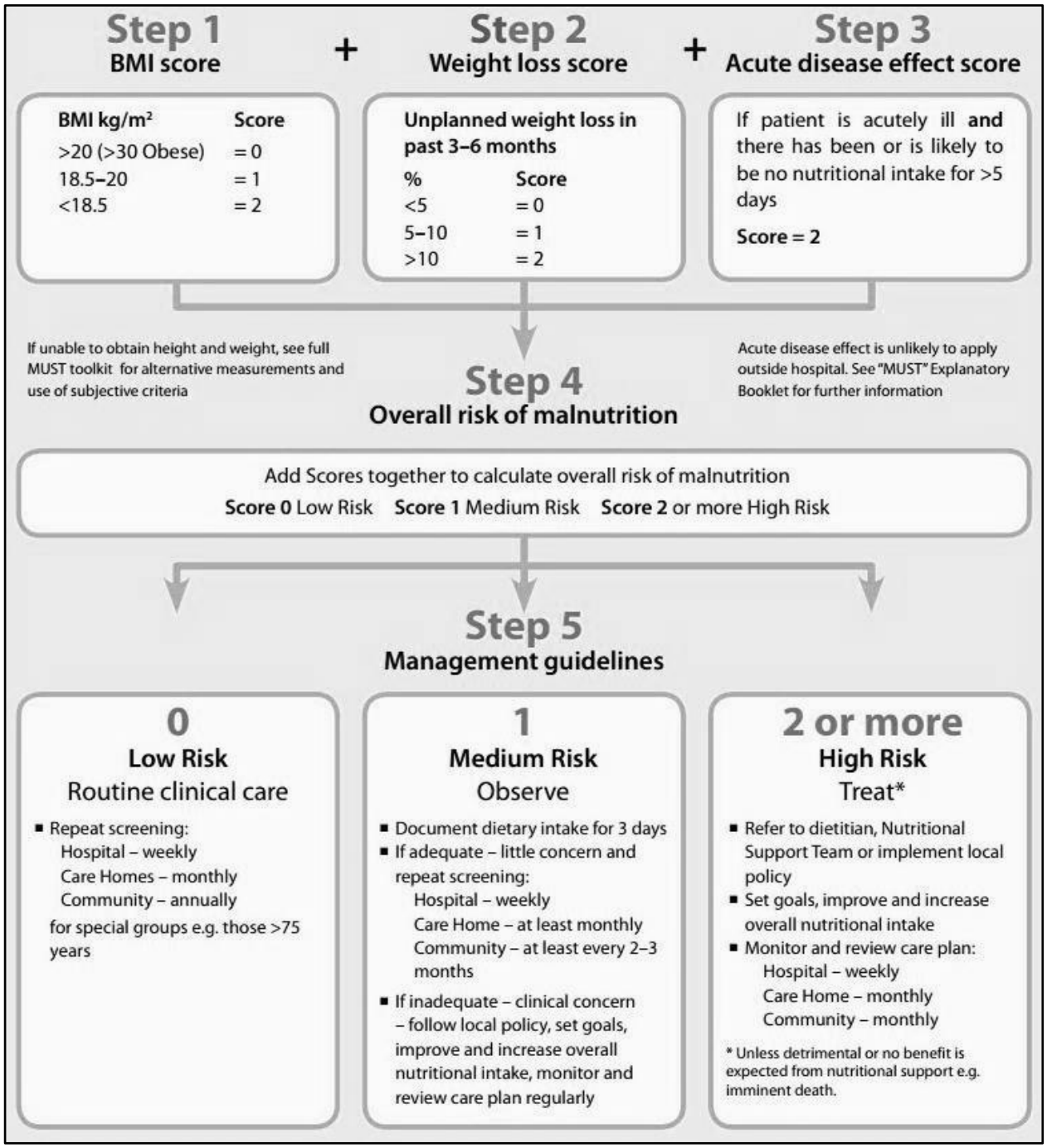

Figure 3.1: The Malnutrition Universal Screening Tool (Bapen, 2003)

3.4.5 Biochemical parameters

The following biochemical markers were measured. Normal values (ranges or cut-off points) for biochemical parameters are indicated below (Du Buisson *et al*., 2010):

- Total protein 60 – 78g/l
- Albumin 35 – 52g/l
- C-reactive protein (CRP) 0.0 – 4.9mg/l

- CD_4 cell count 500 – 2000mm^3
- Mean corpuscular volume (MCV) 79.1 – 89.0f/l
- Haemoglobin Male: 14.3 – 18.3g/dl ; Female: 12.1 – 16.3g/dl

3.4.6 Lifestyle behaviours

3.4.6.1 Smoking habits

Smoking habits were categorised as follows (Peltzer, 2014; Saad & Tirkey, 2013):

- Non-smoker: Patient who had never smoked;
- Former smoker: Patient who had smoked before, but who had stopped smoking for at least 3 months before entering the study.
- Current smoker: Patient that smoked at least one cigarette, pipe, or cigar per day for at least 6 months prior to entering the study.

Patients who were former or current smokers were asked how many times a day and for how many years they were/are smoking.

3.4.6.2 Alcohol consumption

For the purpose of this study, alcohol consumption was categorised according to whether or not the participants formerly drank alcohol more than 3 times per week (Peltzer, 2014; Saad & Tirkey, 2013). An alcohol consumption of less than 3 times per week was considered low, while consumption of alcohol 3 or more times a week was considered high (Saad & Tirkey, 2013).

3.5 Pilot study

A small-scale trial run was conducted to prepare for the main study. The pilot study's function was to determine the feasibility of the study (Smith & Harrison, 2009: 35), to ensure that the respondents understood the questions and to determine how long it would take to complete the necessary interviews with the respondents. The pilot study was conducted by the researcher herself on the first five patients from Standerton TB Specialised Hospital. No changes were made after the pilot study, thus these five patients were included in the main study.

3.6 Data collection process

Step 1

- Approval was obtained from the Research Evaluation Committee of the School of Allied Health Professionals of the University of the Free State.

- Approval was obtained from the Provincial Health and Research Ethics Committee (PHREC) of Mpumalanga Department of Health (Addendum D & E).
- Approval was obtained from the Health Sciences Research Ethics Committee of the University of the Free State (Addendum F).
- Approval was obtained from the Corporate Executive Officer (CEO) at Standerton TB Specialised Hospital (Addendum G & H).
- Informed consent (Addendum I) was obtained from the participating patients. The information document (Addendum J) was discussed with each patient and informed consent was provided by patients before taking part in the study.
- The pilot study was undertaken at Standerton TB Specialised Hospital.

Step 2

- Patients at Standerton TB Specialised Hospital completed the consent forms with the help of the researcher and a translator (if needed). Lay counsellors at the Hospital assisted with translating and explaining the procedure of the study to patients in their own language. The information document was given to patients to provide them with more information regarding the study.
- Questionnaires (including; socio-economic status, eating related side effects, food security, overall risk of malnutrition, smoking habits and alcohol use) were completed with each patient in a structured interview with the researcher. The interviews took place in a private room.
- The researcher conducted anthropometric measurements (weight, height, MUAC and Triceps skinfold) on all the patients.
- Biochemical data (total protein, albumin, CRP, CD_4 cell count, MCV and haemoglobin) were taken from the patients files and recorded on the questionnaire by the researcher.

Step 3

- A feedback report will be given to the hospital to highlight the results of the study and help the hospital to improve in areas that warrant nutrition intervention strategies.

3.7 Techniques

The techniques that were used to obtain information from the participants included a questionnaire, anthropometric measurements and biochemical assessments.

3.7.1 Questionnaire

For the purpose of this study, a questionnaire was designed by the researcher to obtain information related to the nutritional status of patients with TB and TB/HIV co-infection at Standerton TB Specialised Hospital (Addendum K). The questionnaire included questions related to socio-demographic status, eating related side effects and food security (CCHIP questionnaire), overall risk of malnutrition (MUST tool) and lifestyle habits. The questionnaire was administered by the researcher, a registered dietician, via a structured interview with each patient.

3.7.2 Anthropometric measurements

3.7.2.1 Weight

Weight was measured with a platform electronic scale (TCS-200-RT). As recommended by Lee & Nieman (2013:168), the participants were wearing minimal clothing (removed jacket, shoes and jewellery), standing still in the middle of the scale's platform without touching anything and with the body weight equally distributed on both feet. The weight was recorded to the nearest 0.1 kg.

3.7.2.2 Height

Height for adults was measured by means of a stadiometer (TCS-200-RT) with a vertical scale of 2 meters and a sliding head-piece, to the nearest 0.5cm. Participants were measured without shoes. The participants stood with their heels together, arms to the side, legs straight, shoulders relaxed and head in the Frankfort horizontal plane (looking straight ahead). Heels, buttocks, scapulae (shoulder blades), and the back of the head were against the vertical surface of the stadiometer. Just before the measurement was taken, the participant inhaled deeply, held the breath and maintained an erect position while the sliding-headpiece was lowered to the highest point of the head with enough pressure to compress the hair (Lee & Nieman, 2013:167).

3.7.2.3 Mid-upper arm circumference

MUAC was measured using a non-stretch flexible tape-measure. The participants stood erect and sideways to the measurer, with the head in the Frankfurt plane, legs apart, and arms relaxed. Sleeved garments were rolled up or removed. The measurement was taken at the midpoint of the upper arm, between the acromion process and the tip of the olecranon. After locating the midpoint, the arm was extended so that it is hanging loosely by the side, with the palm facing inward. The tape was then wrapped gently but firmly around the midpoint of the arm (Lee & Nieman, 2013: 228; Gibson, 2005: 290). The MUAC measurement was taken three times on each participant and an average was calculated by the researcher to the nearest 1mm.

3.7.2.4 Triceps skinfold

The measurement of the triceps skin fold was performed at the midpoint of the upper right arm, between the acromion process and the tip of the olecranon, with the arm hanging relaxed. To obtain the midpoint, the right arm had to be bent at 90º at the elbow, and the forearm had to be placed palm down across the body. The tip of the acromion process of the shoulder at the outermost edge of the shoulder blade and the tip of the olecranon process of the ulna was located and marked. The distance between these two points was then measured using a non-stretchable tape, and the midpoint was then marked with a soft pen. The right arm was then extended so that it was hanging loosely by the side. The examiner grasped a vertical fold of the skin plus the underlying fat, 2cm above the marked midpoint, using both the thumb and the forefinger. The skinfold was held between the fingers while the measurement was taken to the nearest mm (Lee & Nieman, 2013: 190; Gibson, 2005: 275-276). The triceps skin fold measurement was taken three times on each participant and the average was noted to the nearest 2mm.

3.7.3 Biochemical parameters

Blood of patients are drawn as part of standard procedures in the hospital by a professional nurse. Biochemical parameters (total protein, albumin, CRP, CD_4 cell counts, MCV, and haemoglobin) were analysed in an accredited laboratory using standard laboratory techniques.

3.8 Statistical analysis

Descriptive statistics, namely frequencies and percentages for categorical data, medians and percentiles for continuous data was calculated. Associations between variables were calculated and described by means of 95% confidence intervals (CI) for differences in percentages. All analyses were completed by the Department of Biostatistics at the University of the Free State.

3.9 Measurement and methodology errors and limitations

Illiteracy and language limitations may have been a challenge during the interviews. To overcome this barrier, a translator was present during the structured interviews. In order to ensure that questions were not misinterpreted by the translators, the questionnaire was translated into isZulu and the exact wording was used by the translator.

In order to ensure that weight measurements were accurate, the weight recorded by the scale was compared with a known weight after weighing every 20 participants (Myer & Karim, 2014).

This study only included hospitalised patients, thus the chance that more ill, malnourished patients were included was high, indicating that results may not be representative of patients in the community setting.

3.10 Validity and reliability

Validity is defined as a test that measures what it's supposed to measure. To determine if an instrument is valid, one need to know what the instrument is meant to measure and to ensure that this is what is indeed being measured. Reliability refers to a consistent and stable result (Kimberlin & Winterstein, 2008: 2277-2278; Delport, 2008: 162; Sherry *et al*., 2003: 113).

3.10.1 Questionnaire

3.10.1.1 Validity

All issues addressed by the questionnaire were directly related to the aim and objectives of the study. The CCHIP index is internationally used and validated, has excellent sensitivity and good specificity, is one of the first scales developed to measure hunger in families and is strongly associated with socio demographic variables (Keenen *et al*., 2001; Wehler *et al*., 1992). The MUST tool is internationally validated and regarded as an accurate tool to evaluate the risk of malnutrition in adult patients (Gibson *et al*., 2012: 313; Bapen, 2003; Stratton *et al*., 2004: 807). The content of the lifestyle questionnaire has been selected in accordance with recommended measurements for factors related to lifestyle which have been suggested in the literature (Peltzer, 2014; Saad & Tirkey, 2013).

3.10.1.2 Reliability

Only one person, namely the trained researcher, completed the questionnaire in a personal interview with each participant.

3.10.2 Anthropometric measurements

3.10.2.1 Validity

The scale was moved to the zero point before each measurement. The weight recorded by the scale was regularly compared with a known weight to ensure that an accurate measurement was taken.

3.10.2.2 Reliability

In order to ensure reliability of the results, weight, height, MUAC, and Triceps skin fold were measured by the same trained researcher (a registered dietitian) according to standard procedures, as recommended by Lee & Nieman (2013).

3.10.3 Biochemical parameters

3.10.3.1 Validity

The biochemical variables that were determined included routine tests that are performed on patients in the hospital.

3.10.3.2 Reliability

The results of the blood tests were considered reliable, because they are determined in an accredited laboratory by trained personnel using standard controls

CHAPTER 4

SOCIO-DEMOGRAPHIC PROFILE AND HOUSEHOLD FOOD SECURITY OF PATIENTS WITH TB, AND TB/HIV CO-INFECTION AT STANDERTON TB SPECIALISED HOSPITAL, MPUMALANGA

ABSTRACT

Objective: To determine the socio-demographic profile and level of household food security of patients with TB, and TB/HIV co-infection.

Design: A cross sectional study was undertaken.

Settings and subjects: The study was conducted at Standerton TB Specialised Hospital, Mpumalanga. One hundred hospitalised patients with TB, and TB/HIV co-infection were included.

Outcome measures: A structured interview was conducted by the researcher with each patient to obtain socio-demographic information and the level of food security in the household, using the Community Childhood Hunger Identification Project (CCHIP) tool.

Results: The majority of participants (91%) did not complete matric and two thirds (66%) were unemployed. More than one out of ten participants (12%) indicated that they had no monthly income and in 64% of households, only one person contributed to the monthly income. Room density of more than 2.5 persons per room (crowded) was present in 29% of households. Only 26% of participants reported having a household vegetable garden. As far as household food security was concerned, only 3% were classified as food secure with 27% of households being at risk of hunger and 70% being food insecure (hungry).

Conclusion: The socio-demographic profile of patients with TB and TB/HIV co-infection reflected high rates of poverty, unemployment and household food insecurity. These factors are known to increase the risk of developing TB disease and progression of latent TB infection to TB disease. Interventions aimed at addressing TB need to address unfavourable socio-demographic conditions.

INTRODUCTION

Tuberculosis (TB) is an infectious disease caused when the *Mycobacterium tuberculosis* (*M. tb*) organism enters the lungs (Shi & Sugawara, 2013: 127). According to The World Health Organisation (WHO), 9.6 million new TB cases were diagnosed in 2014, with an estimated 1.2 million that were human immunodeficiency virus (HIV) co-infected. The African Region accounts for 28% of TB cases and 74% of TB and HIV co-infected cases worldwide. This amounts to 281 cases per 100 000 population, which is more than double the global average of 133 cases per 100 000 population (WHO, 2015).

Socioeconomic factors are closely related to TB infection. These include poverty, crowding, unemployment, malnutrition, and poor access to efficient health facilities. These factors do not only increase the risk for developing TB, but also increase the chances of treatment failure. According to the South African National Tuberculosis Association (SANTA), the incidence of TB is especially high amongst males, miners, the poor

and the very young in South Africa (SANTA, 2014; Chee *et al.*, 2013: 205; Songpol *et al*., 2005: 221). TB is mostly associated with specific population subgroups including immigrants from countries with high endemicity, ethnic minorities, refugees, and the homeless (Faccini *et al*., 2013: 485). According to Villamor *et al*. (2006: 170), poor socioeconomic status is an important predictor of malnutrition in patients with TB disease, independent of HIV infection.

Food insecurity plays an important role in the progression of TB infection to active TB disease (Bloem & Saadeh, 2010). Food security is defined as "access to enough food at all times by all people for an active and healthy life" (Anderson, 1990; Keenan *et al*., 2001). According to Bloem & Saadeh (2010), food insecurity is defined as limited food utilisation, availability, or access. Households experience food insecurity in the most basic form when they do not have adequate resources to obtain enough food to meet their basic nutritional needs; resulting in hunger for all household members (Keenan *et al*., 2001). In an attempt to optimise nutritional status, food and nutrition security are essential factors to consider, especially in the TB population (ADA, 2010).

Globally household food security is a major concern. According to the global International Food Security Assessment for 2011 to 2021, the number of food-insecure people and the food gap are estimated to decline respectively by 16% and 7% during the ten year period. In Sub-Saharan African, however, the opposite is predicted, with an increase of 17 million in the number of food-insecure people and an increase of 20% in the food gap between 2011 and 2021 (USDA, 2011).

