

THE HEALTH AND NUTRITIONAL STATUS
OF HIV POSITIVE WOMEN (25-44 YEARS)
IN MANGAUNG

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LIST OF ABBREVIATIONS

α	alpha
	beta
AI	Adequate Intake
AIDS	Acquired Immune Deficiency Syndrome
AIM	Aperture Integrity Monitor
ART	antiretroviral therapy
AZT	Zidovudine / Azidothymidine
bcg	Bromocresol green
BIA	Bioelectrical impedance analysis
BMI	Body Mass Index
°C	degrees Celcius
CDC	Centers for Disease Control
CI	Confidence Interval
cm	centimeter
C.V.	coefficient of variation
DNA	Deoxyribonucleic acid
DoH, SA	Department of Health, South Africa
DRI	Dietary Reference Intake
EDTA	Ethyldimethylacetic acid
F	Fisher's exact test
FAO	Food and Agriculture Organization of the United Nations
Fe	Iron
Femto liter	fL

FFQ	food frequency questionnaire
g	gram
g/dL	gram per deciliter
g/L	gram per liter
GOD	glucose-oxidase
HAART	highly active antiretroviral therapy
HDL	High-density lipoprotein
HIV	Human Immunodeficiency Virus
IU	International Units
kg	kilogram
kg/m²	kilogram per meter squared
kHz	kilo Hertz
kJ	kilojoule
L	liter
L/L	liter per liter
LD	Light Diode
LED	Light energy display
LDL	Low-density lipoprotein
M	Molar = Mol/ILiter
MCH	mean corpuscular haemoglobin
MCHC	mean corpuscular haemoglobin concentration
MCV	mean corpuscular volume
mg	milligram
mg/L	milligram per liter
ml	milliliter
mm	millimeter

mm³	cubic millimeter
mmol/L	millimol per liter
MTPL	microtiterplate
nm	nanometer
NICDAM	National Institute Community Development and Management
NICUS	Nutrition Information Centre, University of Stellenbosch
OR	Odds Ratio
PA	Physical Activity
PAI	Physical Activity Index
Pg	Picogram
PGL	Progressive generalized lymphadenopathy
PCR	Polymerase Chain Reaction
POD	peroxidase
RBC	red blood cell
RDA	Recommended Dietary Intake
REE	Resting Energy Expenditure
RNA	Ribonucleic acid
rpm	revolutions per minute
s.a.	sine anno (date of publication unavailable)
SD	Standard Deviation
s.l.	sine loco (place of publication unavailable)
s.n.	sine nomine (publisher unavailable)
STD	sexually transmitted diseases
TAC	Treatment Action Campaign
TB	Tuberculosis
TNF	Tumor necrosis factor

THUSA	Transition and Health during Urbanization of South Africans
UN	United Nations
UNAIDS	Joint United Nations Programme on HIV/AIDS
USA	United States of America
USAID	United States Agency for International Development
VLDL	Very low-density lipoprotein
WBC	white blood cell
WHO	World Health Organization
WHR	waist-hip-ratio
μg	microgram
μg/L	microgram per liter
μU/ml	micro-units per milliliter
≤	Equal or below
<	Smaller than
>	higher than
≥	equal or above

CHAPTER 1

THE MODERN EPIDEMIC

1.1 INTRODUCTION

Acquired Immune Deficiency Syndrome (AIDS) has become the most devastating disease humankind has ever faced (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2001). AIDS has been defined as a disease caused by a retrovirus known as the Human Immunodeficiency Virus (HIV), which attacks and impairs the body's natural defense system against disease and infection (United States Agency for International Development (USAID), 2001). The virus can be transmitted through unprotected sexual intercourse with a person already carrying the virus, transfusions of contaminated blood and its by-products, the use of un-sterilized instruments, and from an infected mother to her child before or during birth, or through breastfeeding (USAID, 2001; Fenton & Silverman, 2004, p. 1030).

To date, the HIV/AIDS epidemic has not been overcome anywhere in the world (USAID, 2001), making this disease a serious health challenge for the new millennium. Even more disturbing, is the fact that the vast majority of infected people are unaware of the fact that they have acquired HIV (UNAIDS, 2001).

The main aim of this study is to determine the relationship between HIV/AIDS status and parameters such as socio-demographic status, anthropometric nutritional status, dietary intake, physical activity levels and biochemical status.

1.2 HIV/AIDS: A GLOBAL PERSPECTIVE

Worldwide trends in HIV/AIDS indicate that this disease is increasing at an alarming rate. HIV/AIDS is therefore now recognized as a pandemic. According to the Food and Agriculture Organization (FAO, 2001a), the United Nations (UN) has moved its focus away from "AIDS as a medical issue with doctors as the experts, to a global responsibility that affects everyone".

Figures released in December 2003, indicate that globally, forty million individuals have been infected with HIV (UNAIDS, 2003). Globally, the spread of this disease intensifies quickly (Gordon, 2000), and it continues to spread rapidly (Baum & Shor-Posner, 1998; Gordon, 2000). In 1998, infection with the HIV virus was estimated to affect between 15 million and 33.4 million people worldwide, with 95 percent of the people with HIV/AIDS, living in developing countries (Baum & Shor-Posner, 1998; UNAIDS, 1999). In the same year, 2.3 million people died from AIDS worldwide, making this disease one of the seven most deadly infectious diseases that caused the highest number of deaths in 1998 (Gordon, 2000). In 1999, more than 16 million people had already died of this disease (UNAIDS, 1999).

When AIDS was first diagnosed about twenty years ago in the United States of America (USA), it was almost exclusively confined to homosexual men (Fenton & Silverman, 2000, p. 890). An estimated 850 to 950 thousand Americans are currently HIV-infected, while 40 thousand new infections occur yearly