Between 1999 and 2008 the prevalence of food insecurity in South Africa appears to have been reduced by half (from 52.3% to 25.9%), but the percentage of people at risk of experiencing food insecurity remained almost unchanged, due to population growth together with high levels of unemployment (WHO, 2013; Labadarios *et al*., 2011). A major concern with regards to household food security is that a household may be food secure overall, but a poor understanding of individual needs, together with an unequal distribution among household members, may lead to food and nutrition insecurity for the more vulnerable household members, such as those infected with TB and/or HIV (Ogundiran *et al*., 2014; Bloem & Saadeh, 2010: S290).

"The Right to Food" is a basic human right enshrined in the South African constitution. The right to adequate food as a basic human right was first formally recognised by the United Nations in the Universal Declaration of Human Rights (UDHR), as a part of the right to a decent living standard (FAO, 2016). During 2009 the World Food programme (WFP) provided food assistance to 3 million people that were affected and infected with HIV and TB (Bloem & Saadeh, 2010: S291). As mentioned, food insecurity is a major risk factor for the development and prognosis of TB disease.

In view of the reported negative impact of poor socio-economics conditions on TB, the purpose of this study was to determine the socio-demographic profile and level of food security of patients with TB and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga, where information of this nature has not previously been collected. This information may contribute to the identification of specific areas that need to be considered in health and nutrition interventions, which may in turn play a vital role in improving the outcome, quality of life and prognosis of patients with TB and TB/HIV co-infection.

METHODOLOGY

Study design

A cross sectional study was conducted.

Target population and sampling

The study population included all patients between 20-65 years with TB, and TB/HIV co-infection that gave informed consent to participate at Standerton TB Specialised Hospital, Mpumalanga in wards 1 and 2 over a period of one month (21/07/2015 – 17/08/2015). Patients with any additional diagnoses other than TB and TB/HIV co-infection, pregnant or lactating patients, and mentality or physically disabled patients were excluded from the study. The sample included 100 patients with TB and TB/HIV co-infection that met the inclusion criteria.

Pilot study

A pilot study was conducted on the first five patients that met the inclusion criteria and provided onfrormed consent from Standerton TB Specialised Hospital to determine the feasibility of the methodology. No changes were made to the questionnaire and data of these participants was thus included in the main study.

Variables and operational definitions

Information related to socio-demographic status included gender, age, marital status, education level, employment status, household income and housing density.

Food security was assessed by means of the Community Childhood Hunger Identification Project (CCHIP) tool that includes eight questions that investigate whether adults and/or children in the household are affected by food insecurity, food shortages, perceived food insufficiency or altered food intake due to constraints on resources. Food insecurity was categorised as follows (FRAC, 1991):

- A score of five or more positive responses (Yes answers) out of a maximum of eight indicate that the family is “hungry”.

- A score of one to four positive responses (Yes answers) indicate that the family is at "risk of hunger".
- A negative response (No answer) to all questions indicates that the household is "food secure".

Techniques

Based on a comprehensive literature review, a questionnaire was designed by the researcher to obtain information regarding the socio-demographic status of participants. Information related to food security of patients with TB and TB/HIV co-infection at Standerton TB Specialised Hospital was collected using the CCHIP questionnaire. The researcher completed a structured interview with each participant.

Validity and reliability

All issues addressed by the questionnaire were directly related to the aim and objectives of the study. The CCHIP index is an internationally used and validated tool (Wehler *et al*., 1992). Keenan *et al*. (2001: S56) confirmed that the CCHIP huger index has excellent sensitivity and good specificity. Only one person, namely the trained researcher, completed the questionnaire in a personal interview with each participant.

Ethics

Ethics approval was obtained from the Provincial Health and Research Ethics Committee (PHREC) of Mpumalanga Department of Health (PHREC MP_2015RP38_556) and the Health Sciences Research Ethics Committee of the Faculty of Health Sciences, University of the Free State (UFS) (ECUFS 56/2015).

Data collection

All eligible participants signed consent in their language of choice (English/IsiZulu), after the purpose and procedure of the project had been explained to them by the researcher or a lay counsellor who spoke the native language. The information document was given to patients to provide them with all the relevant information regarding the study. Once informed consent had been obtained, participants were interviewed by the researcher. In addition to information on socio-demographic status and food security, information on nutritional status, smoking habits and alcohol use were also collected; these are reported elsewhere.

Statistical analysis

Descriptive statistics, namely frequencies and percentages for categorical data, and medians and percentiles for continuous data were calculated. Associations between variables were calculated and described by means of 95% confidence intervals (CI) for differences in percentages. All analyses were completed by the Department of Biostatistics at the UFS.

RESULTS

The study sample included 100 participants (60 males and 40 females). The median age of the sample was 39.2 (20.3-63.5) years. More than two thirds of participants (68%) were HIV positive; with HIV co-infection being slightly higher among women (70%) than among men (66.7%).

Socio-demographic profile

Socio-demographic information is presented in *Table 4.1*. Half of participants (50%) indicated that they were unmarried. The majority (91%) did not complete matric, 44% had completed less than grade nine and 8% had no schooling. Two thirds (66%) were unemployed. Almost one third (32%) of participants indicated that the total household income per month was R1001-R3000 and 12% indicated that they had no monthly income. In 13% of participants, no one contributed to the monthly income and more than two thirds (64%) indicated that only one person contributed to the monthly income

Table 4.l: Socio-demographic information

	Frequency (n)	Percentage (%)
Marital Status (n=100)		
Unmarried	50	50.0
Married/Traditional marriage	23	23.0
Divorced/Separated	2	2.0
Widow/Widower	6	6.0
Living together	19	19.0
Level of education (n=100)		
No schooling completed	8	8.0
Less than Grade 9	36	36.0
At least Grade 9	47	47.0
Matric completed	7	7.0
Tertiary education	2	2.0
Current employment status (n=100)		
Unemployed	66	66.0
Self-employed	1	1.0
Full time wage earner	15	15.0
Part time wage earner	9	9.0
Receives a grant	9	9.0
Total household income per month (n=100)		
None	12	12.0
R100 – R500	10	10.0
R501 – R1000	22	22.0
R1001 – R3000	32	32.0
R3001 – R5000	13	13.0
Over R5000	4	4.0
Don’t know	7	7.0
Number of people contributing to the monthly income (n=100)		
None	13	13.0
1 Person	64	64.0
2 Persons	20	20.0
3 Persons	3	3.0

The median number of people per household was 5 with a maximum of 11 people. A room density of more than 2.5 persons per room (ppr), indicative of crowding, was present in 29% of households. The median room density was 2 ppr (0.5-8)

Only 26 of the 100 participants had a vegetable garden. The type of vegetables reportedly grown by participants with gardens is presented in *Table 4.2*. Spinach (76.9%) followed by cabbage (42.3%) and beetroot (34.6%) were the most commonly grown vegetables.

Table 4.2: Vegetable gardens (n=26)

	Frequency	**Percentage**
Type of vegetable		
Spinach	20	76.9
Cabbage	11	42.3
Beetroot	9	34.6
Pumpkin	8	30.8
Potato	5	19.2
Tomato	4	15.4
Maize '*Mielies'*	3	11.5
Carrots	3	11.5
Onions	3	11.5
Green beans	1	3.9
Sweet potato	1	3.9
Number of vegetables		
1 Type of vegetable	7	26.9
2 Types of vegetables	6	23.1
3 Types of vegetables	7	26.9
4 Types of vegetables	3	11.5
5 Types of vegetables	1	3.9
6 Types of vegetables	2	7.7

Household food security

The responses to the CCHIP questionnaire are presented in *Table 4.3*. Almost every participant (97%) indicated that they ran out of money during the month to buy food, and more than nine out of ten (93%) relied

on a limited number of foods. More than half (53%) of participants (n=94) reported that their children sometimes go to bed hungry, because there is not enough money for food.

Table 4.3: Responses to Community Childhood Hunger Identification Project questionnaire

CCHIP Question	Yes responses (%)	No responses (%)
Household-level food insecurity (n=100)		
Q1: Does your household ever run out of money to buy food?	97	3
Q2: Do you ever rely on a limited number of foods because you are running out of money to buy food?	93	7
Q3: Do you ever cut the size of meals or skip meals because there is not enough money to buy food?	77	23
Individual-level food insecurity (n=100)		
Q4: Do you ever eat less than you should because there is not enough money for food?	79	21
Child hunger (n=94)		
Q5: Do your children ever eat less than you feel they should because there is not enough money for food?	75	19
Q6: Do your children ever say they are hungry because there is not enough food in the house?	63	31
Q7: Do you ever cut the size of your children's meals or do they ever skip meals because there is not enough money to buy food?	62	32
Q8: Do any of your children ever go to bed hungry because there is not enough money to buy food?	53	41

A significantly higher percentage of HIV co-infected than HIV uninfected participants reported relying on a limited number of foods to feed their children (97.1% compared to 83.9% respectively; 95% CI [-29.8%; -1.7%]), sometimes cut the size of their meals or skip meals (83.8% and 61.3% respectively; 95 CI [4.2%; 41.3%]), eating less than they wanted to (86.8% and 61.3% respectively; 95% CI [7.4%; 44.0%]) and their children tend to eat less than they should because there was not enough money available for food purchases (85.7% and 66.7% respectively; 95% CI [1.4%; 38.1%]).

After the scoring of the responses to the CCHIP questions had been applied, categories of household food security were determined and are presented in *Table 4.4*. Only 3% of households were classified as food secure with 27% of households at risk of hunger and 70% being classified as food insecure (hungry). There was no noticeable difference between males and females in terms of household food insecurity. Although a lower percentage of participants with TB and HIV co-infection were food insecure (1.5%) compared to participants that only had TB (6.5%), the difference was not statistically significant (95% CI [-2.3%; 36.3%]).

Table 4.4: Household food security

CCHIP Group	**Males (n=60)**	**Females (n=40)**	**Total**
Food secure (no positive responses)	2 (66.7%)	1 (33.3%)	3
Risk of hunger (1-4 positive responses)	18 (66.7%)	9 (33.3%)	27
Hungry (5 of more positive responses)	40 (57.1%)	30 (42.9%)	70

CCHIP Question	**HIV positive (n=68)**		**HIV negative (31)**		**95% Confidence interval for the % difference**
	Yes response (%)	**No response (%)**	**Yes response (%)**	**No response (%)**	
Q1	98.5	1.5	93.5	6.5	[-19.3%; 2.9%]
Q2	97.1	2.9	83.9	16.1	[-29.8%; -1.7%]*
Q3	83.8	16.2	61.3	38.7	[4.2%; 41.3%]*
Q4	86.8	13.2	61.3	38.7	[7.4%; 44.0%]*
Q5	85.7	14.3	66.7	33.3	[1.4%; 38.1%]*
Q6	71.4	28.6	56.7	43.3	[-5.3%; 34.7%]
Q7	69.8	30.2	56.7	43.3	[-6.9%; 33.3%]
Q8	58.7	41.3	50.0	50.0	[-12.1%; 29.0%]
Classification (%)					
Food secure (n=3)	1.5		6.5		
Risk of hunger (n=27)	23.5		35.5		[-2.3%; 36.3%]
Hungry (n=69)	75.0		58.1		

* Statistically significant difference

DISCUSSION

The median age of participants in the current study was below 40 years (39.2 years) and most (60%) were men. This is similar to that reported in other studies undertaken in patients with TB where mean age ranged from 29-46 years (Kirenga *et al*., 2015; Bhargava *et al*., 2013; Frediani *et al*. 2013: 1025; Gill et al., 2013: 985; Matos & Moreira Lemos, 2006: 1361; Marra *et al*., 2004). When looking at the above studies, the median age illustrates that TB often affects the working age population in their prime productive years. According to the WHO (2013a), 75% of all TB cases occur among people between 15-54 years of age.

Sixty percent of participants in the present study were male. Worldwide most TB cases and deaths occur among men (Bhargava *et al*., 2013; Frediani *et al*. 2013: 1025; Miyata *et al*., 2013; Matos & Moreira Lemos, 2006: 1361; Marra *et al*., 2004). In women TB disease also remains among the top three killers (WHO, 2013a). Gill *et al*. (2013: 985) undertook a research study among patients with TB in a low endemic area in Australia and found that 55% were female. In some studies women have been found to be more likely to progress from TB infection to active disease than men. In addition, households in which women suffer from TB are more likely to experience additional losses, since women are most often responsible for food purchases, cooking, breastfeeding and childcare (Ahlburg, 2000).

An estimated 1.1 million of the 8.6 million people who developed TB in 2012 were HIV-positive and around 75% of these cases were from the African Region (WHO, 2013). Worldwide, 12% of the 9.6 million new cases of TB in 2014 were HIV positive (WHO, 2015). Globally an estimated 70% of patients with TB are co-infected with HIV (Amollo, 2009). The results of the current study is similar, with 68% of patients with TB disease being co-infected with HIV. Louwagie *et al*. (2014: 503) found a co-infection rate of 85% in male patients with TB in Tshwane, South Africa, while Villamor *et al*. (2006: 165) have reported lower rates in Tanzania (50% among women and 24% among men). In the current study women also had slightly higher HIV co-infection rates than men (70% among women 66.7% among men).

The South African National Health and Nutrition Examination Survey (SANHANES) was undertaken in a random sample of South Africans in 2012 and reported that 40% of participants had an education level of primary school or less and only 20% had completed matric (Shisana *et al*., 2013). The current study also found high levels of illiteracy among patients with TB and TB/HIV co-infection (8% with no education and 36% with less than Grade 9). This finding is similar to a study conducted in Pakistan that reported that 65.8% of patients with active TB had never attended school (Awan *et al*., 2012: 329). A study that was undertaken amongst 1005 male patients with TB in the Tshwane Metropolitan Municipality, South Africa, found than 31.1% of patients had an education level of primary school or less and 45.3% had some high school education (Louwagie *et al*., 2014: 503).

Not only basic education, but TB specific education is very important, since lack of knowledge, discrimination and stigma are influential social determinants of the disease (Nieburg & Angelo, 2015). In the words of Dr Thato Mosidi in 2015, a TB activist who previously also suffered from extreme drug resistant TB (XDR TB): "*I believe if we start talking about it and educating people about the disease, we'll be well on the way to eradicating it".*

According to the SANHANES, the majority of participants in urban formal, urban informal and rural informal areas had no formal monthly income. Out of the nine provinces, Mpumalanga (where the current study was conducted) was the province in which the highest percentage (46%) of respondents reported that they have no monthly income (Shisana *et al*., 2013).

The published unemployment rate in South Africa is currently 24.3%, thus one out of four citizens is jobless (Trading Economics, 2016). An almost three times higher unemployment rate of 66% was noted in the current study. High rates of unemployment were also reported in an outpatient TB clinic in Tbilisi with an unemployment rate of 52% (Frediani *et al*., 2013: 1025). Similarly, Lombardo *et al*. (2012: 1025) reported an unemployment rate of 58% in patient with TB in Delft, Cape Town, South Africa. High levels of unemployment complicate the situation, since it means that limited funds are available for food purchases, putting families at risk for developing TB disease. The WHO estimates that adults infected with TB disease lose an average of 3-4 months of potential work time and an adult TB death results in an average of 15 lost years of economic activity (Ahlburg, 2000).

Results of the current study indicated that the total household income was very low for the majority of participants. These findings have been confirmed in other studies undertaken amongst large samples of patients with TB, such as the study undertaken in Tshwane (Louwagie *et al*., 2014: 5503). It is well known that population groups at higher risk for poor nutrition are also at high risk for TB, poverty being a strong denominator (Cegielski & McMurray, 2004: 286). Kirenga *et al*. (2015) classified the risk factors in patients with TB in Uganda and found a prevalence of poverty in 39.5% of participants. On the other hand, TB also increases one's risk of poverty, since people with TB often face the double burden of reduced income and increased expenses associated with the treatment program (WHOa, 2013). TB is sometimes referred to as "a disease of poverty", because the disease spreads easily in badly ventilated, overcrowded places and among people with poor nutritional status (Oxlade & Murray, 2012).

Environmental factors such as poor ventilation and crowded living conditions increase the probability of TB infection (Tornee *et al*., 2005: 222). Clark *et al*. (2002: 942) have confirmed that the incidence of TB disease is higher in communities located in isolated areas, and in communities with a higher average housing density. Housing density is defined as the average number of ppr. A large percentage of participants in the current

study lived in homes with a high room density (≥2.5 ppr). Similar findings have been reported in studies undertaken in Dellft, Cape Town where 53% of patients with TB indicated that five to eight persons were sharing a room (Lombardo *et al*., 2012: 1025) as well as in Canada where significant association between housing density, isolation, income levels, and TB disease were identified (Coetzee *et al*., 1988: 352-354). A study undertaken in Uganda, reported that 57.3% of patients with TB were living in overcrowded households (Kirenga *et al*., 2015). Overcrowded housing conditions have the potential to increase exposure of susceptible people to those with infectious respiratory disease, increasing the probability of transmission. This is because close proximity makes it more likely for these individuals to come into contact with air contaminated with the bacteria that causes the infection. Furthermore, isolation from health services may increase the likelihood of developing TB (Tornee *et al*., 2005: 224; Clark *et al*., 2002: 940).

Food security

South Africa has recently been classified as the country with the greatest rate of income inequality in the world according to the GINI Index (a standard economic measurement of inequality looking at the income distribution among residents in a country) (World Bank, 2016). While South Africa as a country may be food secure, large numbers of households in the country are food insecure (Altman *et al*., 2009), as was confirmed in the current study.

Food insecurity is very difficult to measure. For this reason, there is little certainty about the precise household food security status of South African households (Altman *et al*., 2009: 5). According to the National Food Consumption Survey (NFCS) of 1999, 33% of household were at risk of hunger and 52% of households experienced hunger (Labadarios *et al*., 2005). According to the NFCS of 2005, similar results were found with one out of three households at risk of hunger and 51.6% of households experiencing hunger (Labadarios *et al*., 2008). Both of the NFCS's used the CCHIP hunger index questionnaire to determine the level of household food security. In contrast, the General Household Survey in 2007 indicated that only 10.6% of adults and 12.2% of children were sometimes or always hungry. The participants were asked whether they ever gone hungry because there was not enough food. The participants could responded by indicating never, seldom, sometimes, often or always (Stats SA, 2007). More recently the SANHANES of 2012 interviewed 5972 households and concluded that 39% of households do not have enough money for basic needs, like food (Shisana *et al*., 2013). The results of the current study found even higher occurrence of food insecurity with 27% of households being at risk of hunger and 70% of households experiencing hunger. These findings might indicate that patients with TB and TB/HIV co-infection are more likely to experience food insecurity than the general public.

Food insecurity is an important contributor to the global burden of TB disease (WHOa, 2013). High levels of food insecurity were identified in the current study, with the problem of food insecurity at both the household and individual level being worse in the HIV co-infected participants. A significantly higher percentage of HIV co-infected respondents reported relying on a limited number of foods to feed their children, sometimes cut the size of their meals or skip meals, eating less than they wanted and felt like their children eat less than they should because there was not enough money available for food purchases. After the scoring had been applied, however, the difference in the percentage of households with patients with TB and HIV co-infection and patients with TB without HIV co-infection that were food secure, at risk of hunger and hungry did not reach statistical significance.

Very few participants in the current study reported having a household vegetable garden. The International Food Security Assessment 2011-2021, food production at household level is an important factor in assuring food security in sub-Sahara Africa (USDA, 2011). Ogundiran *et al*. (2014) suggest that home gardening has the potential to improve food security, health and social interaction of households. Altman *et al*. (2009: 17) have concluded that poor households may also engage in gardening as a form of recreation, but that it may contribute to additional burdens rather than relief in some resource-poor households.

We acknowledge that the results of this single-centre study may not be generalised to all patients with TB and TB/HIV co-infection.

CONCLUSION AND RECOMMENDATIONS

The present study identified that patients with TB and TB/HIV co-infection are characterised by high levels of poverty and household food insecurity. The literature confirms that this may have a negative impact on the development of TB disease in other household members, nutritional status and progression of latent TB infection to TB disease.

In order to improve outcome, TB control programmes and other interventions should take the socio-demographic situation of patients into consideration. In view of this, appropriate and relevant preventative actions need to be planned and implemented through a multi-sectorial approach. Despite the high rate of food insecurity in households, very few households grew vegetable gardens. Agricultural involvement has the potential to improve household and individual food security and should thus be encouraged.

Community support groups can play an important role in reducing the burden of TB and HIV through alleviating its impact, stigma and discrimination. In addition to community intervention programmes, basic education together with the incorporation of TB education into the school syllabus, may contribute to creating awareness of the disease.

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CHAPTER 5

NUTRITIONAL STATUS OF PATIENTS WITH TB, AND TB/HIV CO-INFECTION AT STANDERTON TB SPECIALISED HOSPITAL, MPUMALANGA

ABSTRACT

Objective: To determine the nutritional status of patients with TB, and TB/HIV co-infection.

Design: A cross sectional study was undertaken.

Settings and subjects: The study was conducted at Standerton TB Specialised Hospital, Mpumalanga. One hundred hospitalised patients with TB, and TB/HIV co-infection were included.

Outcome measures: A structured interview was conducted by the researcher with each patient to obtain information on food related side effects. The Malnutrition Universal Screening Tool (MUST) was used to determine risk of malnutrition. Weight, height, mid-upper arm circumference (MUAC) and triceps skinfold were measured using standard techniques. Biochemical parameters included total protein, albumin, C-reactive protein (CRP), CD_4 cell counts, mean corpuscular volume (MCV) and haemoglobin. These were determined in an accredited laboratory using standard laboratory techniques.

Results: The food related side effects mostly reported included loss of appetite (59%) followed by dry mouth (48%). According to the MUST, the overall risk for malnutrition was as follows: 70% had a high risk, 22% had a medium risk and 8% had a low risk. Actual unplanned weight loss and percentage of unplanned weight loss were significantly higher in patients with TB and HIV co-infection than in patients with TB only (95% CI [1.5%; 38.2%] and [5.3%; 51.0%] respectively). Median body mass index (BMI) was in the underweight category at 18.3 kg/m². More than half of participants (51%) had low MUAC measurements and nearly half of participants (49.9%) had triceps skinfold measurements below the 15th percentile, indicating malnutrition. The majority of participants had albumin and haemoglobin values below the normal ranges (79% and 92% respectively).

Conclusion: Patients with both TB and TB/HIV co-infection had a compromised nutritional status and an increased risk of developing malnutrition. Interventions aimed at addressing malnutrition could make a meaningful contribution to improving drug efficacy and quality of life in these patients.

INTRODUCTION

Tuberculosis (TB) is a leading cause of morbidity and mortality, especially in middle- and low-income countries. Globally, an estimated 2 billion people are infected with TB of which 1 billion are malnourished. TB is strongly influenced by nutritional status, with nutrition interventions being likely to impact on prevalence of active disease, response to drug therapy and quality of life (Cegielski *et al*., 2012: 409; Moses *et al*., 2008: 208). According to Semba *et al*. (2010: S353) HIV co-infection seems to be a much stronger risk factor for mortality in adults with TB than is malnutrition alone.

Proper nutrition plays a vital role in supporting the health and quality of life of people with TB and HIV (ADA, 2010). Immune function and nutritional status are closely related (Lowry & Coyle, 2014: 1261) and nutrition, immune function and infection interact in complex ways (Cegielski & McMurray, 2004: 288). According to Rudolph *et al*. (2013) malnutrition in general is a serious global health problem which is often

not adequately addressed in public health programs. Neither current World Health Organisation (WHO) guidelines for treatment of TB, nor the 17 International Standards of Tuberculosis Care, address the importance of under-nutrition or nutrition support during treatment (Bhargava *et al*., 2013; Hopewell *et al*., 2006: 710-725).

The Academy of Science of Southern Africa (ASSAf) refers to malnutrition and TB as the so-called "chicken vs egg conundrum". This is because malnutrition may predispose to TB and having TB increases one's risk of developing malnutrition. In 2007, the ASSAf identified the top three epidemics as HIV infection, TB infection and malnutrition and called it the "three concurrent epidemics". The third epidemic, malnutrition, is very often a consequence of these two disease states (ASSAf, 2007). Thus; HIV, TB and malnutrition result in a vicious cycle, with the one epidemic exacerbating the other. Van Lettow *et al*. (2003: 81) refer to HIV, TB and malnutrition as "triple trouble".

Malnutrition has been described in patients with TB by several researchers (Bhargava *et al*., 2013; Frediani *et al*., 2013: 1026; Villamor *et al*., 2006: 169; van Lettow *et al*., 2004: 61; Frieden *et al*., 2003: 895; Karyadi *et al*., 2000). Both malnutrition and HIV infection are associated with an increased risk of progression from latent TB infection to active TB disease, because of the negative impact that dietary deficiencies have on cell-mediated immune response (Lönnroth *et al*., 2010: 152; Semba *et al*., 2010; Cegielski & McMurray, 2004: 296). TB (and HIV infection) very often results in poor dietary intake, nutrient deficiencies, malnutrition and wasting (Cegielski & McMurray, 2004: 296; van Lettow *et al.,* 2004: 61; Paton *et al*., 2003: 322).

Considering the negative impact of a poor nutritional status on outcome in patients with TB and TB/HIV co-infection, the purpose of this study was to determine the nutritional profile of patients with TB and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga, where information of this nature has not previously been collected. This information can contribute to the identification of specific areas that need to be taken into account in nutrition interventions, which may in turn play a vital role in improving the outcome and prognosis of patients with TB and TB/HIV co-infection.

METHODOLOGY

Study design

A cross sectional study was conducted.

Target population and sampling

The study population included all patients between 20-65 years with TB, and TB/HIV co-infection that gave informed consent to participate at Standerton TB Specialised Hospital, Mpumalanga in wards 1 and 2 over a

period of one month (21/07/2015 – 17/08/2015). Patients with any additional diagnoses other than TB and TB/HIV co-infection, pregnant or lactating patients, and mentality or physically disabled patients were excluded from the study. The sample included 100 patients with TB and TB/HIV co-infection that met the inclusion criteria.

Pilot study

A pilot study was conducted on the first five patients that met the inclusion criteria and provided onfrormed consent from Standerton TB Specialised Hospital to determine the feasibility of the methodology. No changes were made to the questionnaire and data of these participants was thus included in the main study.

Variables and operational definitions

Eating related side effects

For the purpose of this study, eating related side effects referred to: loss of appetite, sore mouth, dry mouth, nauseas, vomiting, constipation, diarrhoea and night sweats that has been experienced during the past 7 days.

Overall risk of malnutrition

For the purpose of this study, the overall risk of malnutrition was determined by making use of the Malnutrition Universal Screening Tool (MUST) which includes information related to body mass index (BMI), unplanned weight loss over the past 3-6 months and an acute disease score (Bapen, 2003).

Anthropometric measurements

For the purpose of this study, anthropometric indicators of nutritional status included height, weight, MUAC and Triceps skinfold.

Body mass index (BMI)

BMI was calculated by dividing weight in kilograms (kg) by height in meter square (m^2). BMI was interpreted according to the World Health Organisation (WHO) categories of BMI, with underweight: <18.5 kg/m^2, normal weight: 18.5-24.9 kg/m^2 and overweight: >25 kg/m^2 (WHO, 2006).

Mid-upper arm circumference (MUAC)

For the purpose of this study, a MUAC of <22cm for females and <23cm for males indicated malnutrition (Tang *et al*., 2013).

Triceps skinfold

For the purpose of this study a Triceps skinfold measurement was interpreted according to the Triceps Skinfold Norms from NHANES 2003 – 2006 and are indicated in *Table 5.1* for females and *Table 5.2* for males (Lee & Nieman, 2013: 459-460).

Table 5.1: Triceps skinfolds in millimetres for females 20 years of age and older

Race, ethnicity and age	Percentile (mm)								
All race and ethnicity groups	**5th**	**10th**	**15th**	**25th**	**50th**	**75th**	**85th**	**90th**	**95th**
20-29 years	10.4	11.9	13.2	15.5	21.1	27.3	30.3	32.4	34.7
30-39 years	12.1	14.7	15.8	18.2	23.9	30.2	32.9	35.3	37.4
40-49 years	12.1	14.1	15.9	19.5	25.6	30.9	33.6	35.2	36.9
50-59 years	13.3	16.1	17.5	20.5	25.9	31.0	33.2	34.9	36.5
60-69 years	13.4	16.6	18.1	20.3	25.4	30.2	32.8	34.2	36.0

Table 5.2: Triceps skinfolds in millimetres for males 20 years of age and older

Race, ethnicity and age	**Percentile (mm)**								
All race and ethnicity groups	**5th**	**10th**	**15th**	**25th**	**50th**	**75th**	**85th**	**90th**	**95th**
20-29 years	5.0	6.2	7.1	8.8	12.7	18.9	21.7	25.4	29.4
30-39 years	5.8	7.1	8.2	10.0	13.6	18.3	21.4	23.4	27.0
40-49 years	6.6	7.6	8.7	10.4	13.9	19.2	22.3	24.1	27.9
50-59 years	6.2	7.4	8.9	10.8	14.1	18.5	21.5	23.2	26.7
60-69 years	7.3	8.3	9.4	11.2	14.9	19.7	22.5	25.2	30.3

Biochemical parameters

The following biochemical markers were assessed. Normal value ranges for biochemical parameters are indicated below (du Buisson *et al*., 2010):

- Total protein 60 – 78 g/l
- Albumin 35 – 52 g/l
- C-reactive protein (CRP) 0.0 – 4.9 mg/l
- CD_4 cell count 500 – 2000mm^3
- Mean corpuscular volume (MCV) 79.1 – 89.0 f/l
- Haemoglobin Male: 14.3 – 18.3 g/dl ; Female: 12.1 – 16.3 g/dl

Methods and techniques

Questionnaire

For the purpose of this study, a questionnaire was designed by the researcher to obtain information related to eating related side effects of participants. Results of the overall risk of malnutrition (MUST tool) were noted on the same questionnaire.

The MUST tool consists of three steps. Step one classifies a patient according to their BMI (>20 kg/m² = 0; 18.5-20 kg/m² = 1; <18.5 kg/m² = 2). Step two evaluates the percentage of unplanned weight loss during the past 3-6 months (<5% = 0; 5-10% = 1; >10% = 2). Step three evaluates if the patient is acutely ill, and if there has been most likely no nutritional intake over the past 5 days or more; if so, the patient scores an additional 2 points. The overall risk of malnutrition is then determined by adding step 1, 2 and 3 together. A low risk of malnutrition equals a total score of 0, a medium risk equals a total score of 1 and a high risk equals a total score of 2 or more (Bapen, 2003).

Anthropometric measurements

Weight

Weight was measured with a platform electronic scale (TCS-200-RT). As recommended by Lee & Nieman (2013: 168), the participants were wearing minimal clothing (removed jacket, shoes and jewellery), standing still in the middle of the scale's platform without touching anything and with the body weight equally distributed on both feet. Weight was recorded to the nearest 0.1 kg.

Height

Height was measured by means of a stadiometer (TCS-200-RT) with a vertical scale of 2 meters and a sliding head-piece, to the nearest 0.5cm. Height of participants was measured without shoes. The participants stood with their heels together, arms to the side, legs straight, shoulders relaxed and head in the Frankfort horizontal plane (looking straight ahead). Heals, buttocks, scapulae (shoulder blades), and the back of the head were against the vertical surface of the stadiometer. Just before the measurement was taken, the participant inhaled deeply, held the breath and maintained an erect position while the sliding-headpiece was lowered to the highest point of the head with enough pressure to compress the hair (Lee & Nieman, 2013: 167).

Mid-upper arm circumference

MUAC was measured using a non-stretch flexible tape-measure. Participants stood erect and sideways to the measurer, with the head in the Frankfurt plane, legs apart, and arms relaxed. Sleeved garments were rolled

up or removed. The measurement was taken at the midpoint of the upper arm, between the acromion process and the tip of the olecranon. After locating the midpoint, the arm was extended so that it is hanging loosely by the side, with the palm facing inward. The tape was then wrapped gently but firmly around the midpoint of the arm (Lee & Nieman, 2013: 228; Gibson, 2005: 290). The MUAC measurement was taken three times on each participant and an average was calculated to the nearest 1mm.

Triceps skinfold

The measurement of the triceps skinfold was performed at the midpoint of the upper right arm, between the acromion process and the tip of the olecranon, with the arm hanging relaxed. To obtain the midpoint, the right arm had to be bent at 90º at the elbow, and the forearm had to be placed palm down across the body. The tip of the acromion process of the shoulder at the outermost edge of the shoulder blade and the tip of the olecranon process of the ulna was located and marked. The distance between these two points was then measured using a non-stretchable tape, and the midpoint was then marked with a soft pen. The right arm was then extended so that it was hanging loosely by the side. The examiner grasped a vertical fold of the skin plus the underlying fat, 2cm above the marked midpoint, using both the thumb and the forefinger. The skinfold was held between the fingers while the measurement was taken to the nearest mm (Lee & Nieman, 2013: 190; Gibson, 2005: 275-276). The triceps skinfold measurement was taken three times on each participant and the average was noted to the nearest 2mm.

Biochemical parameters

Blood of patients are drawn as part of standard procedures in the hospital by a professional nurse. Biochemical parameters (total protein, albumin, CRP, CD_4 cell counts, MCV, and haemoglobin) were determined in an accredited laboratory using standard laboratory techniques.

Validity and reliability

Questionnaire

All issues addressed by the questionnaire were directly related to the aim and objectives of the study. The MUST tool is internationally validated and regarded as an accurate tool to evaluate the risk of malnutrition in adult patients (Gibson *et al*., 2012: 313; Stratton *et al*., 2004: 807; Bapen, 2003). Miyata *et al*. (2013) conducted a research study to evaluate the effectiveness of using the MUST to assess the nutritional status of patients with TB. The conclusion was that the MUST is a reliable tool for nutritional risk assessment and also a useful indicator of survival in patients with TB.

Only one person, namely the trained researcher, completed the questionnaires in a personal interview with each participant.

Anthropometric measurements

The scale was moved to the zero point before each measurement. The weight recorded by the scale was compared with a known weight. In order to ensure reliability of the results, weight, height, MUAC, and Triceps skinfold were measured by the same trained researcher (a registered dietician) according to standard procedures, as recommended by Lee & Nieman (2013).

Biochemical parameters

The biochemical variables that were determined included routine tests that are performed on patients in the hospital. The results of the blood tests were considered reliable, because they are determined in an accredited laboratory by trained personnel using standard controls.

Ethics

Ethics approval was obtained from the Provincial Health and Research Ethics Committee (PHREC) of Mpumalanga Department of Health (PHREC MP_2015RP38_556) and the Health Sciences Research Ethics Committee of the Faculty of Health Sciences, University of the Free State (UFS) (ECUFS 56/2015).

Data collection

All eligible participants signed consent in their language of choice (English/IsiZulu), after the purpose and procedure of the project had been explained to them by the researcher or a lay counsellor who spoke the native language. The information document was given to patients to provide them with all the relevant information regarding the study. Once informed consent had been obtained, participants were interviewed by the researcher. In addition to information on nutritional status, information on socio-demographic status, food security, smoking habits and alcohol use were also collected; these are reported elsewhere.

Statistical analysis

Descriptive statistics, namely frequencies and percentages for categorical data, and medians and percentiles for continuous data were calculated. Associations between variables were calculated and described by means of 95% confidence intervals (CI) for differences in medians or percentages. All analyses were completed by the Department of Biostatistics at the UFS

RESULTS

The study sample included 100 participants (60 males and 40 females). The median age of the sample was 39.2 (20.3-63.5) years. More than two thirds of participants (68%) were HIV positive; with HIV co-infection being slightly higher among women (70%) than among men (66.7%).

Food related side effects

The food related side effects reported by the participants are summarised in *Table 5.3*. The majority of patients experienced a loss of appetite (59%) followed by a dry mouth (48%). Patients with TB and HIV co-infection experienced more food related side effects than patients without HIV co-infection, but the differences were not statistically significant.

Table 5.3: Food related side effects according to HIV status

Symptom	**Total yes responses (n=100)**	**TB with HIV co-infection (n=68)**	**TB without HIV co-infection (n=31)**	**95% CI for the percentage difference**
		Yes	**Yes**	
Loss of appetite	59%	40 (58.8%)	18 (58.1%)	[-18.8%; 21.2%]
Sore mouth	23%	15 (22.1%)	8 (25.8%)	[-23.0%; 12.7%]
Dry mouth	48%	30 (44.1%)	17 (54.8%)	[-30.2%; 10.0%]
Nausea	29%	21 (30.9%)	8 (25.8%)	[-14.9%; 21.9%]
Vomiting	23%	17 (25.0%)	6 (19.3%)	[-13.4%; 20.9%]
Constipation	30%	18 (26.5%)	12 (38.7%)	[-31.9%; 6.7%]
Diarrhoea	7%	7 (10.3%)	0 (0.0%)	[-1.9%; 19.8%]
Night sweats	27%	19 (27.9%)	7 (22.6%)	[-14.2%; 21.5%]

Table 5.4 illustrates the number of food related side effects that were experienced by the participants. Only 14% of participants reported not experiencing any of the listed food related side effects. A large percentage of patients (29%) experienced two of the seven symptoms. Almost a quarter (24%) of participants reported experiencing four to seven of the side effects.

Table 5.4: Number of food related side effects experienced (n=100)

Number of symptoms experienced	Percentage	Cumulative Percentage
0	14.0	14.0
1	15.0	29.0
2	29.0	58.0
3	18.0	76.0
4	9.0	85.0
5	8.0	93.0
6	6.0	99.0
7	1.0	100.0

The overall risk of malnutrition is summarised in *Table 5.5*. More than half (51%) of participants had a BMI of lower than 18.5kg/m² and almost half (48%) of participants had experienced more than 10% weight loss during the past 3-6 months. Nearly two out of ten (18%) participants were acutely ill and had or were likely to have no nutritional intake for more than five days. Nearly a third (29%) of participants had a total score of four, indicating a high risk of malnutrition. More than two thirds (70%) participants had a high risk for malnutrition (total score of 2 or more). Almost a quarter (22%) had a medium risk for malnutrition (total score of 1) and only 8% had a low risk for malnutrition (total score of 0).

Table 5.5: Overall risk of malnutrition

n=100	Frequency	Cumulative Frequency
BMI score		
0 (> 20kg/m²)	36	36
1 (18.5-20kg/m²)	13	49
2 (< 18.5kg/m²)	51	100
Weight loss score (unplanned weight loss in the past 3-6 months)		
0 (< 5%)	38	38
1 (5-10%)	14	52
2 (>10%)	48	100
Acute disease score (looking at food related side effects)		
0	82	82
2 (has been or is likely to be no nutritional intake for >5 days)	18	100
Total score (BMI score + Weight loss score + Acute disease score)		
0	22	22
1	8	30
2	15	45
3	15	60
4	29	89
5	4	93
6	7	100
Overall risk for malnutrition		
High (total score of 2 or more)	70	70
Medium (total score of 1)	22	92
Low (total score of 0)	8	100

Anthropometric measurements

The median weight lost during the last 3-6 months was 6kg (2kg-14kg). There was a statistically significant difference in the unplanned weight loss during the past 3-6 mouths and the percentage of unplanned weight loss of >10% between patients with TB and patients with TB and HIV co-infection, as presented in *Table 5.6*.

Unplanned weight loss and percentage of unplanned weight loss was statistically significantly higher in patients with TB and HIV co-infection.

Table 5.6: Unplanned weight loss; comparing TB with and without HIV co-infection

	TB with HIV co-infection (n=68)			TB without HIV co-infection (n=31)			95% CI for the percentage difference
Unplanned weight loss during the past 3-6 months	57 (83.82%)			20 (64.52%)			[1.5%; 38.2%]*
	< 5%	**5-10%**	**> 10%**	**< 5%**	**5-10%**	**> 10%**	Compared >10%
Percentage of unplanned weight loss	11 (19.30%)	6 (10.53%)	40 (70.18%)	5 (25.00%)	7 (35.00%)	8 (40.00%)	[5.3%; 51.0%]*

***** Statistically significant difference

The anthropometric results pertaining to BMI, MUAC and triceps skinfold are presented in *Table 5.7* for median values and *Table 5.8* for categorical values. Median BMI was 18.3 kg/m² (men: 18.2 kg/m²; women: 20.6 kg/m²), with more than half (53%) of participants having a BMI of <18.5kg/m². Male participants had a median BMI in either the underweight or normal range. The BMI of women ranged from underweight to obese, with 12.5% of women having BMI scores above the normal range. The median MUAC of participants was 22.6cm (men: 22.5cm; women: 24.2cm). More than half (51%) of participants, fell in the category of malnourished according to their MUAC measurements. Nearly half of participants (49.9%) had triceps skinfold measurements below the 15th percentile (40.8% in the 5th percentile and 9.1% in the 10th percentile), which indicates malnutrition. Men had significantly lower median Triceps skinfold measurements than women (men: 13.0mm; women: 19.5mm), 95% CI [-10; -2].

Table 5.7: BMI, MUAC and triceps skinfold (median), comparing genders by means of 95% CI

Anthropometric indication	**Total group**	**Men (n=60)**	**Women (n=40)**	**95% CI for median difference**
BMI (kg/m²)	18.3 (11.9-41.7)	18.2 (13.0-23.9)	20.6 (12.2-41.7)	[-4.7; 0]
MUAC (cm)	22.6 (14.1-42,7)	22.5 (16.4-29.5)	24.2 (14.1-42.7)	[-4.0; 0.4]
Triceps skinfold (mm)	14.0 (5.0-38.0)	13.0 (5.0-28.0)	19.5 (5.0-38.0)	[-10; -2]*

* Statistically significant difference

Table 5.8: BMI, MUAC and triceps skinfold (categories)

Measurement	n=100	Men (n=60)	Women (n=40)
BMI (%)			
<18.5: Underweight	53.0	65.7	47.5
18.5-24.9: Normal	35.0	43.3	22.5
25.0-29.9: Overweight	7.0	0.0	17.5
>29.9: Obese	5.0	0.0	12.5
MUAC (%)			
Malnourished	51.0	41.7 (<23 cm)	60.0 (<22 cm)
Normal	49.0	58.3 (≥23 cm)	40.0 (≥22 cm)
Triceps skinfold (%)			
5th percentile	40.8	8.3	32.5
10th percentile	9.1	6.6	2.5
15th percentile	7.5	5.0	2.5
25th percentile	22.6	10.0	12.5
50th percentile	34.1	21.6	12.5
75th percentile	56.6	36.6	20.0
85th percentile	15.8	8.3	7.5
90th percentile	9.1	1.6	7.5
95th percentile	4.1	1.6	2.5

Biochemical parameters

Biochemical parameters of participants are illustrated in *Table 5.9* for median values and *Table 5.10* for categorical values. The majority (61%) of participants had total protein values in the normal range, with 11% of participants below normal and 28% above normal. The median value for total protein was 71.5g/l, which

falls within the normal range of 60-78g/l. Almost eight out of ten (79%) participants had albumin values below the normal range of 35g/l and the median albumin value was 29.0g/l. Lower albumin levels were significantly more visible in males than in females. CRP values were only available for 15 participants, of which everyone had increased values with a median of 81.0mg/l. The median in terms of CD_4 cell count was 179mm³ which is far below the lower normal cut-off value of 500mm³. Almost two thirds (64%) of participants had a CD_4 cell count below 500mm³ and 57% of participants had a CD_4 cell count below 350mm³. Four out of ten (40%) participants had MCV values within the normal range of 79.1-89.0f/l and 43% had MCV values above the normal range, while 17% of participants had MCV values below the normal range. The median haemoglobin value was 10.5g/d/l, which is below the lower normal range for males and females. More than nine out of ten (92%) participants had haemoglobin values below the normal range. Males also had significantly lower haemoglobin levels than females.

Table 5.9: Biochemical Parameters (median); according to gender

Measurement	**n**	**Median (range)**	**Men**	**Women**	**95% CI for median difference**
Total protein (g/l)	100	73.1 (46-104)	71.5 (46.0-104.0)	74.7 (48.0-96.0)	[-9; 1]
Albumin (g/l)	100	29.0 (14-49)	29.0 (14.0-47.0)	29.0 (18.0-49.0)	[-5; 1]
CRP (g/l)	15	8.1	9.0	10.2	
CD_4 cell count (mm³)	76	179.0 (4.0-995.0)	234.0 (4.0-737.0)	174.0 (8.0-995.0)	[-116; 59]
MCV (f/l)	100	88.35 (69.8-112.6)	88.4 (71.6-112.6)	88.4 (69.8-100.7)	[-3.2; 3.5]
Haemoglobin (g/dl)	100	10.5 (6.3-16.0)	10.9 (6.3-16.0)	10.2 (8.0-15.6)	[-0.4; 1.2]

Table 5.10: Biochemical Parameters (categories); according to gender

Measurement	Men (n=60)	Women (n=40)	95% CI for the percentage difference
Total protein (%) (n=100)			
< 60 g/l: Low	11.7	10.0	[-12.7%; 13.8%]
60-78 g/l: Normal	63.3	57.5	
>78 g/l: High	25.0	32.5	
Albumin (%) (n=100)			
<35 g/l: Low	86.7	67.5	[2.7%; 35.9%]*
35-52 g/l: Normal	13.3	32.5	
CRP (%) (n=15)			
>4.9 mg/l: High	100	100	
CD_4 cell count (%) (n=76)			
>500 mm^3: Low	87.2	79.3	[-8.6%; 26.9%]
500-2000 mm^3: Normal	12.8	20.7	
MCV (%) (n=100)			
<79.1 f/l: Low	16.7	17.5	[-17.0%; 13.5%]
79.1-89.0 f/l: Normal	40.0	40.0	
>89.0 f/l: High	43.3	42.5	
Haemoglobin (%) (n=100)			
Lower than normal range	96.7 (<14.3 g/dl)	85.0 (<12.1 g/dl)	[0.4%; 25.9%]*
Between normal range	3.3 (14.3-18.3 g/dl)	15.0 (12.1-16.3 g/dl)	

* Significant difference

DISCUSSION

Food related side effects

Clinical monitoring of possible side effects in patients with TB is important during treatment (WHO, 2004). It is unknown whether the food related side effects experienced by patients with TB, and TB/HIV co-infection are caused by the disease, the treatment or a combination of the two. Several food related side effects (gastro-

intestinal irritation, nausea, vomiting, abdominal pain, constipation, anaemia, jaundice, pancreatitis, altered taste, anorexia, and fatigue) have been reported to be related to the use of TB medications (Isoniazid and Rifampicin) (SADoH, 2014; Escott-Stump, 2012; WHO, 2004). Adverse side effects from medication are more common in HIV positive that in HIV negative patients with TB (WHO, 2004). In the current study, patients with TB and HIV co-infection did experience more food related side effects than those who did not have HIV, but the difference was not statistically significant.

The most commonly reported food related side effects experienced by patients in the current study included a loss of appetite followed by a dry mouth. In a study undertaken in patients with TB in the city of Cochabamba in Bolivia, appetite regulatory hormones were found to be altered. These hormones usually normalised during treatment after which, appetite was restored and nutritional status improved (Chang *et al*., 2013). It is well recognised that a lack of appetite and a low appetite can both exacerbate malnutrition. It is unclear, however, whether a chronic lack of appetite is due to malnutrition or possibly an unidentified risk factor for TB (Hernández-Garduño & Pérez-Guzmán, 2007: 870). Common reported side effects in patients with TB in Uganda, Iran and Pakistan included loss of appetite, loss of weight, dyspnea, fatigue, weakness, fever, night sweats, chest pain, and hemoptesia (Kirenga *et al*., 2015; Nezhad *et al*., 2012; Shaikh *et al*., 2012). Nezhad *et al*. (2012) also concluded that as the number of reported side effects increased the total recovery time also increased.

Overall risk of malnutrition

Of all the known risk factors for TB, being underweight and malnourished are most likely the least studied indicators (Hernández-Garduño & Pérez-Guzmán, 2007: 870). Malnutrition may predispose to TB; however, TB also increases the risk of developing malnutrition. In the current study, the majority of patients presented with a high risk of malnutrition (according to the MUST). When looking at anthropometric variables (BMI, MUAC, and Triceps skinfold) the majority of patients were malnourished at the time of the data collection. Some important signs and symptoms of TB (e.g. wasting, anaemia, loss of lean and fat mass) are also signs of malnutrition (ASSAf, 2007: 155-156) and this was also seen in the current study.

Although it is well recognised that there is a link between TB and malnutrition, the precise mechanisms that are involved are unclear (Lombardo *et al*., 2012: 184; Cegielski & McMurray, 2004: 295). A high prevalence of malnutrition was also reported in patients with TB in a study conducted by Boloor *et al*. (2014) in India. They used the Mini Nutritional Assessment Short-Form (MNA-SF) to determine the level of malnutrition and concluded that 77% of patients with TB were malnourished and 21% were at risk of malnutrition. These findings are similar to those of the current study, even though a different tool was used to determine the level and risk of malnutrition.

Anthropometric measurements

Involuntary weight loss, wasting and cachexia are common findings in patients with TB. All of the above processes are most likely the result of a combination of factors, including increased nutrient losses, altered metabolism, and decreased appetite and food intake, which are all directly linked to a poor prognosis (Kirenga *et al*., 2015; Chang *et al*., 2013; Nezhad *et al*., 2012; USAID, 2010). The current study also found involuntary weight loss to be very common in patients with TB and TB/HIV co-infection. Both unplanned weight loss and percentage of unplanned weight loss was statistically significantly higher in patients with TB and HIV co-infection than in patients with just TB. This clearly confirms that patients with TB and HIV infection are at a higher risk of developing malnutrition.

According to the WHO, low BMI (<18.5kg/m²) is the best predictor of weight-related morbidity. BMI is the indicator that is most commonly used to measure the degree of fatness or thinness in adults over the age of 18 years (WHO, 2013). Several cross-sectional studies have confirmed a lower BMI in adults with TB disease, together with an increased risk for mortality and micronutrient deficiencies (Lombardo *et al*., 2012: 183; Semba *et al*., 2010; van Lettow *et al*., 2003: 84; Karyadi *et al*., 2000: 725). According to Hanrahan *et al*. (2010: 1507) BMI may be a useful surrogate marker of TB risk or mortality among HIV-positive individuals.

Rudolph *et al*. (2013) reported that the average BMI in adult South African males and females with TB from Johannesburg, Alexandra was 19.2kg/m² (low) and 23.3kg/m² (normal), respectively. Despite the fact that the BMI of South African females with TB were within the normal range, it was still lower than that of the general population (where most women are overweight and obese). The BMI scores in the current study were even lower than the median BMI reported by Rudolph *et al*. (2013), with 18.2kg/m² for males and 20.6kg/m² for females.

The relationship between TB and BMI has been studied by several researchers (Bhargava *et al.*, 2013; Rudolph *et al.*, 2013; Lombardo *et al*., 2012: 183; Hanrahan *et al*., 2012; Lönnroth *et al*., 2010: 154; Semba *et al*., 2010; Villamor *et al*., 2006: 168; Cegielski & McMurray, 2004: 288; van Lettow *et al*., 2003: 84; Karyadi *et al*., 2000: 725; Kennedy *et al*., 1996). A BMI below the lower cut off point (<18.5kg/m²) is an established indicator for energy deficiency and TB incidence has been shown to increase exponentially as BMI decreased (Lönnroth *et al*., 2010: 150). The current study confirms that a low BMI is common in patients with TB and TB/HIV co-infection with a median of 18.3kg/m². Systematic reviews by Lönnroth *et al.* (2010) and Cegielski & McMurray (2004) have reported that malnutrition (defined using BMI) is an important risk factor for the progression of underlying TB infection to active TB disease. Kennedy *et al*. (1996) used BMI to assess the nutritional status of 148 patients in Tanzania who presented with active TB. They found that

malnutrition manifested before and after treatment for TB. A study in India among adults with pulmonary TB found under-nutrition in 85% of males and females in rural areas, and more than two thirds of participants were moderately to severely underweight according to BMI (Bhargava *et al*., 2013).

In the current study, more than half of participants fell in the low BMI category (<18.5kg/m²). Boloor *et al*. (2014: 473) found even higher levels of underweight in hospitalised patients with TB in India, where 79% had a BMI score of 18kg/m² or less. Persons with an underweight BMI of <18.5kg/m² have an increased risk for TB (OR: 2.6) (Horsburgh *et al*., 2012). Cegielski *et al*. (2012: 414) reported an even higher risk of 5.5 to 12.5 for TB in persons with low a BMI, little subcutaneous fat, or low skeletal muscle than in persons with normal nutritional status. Promoting adequate nutrition and weight gain in populations that are malnourished might thus reduce the risk of developing active TB disease (Lönnroth *et al*, 2010:154).

Individuals infected with HIV with a BMI score in the overweight and obese category have a significantly reduced risk of both mortality and TB disease. Overweight and obese BMI scores might be protective against mortality and TB in HIV-infected individuals, even though it raises the risk of developing cardiovascular and metabolic disease (Hanrahan *et al*., 2010: 1507). In the current study only a small percentage of women had BMI scores in the overweight and obese category at 17.5% and 12.5% respectively. More research related to the relationship between very low and very high BMI levels and TB is needed (Hanrahan *et al*., 2010: 1502; Lönnroth *et al*., 2010: 154).

In addition to BMI, MUAC is commonly used to determine the nutritional status of adults (Tang *et al*., 2013). Patients with a low BMI also tend to have a low MUAC (UNAIDS, 2014). Boloor *et al*. (2014), Singla *et al*. (2010) and Karyadi *et al*. (2000: 725) found significantly higher proportions of patients with very low MUAC (<20cm) among patients with TB from India and Indonesia compared to the general population. Lombardo *et al*. (2012: 183) found that patients newly diagnosed with TB had median BMI and MUAC values at the lower end of the normal ranges, at 18.8kg/m² and 23.4cm respectively. In the current study, patients with TB and TB/HIV co-infection had median MUAC values at the lower end of normal (22.6cm) and 51% fell in the low MUAC category, indicating malnutrition.

Low skinfold measurements are common in patients with TB. Villamor *et al*. (2006: 168) performed a cross-sectional study in adults with pulmonary TB co-infected with HIV and found indicators of low lean body mass. Cegielski *et al*. (2012: 412) found low skinfold thickness in 32.6% of persons in the United States who later developed TB with only 4.8% in persons who did not develop TB. In the current study nearly half of participants had triceps skinfold measurements below the 15th percentile, and statistically significantly more men had lower triceps skinfold thickness than women. Karyadi *et al*. (2000: 2955) reported that triceps skinfold measurements of both males and females in Indonesia were significantly lower in patients with TB

than in control groups. In their study, the mean triceps skinfold measurements for males and females with TB were 7.0mm and 12.1mm respectively. In the current study higher mean triceps skinfold measurements were found in both males (13.0mm) and females (19.5mm).

Biochemical parameters

Serum protein concentrations can be useful in assessing protein status, to evaluate a patient's response to nutritional support, and to determine whether a patient is at risk of experiencing medical complications (Lee & Nieman, 2013: 320) on condition that there is no acute phase response present due to metabolic stress (which is unlikely in patients with TB). In the current study the majority of patients had serum protein values in the normal range, and almost a third of patients had serum protein values above the normal range. Total protein is often elevated in patients infected with HIV due to a condition termed "polyclonal gammapathy" (Alexianu & Dan, 2009), which may have been the case in some of the participants in the current study. With metabolic stress (such as TB and HIV) the albumin decreases, but the globulin fraction increases (high levels of IgA and IgG); thus, the total protein might increase, decrease or be normal, which further explains the results of the current study (Shingdang *et al*., 2016).

In the current study a high percentage of participants had an albumin level below the normal cut-off point with a median albumin of 29g/l. Men also had statistically significant lower albumin levels than women. Similar results were confirmed in a study conducted in Singapore amongst patient with TB and HIV co-infection, where a mean albumin value of 29.6g/dl was reported (Paton *et al*., 2003: 321). Serum albumin level is an indicator of depleted protein status and decreased protein intake (Lee & Nieman, 2013: 320). Hypoalbuminaemia is an important marker of severe malnutrition (Matos & Moreira Lemos, 2006: 1363), but is not a reliable indication of nutritional status when an infection is present, since it reacts as a negative phase protein (Litchford, 2012, Salgado *et al*., 2001). Low serum albumin levels are strongly associated with an increased risk of TB. This was confirmed in a study amongst adult patients in the United States (Cegielski *et al*., 2012: 409). Serum albumin concentrations might be a useful diagnostic and prognostic marker for TB in HIV infected patients (Alvarez-Uria *et al*., 2013: 127). Studies in Ethiopia and Malawi both reported that serum albumin levels were significantly lower in patients with TB than in healthy controls (Madebo *et al*., 2003; Mugusi *et al*., 2003). A study of hospitalised patients with TB in Brazil found that the group of patients who died during hospitalisation had statistically significantly lower mean albumin levels that the group of patients that survived (26g/l vs. 31g/l) (Matos & Moreira Lemos, 2006: 1361). Alvarez-Uria *et al*. (2013: 127) found that a serum albumin value of >38g/l was a negative predictor for TB even in settings with a high prevalence, whereas a serum albumin value of <32g/l was associated with 85% TB specificity. Thus,

correcting a low serum albumin value in the hospital setting through nutrition interventions is very likely to improve the prognosis of patients with TB.

In the current study a CRP was only available in 15% of participants. In these patients, the median CRP was above the normal range (median: 8.1mg/l), which indicates that an infection was present in all of them. A study conducted in Pakistan amongst 127 patients with TB, reported that the median CRP was 11.21mg/l in males and 13.82mg/l in females respectively. The researchers concluded that a high CRP is noticeably associated with more severe TB disease (Shaikh *et al*., 2012: 144).

Low haemoglobin values were present in the majority of participants in the current study and were significantly more noticeable in men; the reason for this unexpected finding is unknown. A low MVC (an indication of an iron deficiency) were present in almost a fifth (17%) of participants. It is estimated that one quarter of the world's population are affected by anaemia (WHO, 2008). A number of studies in Gambia, India, the United States, Tanzania and Indonesia have confirmed that anaemia is particularly common in patients with TB (Minchella *et al*., 2015: 764; Boloor *et al*., 2014: 476; Cegielski *et al*., 2012: 412; Isanaka *et al*., 2012: 353; Karyadi *et al*., 2000: 2957) predominantly due to anaemia of inflammation (also known as anaemia of chronic disease) (Minchella *et al*., 2015: 771), which was most probably also the case in the patients included in the current study. Some studies have reported a lower prevalence of iron deficiency in patients with TB compared to the control groups (Friis *et al*., 2006; van Lettow *et al*., 2005). The incidence of an iron deficiency in patients with TB is most likely to vary across populations due to contextual factors, such as dietary intake, and the prevalence of other infections (Isanaka *et al*., 2012: 353).

We acknowledge that the results of this single-centre study may not be generalised to all patients with TB and TB/HIV co-infection.

CONCLUSION AND RECOMMENDATIONS

The current study showed that patients with TB and TB/HIV co-infection had poor nutritional status when considering specific food related side effects, anthropometric measurements and biochemical parameters. These factors elevate their risk of developing malnutrition, as confirmed by the MUST screening index that indicated that most were malnourished.

Nutritional interventions cannot replace the medical management of TB, just as medical management of TB cannot replace adequate nutrition. In order to address the problem of malnutrition, however, nutritional support should be considered a necessary part of the therapeutic approach when treating a patient with TB. In addition, provisioning of nutritional support to families and contacts of persons with TB is indicated to prevent the progression of latent disease to active disease.

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CHAPTER 6

SMOKING HABITS AND ALCOHOL USE OF PATIENTS WITH TB, AND TB/HIV CO-INFECTION AT STANDERTON TB SPECIALISED HOSPITAL, MPUMALANGA

ABSTRACT

Objective: To determine the smoking habits and alcohol use of patients with TB, and TB/HIV co-infection, and how it is associated with gender, level of education and body mass index (BMI).

Design: A cross sectional study was undertaken.

Settings and subjects: The study was conducted at Standerton TB Specialised Hospital, Mpumalanga. One hundred hospitalised patients with TB, and TB/HIV co-infection were included in the study.

Outcome measures: A structured interview was conducted by the researcher with each patient to obtain information on smoking habits, alcohol use and level of education. Weight and height were measured using standard techniques.

Results: Almost six out of ten participants (58%) indicated that they were former (44%) or current (14%) smokers. The average cigarettes, pipes or cigars smoked by the former and current smokers were 4 with a maximum of 20 per day. The average amount of years that the former or current smokers smoked was 9 years with a minimum of 1 year and a maximum of 30 years. Nearly half (49%) reported that they did use alcohol with 25% drinking alcohol more than three times per week. Statistically significantly more females than males were non-smokers and more men drank alcohol three times or more per week than females. Participants that indicated that they were either former or current smokers had significantly lower levels of education than participants who were non-smokers (95% CI [-26.7%; -2.6%] and [-39.9%; -1.0%] respectively). There were no statistically significant differences in terms of BMI in smokers versus non-smokers.

Conclusion: The results indicated that a high percentage of patients with TB, and TB/HIV co-infection previously or currently smoked and used alcohol. Smoking and alcohol use are likely to have a negative impact on nutritional status and may further affect the prognosis of patients with TB. These unhealthy lifestyle habits should thus be targeted in intervention programmes aimed at improving the outcome of patients with TB.

INTRODUCTION

Globally, Tuberculosis (TB) affects many people, impacting on health, nutrition, food security and socioeconomic development. Even though TB is a curable disease, in 2014 alone there were 1.5 million TB related deaths worldwide. Approximately one-third of the world population, an estimation of more than 2 billion people, are infected with *Mycobacterium tuberculosis* (*M. tb*). TB is an infectious disease caused by the *M. tb* organism entering the lungs (WHO, 2015). Sites apart from the lungs that can also be infected include the lymph nodes, pleural cavities, pericardium, peritoneum, meninges, vertebral bodies and synovial tissue of other joints. Multi-organ involvement including the liver, spleen, lungs and bone marrow may also occur (Churchyard & Corbet, 2008: 438).

Tobacco smoking has increased significantly over the past three decades, especially in developing countries. It is expected that smoking will cause about ten million adults deaths in 2030 and most of the increased

tobacco-related deaths will take place in Africa, Asia and South America (Wang & Shen, 2009). It is estimated that up to 20% of TB cases globally are attributable to tobacco exposure (Gegia *et al*., 2015). Patients with TB who smoked, had an increased risk for mortality of nine times more than patients with TB who had never smoked. Smoking is accountable for more than one third of TB related deaths in Taiwan (Wen *et al*., 2010). In China a study also found that cigarette smoking is strongly associated with TB (Wang & Shen, 2009). The prevalence of current smokers among patients with TB in Japan, Osaka city was significantly higher than the national smoking prevalence (Matsumoto *et al*., 2012: 547). According to the National Health and Nutrition Examination Survey (NHANES) 1999 – 2000 in the United States, smoking is a strong risk factor for latent TB infection in countries with a low TB prevalence (Horne *et al*., 2012). In country such as India were HIV infection plays a relatively minor role in the TB epidemic, smoking and malnutrition are also considered to be important risk factors (Bhargava *et al*., 2013). According to Horne *et al*. (2012), individuals with higher prevalence of latent TB infection and an increased risk for progression to active TB disease might be identified through their smoking status. Thus, all smokers from high-risk populations should be considered for TB screening.

Cigarette smoking is associated with an increased lifetime risk for TB infection (Saad & Tirkey, 2013). Both passive and active exposure to tobacco smoke has been shown to be associated with TB infection and progression to TB disease (Saad & Tirkey, 2013: 340). It is more difficult to identify TB among smokers, because smokers and patients with TB share a number of clinical symptoms (Wen *et al*., 2010). In addition to smoking, alcohol use has also been established to be risk factors for acquiring TB disease, and continued use of alcohol and tobacco products once a person has contracted TB lowers the chances of successful treatment (Louwagie *et al*., 2014: 501).

Peltzer (2014) found a high incidence of combined tobacco and alcohol use among patients with TB in primary care clinics in South Africa. Furthermore, Coetzee *et al*. (1988:353) have reported that the prevalence of TB was higher in households where alcohol use was considered to be a problem. Alcohol is also a relative risk factor for TB, especially in individuals who consume more than 40g of alcohol per day (SADoH, 2014).

The recent China Health and Nutrition Survey concluded that smoking is associated with an increased risk of being underweight and a decreased risk of being overweight and obese (Wang, 2015). PrayGod *et al*. (2013: 738) found that not only do smokers weigh less, but that they were more likely to have lower muscle mass and higher fat mass than those that don't smoke. Lower weight among smokers is thought to be due to a reduction in appetite and food intake as well as increased resting energy expenditure mediated by the effects of nicotine on body metabolism (PrayGod *et al*., 2013: 738). Smoking is known to suppress the immune

system, and when smoking is combined with HIV infection, the negative impact on TB development and progression is enormous (Oni *et al*., 2012; Kolappan & Gopi, 2002: 965-966).

When considering the mentioned negative impacts of smoking and alcohol use on patient with TB, the purpose of this study was to determine the smoking habits and alcohol use of patients with TB and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga and how it is associated with gender, level of education and BMI. This information may contribute to the identification of lifestyle habits that need to be taken into account in health and nutrition policies and interventions, which might ultimately play a role in decreasing the incidence and the impact of TB disease on the individual, the household and the wider community.

METHODOLOGY

Study design

A cross sectional study was conducted.

Target population and sampling

The study population included all patients between 20-65 years with TB, and TB/HIV co-infection that gave informed consent to participate at Standerton TB Specialised Hospital, Mpumalanga in wards 1 and 2 over a period of one month (21/07/2015 – 17/08/2015). Patients with any additional diagnoses other than TB and TB/HIV co-infection, pregnant or lactating patients, and mentality or physically disabled patients were excluded from the study. The sample included 100 patients with TB and TB/HIV co-infection that met the inclusion criteria.

Pilot study

A pilot study was conducted on the first five patients that met the inclusion criteria and provided onfrormed consent from Standerton TB Specialised Hospital to determine the feasibility of the methodology. No changes were made to the questionnaire and data of these participants was thus included in the main study.

Variables and operational definitions

Smoking habits

Smoking habits were categorised as follows (Peltzer, 2014; Saad & Tirkey, 2013):

- Non-smoker: Patient who has never smoked;
- Former smoker: Patient who had smoked before, but who has stopped smoking for at least 3 months before entering the study.

- Current smoker: Patient that smokes at least one cigarette, pipe, or cigar per day for at least 6 months prior to entering the study.

Patients who were former or current smokers were asked how many times a day and for how many years they were/are smoking.

Alcohol use

Alcohol consumption was categorised according to whether or not the participants formerly drank alcohol more than 3 times per week (Peltzer, 2014; Saad & Tirkey, 2013). An alcohol consumption of less than 3 times per week was considered low, while consumption of alcohol 3 or more times a week was considered high (Saad & Tirkey, 2013).

Level of education

Information related to socio-demographic status included gender and level of education.

Body mass index (BMI)

BMI was calculated by dividing weight in kilograms (kg) by height in meter square (m^2). BMI was interpreted according to the World Health Organisation (WHO) categories of BMI, with underweight; <18.5 kg/m^2, normal weight; 18.5-24.9 kg/m^2 and overweight; >25 kg/m^2 (WHO, 2006).

Methods and techniques

Questionnaire

A questionnaire was designed by the researcher to obtain information regarding the smoking habits, alcohol use and level of education of patients with TB and TB/HIV co-infection at Standerton TB Specialised Hospital. The researcher completed a structured interview with each participant.

Weight

Weight was measured with a platform electronic scale (TCS-200-RT). As recommended by Lee & Nieman (2013: 168), the participants were wearing minimal clothing (removed jacket, shoes and jewellery), standing still in the middle of the scale's platform without touching anything and with the body weight equally distributed on both feet. Weight was recorded to the nearest 0.1 kg.

Height

Height was measured by means of a stadiometer (TCS-200-RT) with a vertical scale of 2 meters and a sliding head-piece, to the nearest 0.5 cm. Height of participants was measured without shoes. The participants stood with their heels together, arms to the side, legs straight, shoulders relaxed and head in the Frankfort horizontal plane (looking straight ahead). Heals, buttocks, scapulae (shoulder blades), and the back of the head were

against the vertical surface of the stadiometer. Just before the measurement was taken, the participant inhaled deeply, held the breath and maintained an erect position while the sliding-headpiece was lowered to the highest point of the head with enough pressure to compress the hair (Lee & Nieman, 2013: 167).

Validity and reliability

Content validity was enhanced by ensuring that all data collected was directly related to the aim and objectives of the study. Reliability was enhanced by ensuring that all data was collected by a trained researcher, using standardised techniques.

Data collection

All eligible participants signed consent in their language of choice (English/IsiZulu), after the purpose and procedure of the project had been explained to them by the researcher or a lay counsellor who spoke the native language. The information document was given to patients to provide them with all the relevant information regarding the study. Once informed consent had been obtained, participants were interviewed by the researcher and anthropometric measurements were taken in a private room. In addition to information on smoking habits and alcohol use, information on socio-demographic status, food security, and nutrition status were also collected; these are reported elsewhere.

Ethics

Ethics approval was obtained from the Provincial Health and Research Ethics Committee (PHREC) of Mpumalanga Department of Health (PHREC MP_2015RP38_556) and the Health Sciences Research Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS 56/2015).

Statistical analysis

Descriptive statistics, namely frequencies and percentages for categorical data, and medians and percentiles for continuous data were calculated. Associations between variables were calculated and described by means of 95% confidence intervals (CI) for differences in percentages. All analyses were completed by the Department of Biostatistics at the University of the Free State.

RESULTS

The study sample included 100 participants (60 males and 40 females). The mean age of the sample was 39.2 (20.3-63.5) years. More than two thirds of participants (68%) were HIV positive, with HIV co-infection being slightly higher in women (70%) than in men (66.7%).

Smoking habits

Table 6.1 illustrates the number of cigarettes, pipes or cigars smoked per day and the number of years that the former or current smokers had smoked. *Table 6.2* presents the smoking habits of male and female participants. About four out of ten participants (42%) indicated that they were non-smokers, and 58% indicated they were former (44%) or current (14%) smokers. A significantly higher percentage of females (60%) than men (30%) were non-smokers (95% CI for the percentage difference [-10.2%; -47.0%]).

Table 6.1: Median smoking habits of former and current smokers (n=58)

Question	**Median**	**Range (min – max)**
Number of cigarettes, pipes or cigars smoked per day	4	1 - 20
Number of years smoked	9	1 - 30

Table 6.2: Smoking habits (n=100)

	Male (n=60)	**Female (n=40)**	**95% CI for the percentage difference**
Non-smoker (n=42)	30.0	60.0	[-47.0%; -10.2%]*
Former smoker (n=44)	48.3	37.5	
Current smoker (n=14)	21.7	2.5	

* Statistically significant difference

Categories of level of education and BMI and associations with smoking habits are displayed in *Table 6.3*. Participants that indicated that they were either former or current smokers had statistically significant lower levels of education than participants who were non-smokers. Although a higher percentage of participants that formerly or currently smoked had a BMI in the underweight category than those that had never smoked, the difference was not statistically significant.

Table 6.3: Level of education, BMI categories and associations with smoking habits (n=100)

Variables	Non-smoker (n=42)	Former smoker (n=44)	Current smoker (n=14)	95% CI for the percentage difference
Level of education (%)				
No schooling	0.0	13.6	14.3	Non-Former [-26.7%; -2.6%]*
Less than Grade 9	33.3	38.6	35.7	Non-Current [-39.9%; -1.0%]*
At least Grade 9	52.4	43.2	42.9	Former-Current [-27.3%; 16.0%]
Matric completed	9.5	4.6	7.1	
Tertiary education	4.8	0.0	0.0	
BMI score (%)				
<18.5: Underweight	42.9	59.1	64.3	Non-Former [-35.3%; 4.7%]
18.5-24.9: Normal weight	30.9	38.6	35.7	Non-Current [-45.2%; 8.1%]
25.0-29.9: Overweight	14.3	2.3	0.0	Former-Current [-29.5%; 23.5%]
>29.9: Obese	11.9	0.0	0.0	

* Statistically significant difference

Alcohol use

The alcohol use of the male and female participants is presented in *Table 6.4*. More than half (51%) indicated that they do not use alcohol. Almost half (49%) indicated that they do use alcohol of which 25% indicated that they drink alcohol more than three times per week and 24% indicated that they drink alcohol less than three times per week. Men drank alcohol (three or more times per week) significantly more often than women (95% CI for the percentage difference [12.6%; 42.7%]).

Table 6.4: Alcohol use (n=100)

	Male (n=60)	**Female (n=40)**	**95% CI for the percentage difference**
Drink alcohol 3 or more time per week (n=25)	36.7	7.5	[12.6%; 42.7%]*
Drink alcohol less than 3 times per week (n=24)	31.7	12.5	
Do not drink alcohol (n=51)	31.7	80.0	

* Statistically significant difference

The associations of alcohol use with level of education and BMI scores are displayed in *Table 6.5*. There were no statistically significant differences between participants who did or did not drink alcohol in terms of level of education or BMI scores.

Table 6.5: Level of education, BMI categories and associations with alcohol use (n=100)

Variables	Used to drink alcohol 3 or more times per week (n=25)	Used to drink alcohol less than 3 times per week (n=24)	Do not drink alcohol (n=51)	95% CI for the percentage difference
Level of education (%)				
No schooling	4.0	8.3	9.8	>3/week-<3/week [-22.2%; 12.3%]
Less than Grade 9	52.0	29.2	31.4	>3/week-none [-17.5%; 10.7%]
At least Grade 9	36.0	54.2	49.0	<3/week-none [-14.2%; 16.9%]
Matric completed	4.0	8.3	7.8	
Tertiary education	4.0	0.0	2.0	
BMI score (%)				
<18.5: Underweight	56.0	62.5	47.1	>3/week-<3/week [-31.5%; 19.8%]
18.5-24.9: Normal weight	40.0	37.5	31.4	>3/week-none [-14.3%; 30.6%]
25.0-29.9: Overweight	4.0	0.0	11.8	<3/week-none [-8.5%; 36.3%]
>29.9: Obese	0.0	0.0	9.8	

* Statistically significant difference

Combined smoking habits and alcohol use

The combined smoking habits and alcohol use are indicated in *Table 6.6*. Only 35 participants indicated that they did not drink alcohol and were non-smokers. Heavy drinking habits (of more than 3 times per day) together with current smoking were noted in 8 participants.

Table 6.6: Combined smoking habits and alcohol use (n=100)

% (n)	Used to drink alcohol 3 or more times per week (n=25)	Used to drink alcohol less than 3 times per week (n=24)	Do not drink alcohol (n=51)
Non-smoker (A) (n=42)	4.8 (2)	11.9 (5)	83.3 (35)
Former smoker (n=44)	34.1 (15)	34.1 (15)	31.8 (14)
Current smoker (n=14)	57.1 (8)	28.6 (4)	12.3 (2)

DISCUSSION

The results of the current study indicated that a high percentage of patients with TB, and TB/HIV co-infection smoked and used alcohol. The smoking habits and alcohol use of patients with TB have been studied by a number of researchers (Louwagie *et al*., 2014; Peltzer, 2014; PrayGod *et al*., 2013; Saad & Tirkey, 2013; Singh *et al*., 2013; Awan *et al*., 2012; Biranvand *et al*., 2012; Horne *et al*., 2012; Lombardo *et al*., 2012; Matsumoto *et al*., 2012; Wen *et al*., 2010; Wang & Shen, 2009; Kolappan & Gopi, 2002; Coetzee *et al*., 1988; Feingold, 1976) all of whom found that these unhealthy lifestyle habits were very prevalent in patients with TB.

A study among patients in Pakistan with TB reported that 42.5% of participants were smoking and 1.7% were using alcohol at the time that the study was undertaken (Awan *et al*., 2012: 329). In newly diagnosed TB patients in Tanzania, 24.4% were current smokers and 54.2% reported that they consumed alcohol (PrayGod *et al*., 2013: 737). Among other risk factors for TB, smoking was prevalent in 26.4% and alcohol use in 50.7% of patients with TB in Uganda (Kirenga *et al*., 2015). Cegieski *et al*. (2012: 412) reported that 79% of persons who were current smokers and 23.5% of persons who consumed more than 7 alcoholic drinks per week developed TB later in life, thus both smoking and alcohol consumption were listed as risk factors for the development of TB of persons in the United States. More than 40 years ago, Feingold (1976:1336) conducted a hospital-based study and found a 49% prevalence of alcoholism in patients newly diagnosed with TB in Georgia. Nearly three decades ago Coetzee *et al*. (1988: 354) found that frequent alcohol consumption was a risk factor for the development of TB disease in households from Mamre, Cape Town.

A study of 1005 male patients with TB in Tshwane Metropolitan Municipality, South Africa, reported that 37.6% of participants smoked and 27.3% were alcohol dependant (Louwagie *et al*., 2014: 503). Similar results were found in the current study where 58% of participants were either former (44%) or current (14%) smokers and 49% of participants used alcohol. This study was conducted amongst hospitalised patients, and despite this, 14% indicated that they were currently smoking. Louwagie *et al*. (2014: 508) reported even higher levels of smoking and alcohol use in patients with TB in South Africa, with 79% of participants in their study currently smoking and 23.5% consuming more than 7 alcoholic drinks per week. Another study undertaken in South Africa among a large sample of 4900 patients with TB, reported that 10.1% (15.5% males and 3.4% females) of participants smoked and used alcohol simultaneously (Peltzer, 2014). In the current study similar results were found with 8% of participants previously drinking alcohol heavily (used alcohol more than three times per week) together with current smoking.

Smoking and alcohol use is more common in males with TB. The current study also confirmed that significantly more men smoked and drank alcohol (three or more times per week) than women. This finding has also been reported by other researchers (Singh *et al*., 2013; Kolappan & Gopi, 2002). The smoking prevalence in adult men with TB in India is two to four times higher than in women and a study conducted by Kolappan & Gopi (2002: 964) found a positive association between tobacco smoking and being an adult man with pulmonary TB in India (OR=2.48). A study in Iran amongst 183 patients with TB also found that men were significantly more likely to be smokers than women (OR=12.4) (Biranvand *et al*., 2012). A study that included a large national sample of adult patients with a history of TB in Cambodia found that TB infection was more common in men who smoked manufactured cigarettes and in those that were the heaviest smokers (more than 1 pack per day, more than 30 packs per year) (Singh *et al*., 2013). This was also confirmed in India were both the cumulative smoking years and number of cigarettes smoked were associated with a significantly increased risk of TB (Saad & Tirkey, 2013: 340).

Some other factors that are strongly related with smoking and alcohol use have been identified by several researchers. Louwagie *et al*. (2014: 508) concluded that drug, tobacco and alcohol use were closely related to poverty in patients with TB in South Africa. Saad & Tirkey (2013: 340) reported that patients with TB who smoked were more likely to be older adults with lower levels of education and a history of drinking alcohol. Similarly, male gender, a lower level of education and higher levels of poverty were found to be associated with simultaneous alcohol and tobacco use, as well as with alcohol or tobacco use among patients with TB in South Africa (Peltzer, 2014). An analysis of 14 national studies of 14 high-burden TB countries found that smoking, alcohol consumption and with a BMI <18.5 kg/m² were each independently associated with TB (PrayGod *et al*., 2013).

In the current study there was a statistically significant difference between the level of education of non-smokers and smokers (95% CI for the percentage differences [-26.7%; -2.6%] and [-39.9%; -1.0%] respectively). Smokers had a lower level of education (no schooling completed and less than grade 9) than non-smokers. Although a high percentage of participants that were underweight (according to their BMI scores) smoked and used alcohol (42.9% vs. 56%), the difference was not statistically significant.

Smoking and alcohol status were based on the patient's self-report rather than the detection of nicotine or alcohol levels. We acknowledge that the results of this single-centre study may not be generalised to all patients with TB and TB/HIV co-infection. .

CONCLUSION AND RECOMMENDATIONS

A high prevalence of smoking and alcohol use was identified among patients with TB and TB/HIV co-infection in the current study. This may lead to poorer treatment outcomes, and may also expose more surrounding people to TB infection due to passive smoking exposure (Matsumoto *et al*., 2012: 547).

Guidelines on smoking and alcohol use should be incorporated into the National TB control plan and should also be included in Directly Observed Therapy, Short-course (DOTS) interventions (Wang & Shen, 2009). Stricter health policies could be implemented on smoking and heavy drinking in populations where TB is a major problem in order to improve their health and quality of life (PrayGod *et al*., 2013; Awan *et al*., 2012: 331).

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CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

The objective of this study was to determine the nutritional status of patients with TB, and TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga.

7.2 CONCLUSIONS

The following conclusions evolved from the study:

7.2.1 Socio-demographic characteristics and household food security

As reported in other studies, high levels of poverty were identified in the patients with TB and TB/HIV co-infection that were included in the present study. This was evidenced by the high percentage of participants that were unemployed and the fact that in the majority of households only one person contributed to the monthly income. A room density of more than 2.5 persons per room (ppr), thus crowding, was present in a significant number of households.

As far as household food security is concerned, a high percentage of participants were found to be food insecure. The majority of participants indicated that they ran out of money to buy food during the month and that they relied on a limited number of foods. A significant percentage of participants indicated that their children sometimes go to bed hungry, because there is not enough money for food. A higher percentage of HIV co-infected respondents reported relying on a limited number of food to feed their children, reported eating less that they wanted to and tended to eat less that they should because there was not enough money available for food purchases, indicating that poverty was more prevalent amongst this group. Even though the majority of household indicated that they were food insecure, the minority of participants reported having a household vegetable garden at home.

7.2.2 Nutritional status

The current study found that patients with TB and TB/HIV co-infection had poor nutritional status when considering specific food related side effects, anthropometric measurements and biochemical parameters. These factors increase their risk for developing malnutrition, as confirmed by the MUST screening index that indicated that most were malnourished.

When considering food related side effects experienced by the participants, a loss of appetite followed by a dry mouth were the most common reported food related side effects. Patients with HIV co-infection experienced more food related side effects than patients without HIV co-infections, but the differences were not statistically significant.

As far as anthropometric measurements are concerned, low median values for BMI, MUAC and Triceps skinfold measurements were reported, confirming the high levels of malnutrition in this sample. Males were more likely to be malnourished, as evidenced by the significantly lower median Triceps skinfold measurements than in females. The majority of participants had BMI and MUAC scores in the underweight and malnourished categories.

Involuntary weight loss was reported by the majority of participants. Significantly more participants with HIV co-infection had experienced unplanned weight loss (absolute values and percentage) during the past 3-6 months than participants without HIV co-infection. Similarly, a high percentage of participants were identified as having a high risk for malnutrition according to the MUST screening index.

As far as biochemistry is concerned, a high percentage of participants had albumin and haemoglobin values below the normal range, with a significantly higher percentage of males than females affected.

7.2.3 Lifestyle behaviours

A high prevalence of smoking and alcohol use was identified among patients with TB and TB/HIV co-infection that were included in the present study. As reported in other studies, a significantly higher percentage of men than women smoked. Participants that indicated that they were either former or current smokers had significantly lower levels of education than participants who were non-smokers. Significantly more men drank alcohol (three or more times per week) than women.

7.3 RECOMMENDATIONS

7.3.1 Recommendations to address TB

7.3.1.1 Poverty relief

Poverty in South Africa remains a challenge and a concern. The situation is becoming more and more problematic as the unemployment rate increases in the midst of income inequality (Trading Economics, 2016; World Bank, 2016). The fact that poverty is so closely linked to TB points to the urgent need to address poverty in the fight against TB. The poor are the sector that are least likely to access TB diagnosis and treatment, emphasising the urgent need to focus and improve TB services in this group (Oxlade & Murray, 2012).

Food security of individuals and households are influenced by various factors, especially those related to their immediate environment (Labadarios *et al*., 2011). Poverty is most often responsible for poor household food security, since most South Africans depend on food purchases to ensure food security. In this context, there is an urgent need for economic growth to take place and employment opportunities to increase in order to alleviate poverty and improve household food security. It is thus recommended that communities be taught skills on how to use available resources effectively and be empowered to become involved in food production

(such as household vegetable gardens) and income generating projects that will increase income and address the issue of food insecurity.

7.3.1.2 Nutrition education

Basic education together with incorporation of TB education in the school syllabus can contribute to creating awareness of the disease. Furthermore, nutrition education has the potential to play an important role in improving food security and nutritional status (Keenan *et al*., 2001) by teaching communities about the importance of food distribution according to the needs of the individual. Nutrition education also has the potential to empower communities to eat a healthy diet using the limited resources available to them. A patient's immune system can be strengthened by educating patients about optimal nutrition and helping them to eat a balanced diet using the resources available to them wisely (Suttajit, 2007).

Interventions aimed at improving nutritional status and quality of life in patients with TB and HIV co-infection should aim at preventing weight loss by focusing on affordable, available and acceptable food sources. Nutrition interventions cannot replace TB treatment, just as TB treatment cannot replace adequate nutrition. In order to address the problem of malnutrition, nutrition support and education should be considered a necessary part of the therapeutic and preventative approach when treating a patient with TB. In addition, providing nutrition support and education to families and contacts of persons with TB is indicated to prevent the progression of latent disease to active disease (Cegielski *et al*., 2012: 418).

7.3.1.3 Support networks

Community based support groups are one of the cheapest and most effective strategies that can be implemented in the fight against TB. In a country such as South Africa, this can contribute to the effective management of TB. Communities can play an important role in reducing the burden of TB and HIV and in alleviating its impact, stigma and discrimination. Therefore a necessary supportive environment should be created in TB affected areas in order to improve or maintain quality of life of those infected with TB. Despite this, community resources in most settings are often inadequate and their role remains undefined (Zacharaih *et al*., 2006).

The DOTS strategy is an example of an effective initiative to support patients with TB. The DOTS strategy has been shown to lower the indirect costs of TB to patients and family members, but the current implementation of the DOTS strategy needs to be reassessed in order to improve its potential (Ahlburg, 2000).

Guidelines on smoking and alcohol use should be incorporated into the National TB plan and should also be included in the DOTS strategy (Wang & Shen, 2009). Patients who experience higher levels of poverty also appear to have more depressive symptoms, and alcohol, drug and smoking are closely related with poverty (Louwagie *et al*., 2014: 508). Therefore, community support groups might also assist in addressing smoking

and alcohol use, which may in turn, improve household food security, and improve the quality of life of the affected.

7.3.2 Recommendations for further research

According to the Academy of Science of Southern Africa (ASSAf, 2007) “the lack of TB research on the specific nutrients that are most beneficial and the conditions under which nutrition interventions are warranted, in terms of cost and effectiveness, is truly astonishing.” In this regard, research to establish the nutritional status of patients with TB and TB/HIV co-infection on a national scale are necessary in South Africa. Studies that apply a longitudinal study design have the potential to effectively determine the role of malnutrition in the development of TB disease on the one hand, while also investigating the impact of TB in affecting nutritional status on the other (Lombardo *et al*., 2012; Cegielski & McMurray 2004).

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ADDENDUM A

Guidelines for food safety (South African guidelines on Nutrition for people living with TB, HIV/AIDS and other chronic debilitating conditions) (SADoH, 2007)

Food safety

Wash your hands well with soap and water (preferably warm):

- Before you touch food
- Between touching raw and cooked food
- After touching an animal
- After using the toilet
- After sneezing and blowing your nose
- Before you eat meals

Food safety when shopping

- Food bought should be kept safe e.g. freeze food
- Discounts might contain unsafe and outdate food – do not be tempted.
- Buy ready packed foods, not food that is unwrapped and sitting in a display case
- Wash vegetables and fruit beforehand; look for 'pasteurized' milk and dairy products; meat should not look/smell 'off'; eggs should never be eaten raw

Kitchen safety

- The room/kitchen should be clean and well aired
- Keep rubbish in a bin with a lid and remove rubbish on a regular basis
- Cloths and sponges should be kept clean and disinfected
- Wash dishes in preferably hot, and soapy water
- Do not use cracked or scratched plastic containers
- Use a special cutting board, not the sink, for cutting raw food

Water safety

- Boil water before drinking it, OR
- Use the bleach method: Add 1 teaspoon of bleach to 25 litres of water. Mix it well and let it stand for 2 hours (overnight is better) before you use it.

ADDENDUM B

Dietary Management of HIV and TB Related Illness (Republic of Ghana, 2013)

Illness	Diet	Care and Nutrition Practices
Anorexia (appetite loss)	• Stimulate appetite by eating favourite foods. • Eat small amounts of food more often. • Eat more energy-dense foods. • Choose foods with pleasant aromas and that the client likes. • Eat meals and snacks in pleasant settings.	• If appetite loss is a result of illness, seek medical treatment.
Mild diarrhoea	• Drink a lot of fluids (soups, diluted fruit juices, boiled water, and light herbal teas) to avoid dehydration. • Avoid citrus fruits (orange, lemon) because they irritate the stomach. • Eat foods rich in soluble fibre (millet, banana, peas, and lentils) to help retain fluids. • Eat fermented foods such as porridges and yogurt. • Eat easily digestible foods such as rice, bread, millet, cereal porridge, potato, sweet potato, and crackers. • Eat small amounts of food frequently. • Continue to eat frequently after illness to recover weight and nutrient loss. • Drink non-fat milk if there is no problem with lactose.	**Prevention** • Drink clean boiled water. • Wash hands with water and soap before handling, preparing, serving, or storing food. • Wash hands with water and soap after using a toilet or latrine or cleaning a child after defecation. **Treatment** • Drink more fluids to prevent dehydration. Prepare rehydration solutions using oral rehydration salt sachets or a homemade solution from cereals. • Go to a health facility if symptoms, such as severe dehydration (low or no urine output), fainting, dizziness, shortness of breath, bloody stools, high fever, vomiting, severe abdominal pain, or diarrhoea, persist for more than 2 days.
Severe diarrhoea	• Drink a lot of fluids (soups, diluted fruit juices, boiled water, and light herbal teas) to avoid dehydration. • Eat fermented foods such as porridges and yogurt. • Eat easily digestible foods such as rice, bread, millet, cereal porridge, potato, sweet potato, and crackers. • Eat small amounts of food frequently. • Continue to eat frequently after illness to recover weight and nutrient loss. • Eat soft fruits and vegetables such as bananas, mashed sweet potato, and mashed carrots. • Drink non-fat milk if there is no problem with lactose. • Boil or steam foods if diarrhoea is associated with fat malabsorption.	**Prevention** • Drink clean boiled water. • Wash hands with water and soap before handling, preparing, serving, or storing food. • Wash hands with water and soap after using a toilet or latrine or cleaning a child after defecation. **Treatment** • Drink more fluids to prevent dehydration. Prepare rehydration solutions using oral rehydration salt sachets or a homemade solution from cereals. • Go to a health facility if symptoms, such as severe dehydration (low or no urine output), fainting, dizziness, shortness of breath, bloody stools, high fever, vomiting, severe abdominal pain,

	• Avoid or reduce intake of dairy products (milk); caffeine (coffee and teas) and alcohol; fatty foods; fried foods and extra oil, lard, or butter; and gas-forming foods such as cabbage, onions, and carbonated soft drinks.	or diarrhoea, persist for more than 2 days.
Fever	• Eat soups rich in foods that give energy and nutrients, such as cereal, potatoes, and carrots. • Drink plenty of fluids. • Drink teas from lemon, guava, and gum tree. • Continue to eat small, frequent meals as tolerated.	• Drink fluids to prevent dehydration, particularly clean boiled water. • Bathe in cool water. • Rest more. • Take two Paracetamol tablets, if available, with a meal three times a day (morning, afternoon, and evening). • Go to the health facility if you have fever that lasts 2 days and is not relieved with Paracetamol or brief loss of consciousness, severe body pain, yellow eyes, severe diarrhoea, or convulsions and seizures.
Nausea and vomiting	• Eat small frequent meals. • Eat soups, unsweetened porridge, and fruits such as bananas. • Eat slightly salty and dry foods, such as crackers, to calm the stomach. • Drink herbal teas and lemon juice in hot water. • Avoid spicy and fatty foods. • Avoid caffeine (coffee and tea) and alcohol. • Avoid strong-smelling foods • Drink liquids such as clean boiled water.	• Avoid an empty stomach; nausea is worse if nothing is in the stomach. • Avoid lying down immediately after eating—wait at least 20 minutes. • Avoid vomiting. • Rest between meals.
Thrush	• Eat soft, mashed foods such as carrots, scrambled eggs, mashed potatoes, bananas, soups, and porridge. • Eat cold or room-temperature foods. • Avoid spicy, salty, or sticky foods that may irritate mouth sores. • Avoid sugary foods that cause yeast to grow. • Avoid strong citrus fruits and juices that may irritate mouth sores. • Avoid alcohol and drink plenty of fluids.	• Seek medical treatment. • Use a spoon or cup to eat small amounts of foods. • Tilt your head back when eating to help with swallowing. • Rinse your mouth with boiled warm, salty water after eating to reduce irritation and keep yeast from growing.
Constipation	• Eat more high-fibre foods such as maize, whole wheat bread, green vegetables, and washed fruits with the peel. • Drink plenty of liquids. • Avoid processed or refined foods.	• Avoid cleansing practices such as enemas and medications. • Drink plenty of fluids, including clean, boiled water.

Anaemia	• Eat more iron-rich foods such as animal products (eggs, fish, meat, liver), green leafy vegetables (*kontomire*, spinach), legumes (beans, groundnuts), nuts, oil seeds, and fortified cereals. • Take iron supplements (if not SAM). • Avoid drinking tea or coffee within 2 hours before or after meals.	• If available, take one iron tablet once a day with some food. • Take your meals with a source of vitamin C, such as fresh tomatoes, oranges, or guavas, to help with absorption of iron from plant-based foods. • Treat malaria and hookworm if you have symptoms.
Muscle wasting	• Eat more and eat more often. • Improve the quality and quantity of foods by eating a variety of foods. • Eat more foods high in protein. • Eat more starchy foods (cereals and other staples). • Eat small frequent meals.	• Perform light exercises (such as walking, climbing stairs), since exercises help build muscles.
Bloating or heartburn	• Eat small, frequent meals. • Avoid gas forming foods (cabbage, soda). • Drink plenty of fluids.	• Eat long enough before sleeping so that food can digest.
TB	• Eat foods high in protein, energy, iron, and vitamins.	• Seek medical attention immediately. • Consult medical personnel about taking food with medications. • If taking Isoniazid for treatment, take a vitamin B6 supplement to avoid deficiency of this micronutrient.
Loss of taste or abnormal taste	• Use flavour enhancers such as salt, herbs, spices, and lemon. • Eat dry foods such as crackers.	• Eat small frequent meals. • Chew food well and move it around the mouth to stimulate receptors.

ADDENDUM C

General nutritional recommendations for people with TB and/or HIV (FANTA, 2013)

The following nutrition recommendations are general guidelines for patients with TB:

- Get weighed regularly, and have weight recorded.
- Where possible, eat regular daily meals.
- If weight loss occur, increased energy intake by consuming more meals, snacks and energy dense foods.
- Eat a variety of foods, and increase the intake of nutritious foods.
- Eat staple foods (rice, wheat, stamp, maize, potato) with every meal.
- Eat legumes every day, if possible.
- Eat foods from an animal source regularly.
- Eat fruit and vegetables daily.
- Increase consumption of micronutrient-rich foods to achieve an intake of one recommended nutrient intake (RNI) per day. If one cannot afford this, taking a multivitamin/mineral supplement that provides one RNI may be helpful.
- Drink plenty of clean safe (boiled and treated) water.
- Avoid habits that can lead to poor nutrition and poor health (alcohol intake, smoking, stress, junk food and lack of sleep).
- Maintain good hygiene and sanitation, and good dental and oral health, to avoid infections that may affect food intake.
- Get exercise whenever physically possible.

ADDENDUM D

Letter for the PHREC of Mpumalanga Department of Health

The Provincial Health and Research Ethics Committee (PHREC) of Mpumalanga Department of Health

I, Janke Wessels (Persal number: 83814078), would like to ask for permission to conduct my research study for my Masters in Dietetics at Standerton TB Specialised Hospital, Mpumalanga, during 2015.

Title of the research project: *Nutritional status of patients with TB and, TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga*

I am registered as a M.Sc. Dietetic student (student number: 2008007022) at the University of the Free State (UFS), Department of Nutrition and Dietetics. The research study will be conducted after ethics approval is obtained from the Ethics Committee of the UFS.

I want to determine the nutritional status of patients with tuberculosis (TB) and, TB/HIV co-infection. The participants will give written consent before they take part in the research study. The information will be gathered via structured individual interviews. The information that will be recorded on the questionnaire include socio-economic status, dietary factors (food related side effects and food security, overall risk of malnutrition and biochemistry), and alcohol and smoking habits. Anthropometric measurements that will be measured include weight and height to determine body mass index (BMI), mid-upper arm circumference (MUAC) and Triceps skinfold.

Participants will be interviewed during their free hours in my office. If necessary, lay counsellors, employed by the hospital, will explain the questions to participants in their language of choice. Questionnaires are available in the most prevalent languages in the area, namely; English and IsiZulu.

All information will be treated with the utmost confidentiality and participants will not be exposed to any risks. The results will be made available to the participants upon request.

Please feel free to request any additional information from me.

Regards

JANKE WESSELS
Dietician, Standerton TB Specialised Hospital
Cell: 073 369 7750
Email: wesselsjanke@gmail.com

ADDENDUM E

Approval letter from the PHREC of Mpumalanga department of Health

Department of Health
Mpumalanga Provincial Government

Building No. 3, No. 7 Government Boulevard, Riverside Park Extension 2, Mbombela, 1200, Mpumalanga
Private Bag X 11285, Mbombela 1200, Tel: 013 766 3429, int: +27 13 766 3429, Fax: 013 766 3459, int: +27 13 766 3459

Litiko Letemphilo Umnyango WezaMaphilo Departement van Gesondheid

Enquiries: Themba Mulungo (013) 766 3511

02 July 2015

Ms. Janke Wessels
P.O BOX 339
Bloemfontein
9300

Dear Ms. Janke Wessels

APPLICATION FOR RESEARCH & ETHICS APPROVAL: NUTRITIONAL STATUS OF PATIENTS WITH TB AND, TB/HIV CO-INFECTION AT STANDERTON TB SPECIALISED HOSPITAL, MPUMALANGA

The Provincial Health Research and Ethics Committee has approved your research proposal in the latest format that you sent.

PHREC REF: MP_2015RP38_556

Kindly ensure that you provide us with the soft and hard copies of the report once your research project has been completed.

Kind regards

MR. MOLEFE MACHABA
RESEARCH AND EPIDEMIOLOGY

02/07/2015
DATE

MPUMALANGA PROVINCE
DEPARTMENT OF HEALTH
PLANNING & INFORMATION
2015 -07- 02
PRIVATE BAG X 11285
NELSPRUIT 1200

MPUMALANGA
THE PLACE OF THE RISING SUN

ADDENDUM F

Approval letter from the ethics committee at the UFS

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

22 July 2015

Ms J Wessels
Department of Nutrition and Dietetics
UFS

Dear Ms J Wessels

ECUFS 56/2015
PROJECT TITLE: NUTRITIONAL STATUS OF PATIENTS WITH TB AND TB/HIV CO-INFECTION AT STANDERTON TB SPECIALISED HOSPITAL, MPUMALANGA.

1. You are hereby kindly informed that, at the meeting held on 21 July 2015, the Ethics Committee approved the above project after all conditions were met.

2. Any amendment, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

3. 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.

4. Kindly use the ECUFS NR as reference in correspondence to the Ethics Committee Secretariat.

5. The Ethics Committee functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the Ethics Committee of the Faculty of Health Sciences.

Yours faithfully

DR SM LE GRANGE
CHAIR: ETHICS COMMITTEE

ADDENDUM G

Letter to ask Permission to Conduct the Study at the Hospital

Acting CEO: Matron T Masemola

I, Janke Wessels (Persal number: 83814078), would like to ask for permission to conduct my research study for my Masters in Dietetics at Standerton TB Specialised Hospital during 2015.

Title of the research project: *Nutritional status of patients with TB and, TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga*

I am registered as a M.Sc. Dietetic student (student number: 2008007022) at the University of the Free State (UFS), Department of Nutrition and Dietetics. The research study will be conducted after ethics approval is obtained from the Ethics Committee of the UFS.

I want to determine the nutritional status of patients with tuberculosis (TB) and, TB/HIV co-infection. The participants will give written consent before they take part in the research study. The information will be gathered via structured individual interviews. The information that will be recorded will include socio-economic status, dietary factors (food related side effects and food security, overall risk of malnutrition and biochemistry), and alcohol and smoking habits. Anthropometric measurements that will be measured will include weight and height to determine body mass index (BMI), mid-upper arm circumference (MUAC) and Triceps skinfold).

The ward routine will not be disturbed in any way. Participants will be interviewed during their free hours in my office. If necessary, lay counsellors, employed by the hospital, will translate the questions to participants in their language of choice.

All information will be treated with the utmost confidentiality and participants will not be exposed to any risks. The results will be made available to the participants upon request.

Please feel free to request any additional information from me.

Regards

JANKE WESSELS
Dietician, Standerton TB Specialised Hospital
Cell: 073 369 7750
Email: wesselsjanke@gmail.com

ADDENDUM H

Approval letter from the CEO at Standerton TB Specialised Hospital

MPUMALANGA PROVINCIAL GOVERNMENT

Lang Street Extension
Sakhile
Standerton
2430
Republic of South Africa

P.O. Box 138
Standerton, 2430
Tel: 017 714 6045
int: +27 17 714 6045
Fax: 017 714 7462

Department of Health
Standerton TB Hospital

Litiko Letemphilo | Umnyango WezaMaphilo | Departement van Gesondheid

TO : **MS. J WESSELS**

FROM : **STANDERTON TB SPECIALISED HOSPITAL**

DATE : **11 MAY 2015**

PERMISSION TO CONDUCT A RESEARCH STUDY AT STANDERTON TB SPECIALISED HOSPITAL

Dear MS J WESSELS

I hereby would like to inform you that your request for the research on TB, and TB/HIV co-infected patients at Standerton TB Specialised Hospital has been approved.

I would like to wish you all the best on your research, I believe that you will be a good ambassador for the institution.

Thank you

Acting CEO
Matron MT Masemola

ADDENDUM I

Informed Consent - English

Title of the project: *Nutritional status of patients with TB and, TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga.*

You have been asked to participate in a research study.

You have been informed about the study by ……..

Your participation will benefit the Department of Health with information on the nutritional status of patients with tuberculosis and, TB/HIV co-infection. The study will form part of a Master's degree qualification in the Department of Nutrition and Dietetics at the University of the Free State.

Should you choose to participate please note that:

- Your participation in this research is entirely voluntary; you are free to choose to participate or not to participate.
- You will be asked to answer questions regarding your socio-demographic status, food related side effects, food security and alcohol and smoking habits. Your weight and height and two other measurements (Triceps skin fold and Mid-upper arm circumference) will also be measured.
- It will take about one hour to complete the questionnaire and to take your measurements.
- All information will be treated with the utmost confidentiality.
- Results will only be reported for the group and your individual information will not be reported. All information will thus remain confidential.
- You will not be penalised or lose benefits if you refuse to participate or want to withdraw from the study at any time. It will not cost anything to participate and you will not be paid to participate.
- You may contact the Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS at telephone number (051) 401 7794/5 if you have questions about your rights as a research subject.
- You may also contact Prof C Walsh at telephone number (051) 401 2894 if there are any questions related to the study.
- If you agree to participate, you will be given a signed copy of this document as well as the participant information sheet, which is a written summary of the research.
- The results of the research study will be available upon your request.

The research study, including the above information has been verbally described to me, I understand what my involvement in the study means and I voluntarily agree to participate in the research study.

_____ _____

Signature of participant Date

Informed Consent – IsiZulu

Isihloko saleliqembu: *Ukudla okunempilo kusiguli esinesifo sofuba Kanye nesandulela ngculaza esibhedlela esibhekelela isifo sofuba sase Standerton, eMpumalanga.*

Uceliwe ukuthi ube yincenye yokucubungulwa kwemfundo.

Wazisiwe ngemfundo ngu ……..

Ukusebenzisana kwakho kuzonceda umyango wezempilo ngokwazi ngempilo yokudla kweziguli ezinesifo sofuba/nesandulela ngculaza.

Uma ukhetha ukusebenzisana yazi ukuthi:

- Ukusebenzisana kwakho kulokucubungula kungukuzikhethela ukusebenzisana nokungasebenzisani.
- Uzocelwa ukuthi uphendule imibuza mayelana ne socio-demographic ukudla okusondelene nezifo, ukudla okuqasheliwe, uphuzo oludakayo Kanye nokubhema njalo. Isisindo sakho, ubude Kanye nokunye okumedwa okuzokwenziwa.
- Kuzothatha isikhathi esingangehora ukuceda ukuphendula lemibuza Kanye nokulinganisa.
- Konke okuqukethwe lapha kuzoba enkulu imfihlo.
- Imiphumela izothulelwa izigaba kodwa eyakho imiphumela ngeke yethulwe. Yonke imiphumela izogqinwa iyimfihlo.
- Angeke usolwe uma ungafuni noma ufuna ukuphuma kulesi sifundo nomangabe kunini. Angeke ukhokhe noma ukhokhelwe ukuze kusetshenziswane kulesifundo.
- Ungaqhumana nobhala imigomo yekomiti lomkhandlu wobuqwepheshe bezempilo, izinombolo zocingo (051 401 7794/5) uma unemibuzo ngamalungelo akho ungacubungula.
- Ungaqhumana no Profesa C. Walsh ocingweni olungu (051) 401 2894 uma kunemibuzo eqhumana nezifundo.
- Uma unuma ukusebenzisana, uzonikwa iphepha elisayiniwe elinemininingwane Kanye nemiphumela yolwazi, Kanye nesinciphiso esibhaliwe esiqubunguliwe.
- Imiphumela equbunguliwe izobonakaliswa kuso isicelo sakho.

Ukuqubungulwa kokufunda, Kanye nolwazi kuchazwe ngokuphelele kimi, ngiyazwisisa okungihlanganise nokuziqeqesha kusho ukuthi ngiyavuma ukuzinikela ekusebenzeni kanye nokuqubungula imfundo.

_____ _____

Sayina lapha Ubuku

ADDENDUM J

Information Document

***Study Title**:* *Nutritional status of patients with TB and, TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga*

Thank you for being willing to help with this important research project.

I, Janke Wessels, a master student at the University of the Free State (UFS), am going to do

Research amongst the patients with tuberculosis (TB) and TB/HIV co-infected at Standerton

TB Specialised Hospital.

In this study I would like determine the nutritional status of patients with TB and TB/HIV co-infection.

All information will be gathered via structured individual interviews in language of choice with the participants, after they have given informed consent.

All questions in the questionnaire will be filled out at Standerton TB Specialised Hospital, in a private room, by a registered dietician. Respondents will be asked to answer questions regarding the following aspects:

- Socio-demographic status,
- Dietary factors (food related side effects and food security),
- Lifestyle factors (smoking habits and alcohol use).

I will also take measurements such as weight, height, mid-upper arm circumference and Triceps skin fold.

Risk of being involved in the research study: The participants will not be exposed to any risks.

Benefits of being involved in the study: Participants will benefit from the research study in terms of; their contribution to the body of knowledge for further nutritional treatment of patients with TB, and TB/ HIV co-infection. It will not cost anything to participate and the participants will also not being paid anything.

Participation is voluntary, and refusal to participate will involve no penalty or loss of benefits to which the patient is otherwise entitled; the participant may also discontinue participation at any time.

Confidentiality: Efforts will be made to keep information confidential by not identifying the participants. The results will be presented as a group and not as individuals.

Expected outcome of the research: The results of the study will assist in describing the nutritional status of patients with TB and, TB/HIV co-infection and thus highlight areas that need to be focused on in nutrition interventions.

You may contact the Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS at telephone number (051) 401 7794/5 if you have questions about your rights as a research subject.

Kind regards,

JANKE WESSELS
Contact details 073 369 7750 / 017 714 6045

ADDENDUM K

Questionnaire - English

Nutritional status of patients with TB and, TB/HIV co-infection at Standerton TB Specialised Hospital, Mpumalanga

Instructions	**FOR OFFICE USE**
Mark the appropriate block with a X or write your answer on the space provided.	[ ][ ][ ] 1-3

1	Date questionnaires is completed (dd/mm/yy) ……/……/……	[ ][ ][ ][ ][ ][ ] 4-9 (d d m m y y)
2	What is your gender?	
	Male(1) Female(2)	[ ] 10
3	What is your birthdate? (dd/mm/yy) ……/……/……	[ ][ ][ ][ ][ ][ ] 11-16 (d d m m y y)
4	What is your marital status?	
	1 Unmarried	[ ] 17
	2 Married/Traditional marriage	
	3 Divorced/Separated	
	4 Widow/Widower	
	5 Living together	
5	What is your level of education?	[ ] 18
	1 No schooling completed	
	2 Less than Grade 9	
	3 At least Grade 9	
	4 Matric completed	
	5 Tertiary education	
6	What is your current employment status?	[ ] 19
	1 Retired by choice	
	2 Unemployed	
	3 Self-employed	
	4 Full time wage earner (receive a salary)	
	5 Part time wage earner	
	6 Receives a grant	
	7 Other, specify (part-ime, piece job etc.)……	
7	How many people live in your house (yourself included)?	
	1 Adults (>18 years) [ ][ ]	[ ][ ] 20-21
	2 Children (<18 years) [ ][ ]	[ ][ ] 22-23

8	How many rooms are in the house (kitchen and bathroom excluded)?	
		24-25
9	What is the total household income per month?	26
	(wages, rent, sales, state grantes etc.)	
	1 None	
	2 R100 - R500	
	3 R501 - R1000	
	4 R1001 - R3000	
	5 R3001 - R5000	
	6 Over R5000	
	7 Don't know	
10	How many people contribute to the total monthly income?	
		27-28
11	Do you have a vegetable garden at home?	29
	1 Yes	
	2 No	
12	If yes, what vegetables do you have in your garden currently?	
	_____	30-31
	_____	32-33
	_____	34-35
	_____	36-37
	_____	38-39
	_____	40-41
	_____	42-43

13	Do you experience any of the following symptoms currently?	
13.1	Loss of appetite:	☐ 46
	1 Yes	
	2 No	
13.2	Sore mouth:	☐ 47
	1 Yes	
	2 No	
13.3	Dry mouth:	☐ 48
	1 Yes	
	2 No	
13.4	Nauseas:	☐ 49
	1 Yes	
	2 No	
13.5	Vomiting:	☐ 50
	1 Yes	
	2 No	
13.6	Constipation:	☐ 51
	1 Yes	
	2 No	
13.7	Diarrhoea:	☐ 52
	1 Yes	
	2 No	
13.8	Night sweats:	☐ 53
	1 Yes	
	2 No	

The CCHIP tool

14 Does your household ever run out of money to buy food? ☐ 54

1 Yes
2 No

15 Do you ever rely on a limited number of foods to feed your children because you are running out of money to buy food for a meal? ☐ 55

1 Yes
2 No

16 Do you ever cut the size of meals or skip meals because there is not enough money for food? ☐ 56

1 Yes
2 No

17 Do you ever eat less than you should because there is not enough money for food? ☐ 57

1 Yes
2 No

18 Do your children ever eat less than you feel they should because there is not enough money for food? ☐ 58

1 Yes
2 No

19 Do your children ever say they are hungry because there is not enough food in the house? ☐ 59

1 Yes
2 No

20 Do you ever cut the size of your children's meals or do they ever skip meals because there is not enough money to buy food? ☐ 60

1 Yes
2 No

21 Do any of your children ever go to bed hungry because there is not enough money to buy food? ☐ 61

1 Yes
2 No

22	Weight		(kg)	62-66
23	Any unplanned weight loss in the past 3-6 months?			67
	1 Yes			
	2 No			
24	If yes, how much?			68
	1 < 5%			
	2 5-10 %			
	3 >10%			
25	Height		(cm)	69-73
26	Body mass index		(kg/m²)	74-77
27	Mid-upper arm circumference		(cm)	78-1
			(cm)	
			(cm)	
	Average		**(cm)**	
28	Triceps skin fold		(mm)	2-3
			(mm)	
			(mm)	
	Average		**(mm)**	
29	HIV status			4
	1 Positive			
	2 Negative			
30	Total protein		g/dL	5-6
31	Albumin		g/dL	7-8
32	CD4 cell count		mm³	9-12
33	CRP		mg/L	13-15
34	MCV		f/l	16-20
35	Haemoglobin		g/dl	21-24
36	Medication currently on:			
	_____			25-26
	_____			27-28
	_____			29-30
	_____			31-32
	_____			33-34
	_____			35-36
	_____			37-38
	_____			39-40

37	Choose one of the following:	☐	41
	1 I am a non-smoker (never smoked before)		
	2 Former smoker (smoked before, but stopped 3 months ago)		
	3 Current smoker (smokes at least one cigarette, pipe, or cigar per day for at least 6 months prior to entering the study)		
	If a former or current smoker:		
38	How many times did/do you smoke per day? ☐☐	☐☐	42-43
39	For how many years did/do you smoke? ☐☐	☐☐	44-45
40	Choose one of the following:	☐	46
	1 I used to drink alcohol 3 or more times per week		
	2 I used to drink alcohol less than 3 times per week		
	3 I do not drink alcohol		

Questionnaire – IsiZulu

Ukudla kwesimo sempilo yeziguli ezinesifo sofuba kanye nesandulela ngculaza esibhedlela esibhekelela isifo sofuba sase Standerton

Imigomo		**FOR OFFICE USE**	
Gqwalisa ngalolu phawu X okanye ubhale impendulo yakho esikhaleni onikwe sona			1-3
1	Usuku ogqwalise ngalo lemibuzo (usuku/inyanga/unyaka) ……/……/……	d d m m y y	4-9
2	Yini ubulili bakho? Isilisa(1) Isifazane(2)		10
3	Usuku lwakho lokuzalwa (usuku/inyanga/unyaka) ……/……/……	d d m m y y	11-16
4	Izinhlelo zemshado?		17
	1 Awushadile		
	2 Ushadile/Ushade ngokwesintu		
	3 Ukuhlukana/Isehlukaniso		
	4 Umfelokazi/Umfelwa		
	5 Umasihlalisane		
5	Izinga lemfundo yakho?		18
	1 Qwuyanga esikolweni nhlobo		
	2 Ngaphansi kwebanga lesishiyagalolunye		
	3 Ibanga lesishiyagalolunye		
	4 Umqedile umatikuletsheni		
	5 Imfundo yebamga eliphakeme		
6	Uyasebenza okwamanje?		19
	1 Umhlalaphansi ozikhethele wona		
	2 Awusebenzi		
	3 Uyazisebenza		
	4 Yasebenza uhola umholowevike noma wenyanga		
	5 Usebenza okwesikhashana		
	6 Thola imau yeqolo		
	7 Okunye, okubekiwe (okwesikhashana)…….		
7	Bangakhi abantu ohlala nabo endlini (nawe ngokunjalo)?		
	1 Abadala (>18 years)		20-21
	2 Izingane (<18 years)		22-23

8	Unamagumbi amangaki endlini yakho (ngaphandle kwekhishi kanye nendlu encane)?		24-25
9	Lithini iholo lendlu yakho ngenyanga? (iholo, rent, imali yeqolo)		26
	1 Ayikho		
	2 R100 - R500		
	3 R501 - R1000		
	4 R1001 - R3000		
	5 R3001 - R5000		
	6 Angaphezulu kuka R5000		
	7 Awunasiqiniseko		
10	Bangakhi abachasayo eholweni labo lwenyanga ohlala nabo endlini?		27-28
11	Unayo ingadi yezithelo ekhaya?		29
	1 Yebo		
	2 Cha		
12	Uma kungu yebo, unaziphi izithelo engadini yakho?		
	_____		30-31
	_____		32-33
	_____		34-35
	_____		36-37
	_____		38-39
	_____		40-41
	_____		42-43

13	Uyaziqaphela lezizimpawu ezilandelayo kulesikhathi?		
13.1	Ukungafuni ukudla kahle:	☐	46
	1 Yebo		
	2 Cha		
13.2	Unezilonda emlonyeni:	☐	47
	1 Yebo		
	2 Cha		
13.3	Ukoma komlomo:	☐	48
	1 Yebo		
	2 Cha		
13.4	Ukuzizwa ngathi ufuna ukuhlanza:	☐	49
	1 Yebo		
	2 Cha		
13.5	Ukuhlanza:	☐	50
	1 Yebo		
	2 Cha		
13.6	Ukungayi endlini encane:	☐	51
	1 Yebo		
	2 Cha		
13.7	Isifo sohudo:	☐	52
	1 Yebo		
	2 Cha		
13.8	Ukujuluka:	☐	53
	1 Yebo		
	2 Cha		

14	Ekhaya niyaphelelwa imali yokuthenga ukudla?	☐ 54	
	1 Yebo		
	2 Cha		
15	Uke wagqila ekubaleni ukudla okupha izingane ngenxa yakungabi nemali eyanele ukuthenga ukudla?	☐ 55	
	1 Yebo		
	2 Cha		
16	Uke wadlulisa ukudla wangadla ngenxa yokungabi nemali yokuthenga ukudla?	☐ 56	
	1 Yebo		
	2 Cha		
17	Ukewadla ngokungenele ngoba kunganamali eyenele yokudla?	☐ 57	
	1 Yebo		
	2 Cha		
18	Izingane zike zadla ukudla okungenele ngenxa yemali yokudla okungenele?	☐ 58	
	1 Yebo		
	2 Cha		
19	Izingane zike zathi zilambile ngenxa yokudla okungenele endlini?	☐ 59	
	1 Yebo		
	2 Cha		
20	Izingane zike zangathola ukudla ngenxa yokungabi nemali yokuthenga ukudla?	☐ 60	
	1 Yebo		
	2 Cha		
21	Izingane zike zayolala zilambile ngoba kungana mali eyenele yokuthenga ukudla?	☐ 61	
	1 Yebo		
	2 Cha		

22	Isisindo	___.___ (kg)	___.___ 62-66
23	Ukwehla kwesisindo sakho ungasihlelelanga ezinyangeni ezintathu ukuya kweziyisithupha?		67
	1 Yebo		
	2 Cha		
24	Uma kungu yebo, kangakanani?		68
	1 < 5kg		
	2 5-10 kg		
	3 >10kg		
	4 Awunasiqiniseko		
25	Ubude	___.___ (cm)	___.___ 69-73
26	Body mass index	__.__ (kg/m²)	__.__ 74-77
27	Mid-upper arm circumference	__.__ (cm)	__.__ 78-1
		__.__ (cm)	
		__.__ (cm)	
	Okungenani	__.__ **(cm)**	
28	Triceps skin fold	__ (mm)	__ 2-3
		__ (mm)	
		__ (mm)	
	Okungenani	__ **(mm)**	
29	Isandulela ngculaza		4
	1 Unegciwane		
	2 Awunalo igciwane		
30	Total protein	__ g/dL	__ 5-6
31	Albumin	__ g/dL	__ 7-8
32	CD4 cell count	____ mm³	____ 9-12
33	CRP	_.__ mg/L	_.__ 13-15
34	MCV	___.___ f/l	___.___ 16-20
35	Haemoglobin	__.__ g/dl	__.__ 21-24
36	Amaphilisi owathathayo okwamanje:		
	_____		__ 25-26
	_____		__ 27-28
	_____		__ 29-30
	_____		__ 31-32
	_____		__ 33-34
	_____		__ 35-36
	_____		__ 37-38
	_____		__ 39-40

37	Khetha okukodwa kulokhu okulandelayo:		41
	1 Angibhemi (angikaze ngabhema)		
	2 Ngike ngabhema ngayeka ezinyangeni ezintathe ezindlulile		
	3 Ngisabhema namanje kanye ngelanga izinyanga eziyisithupha		
	Umangabe bowubhema okanye usabhema nomanje		
38	Ubhema kangaki ngosuku?		42-43
39	Uneminyaka emingakhi ubhema ugwayi?		44-45
40	Khetha okukodwa kulokhu okulandelayo:		46
	1 Ngangiphuza utshwala kathathu noma ngokudlulele ngeviki		
	2 Ngangiphuza utshwala ngaphansi kokuthathu ngeviki		
	3 Angibuphuzi utshwala		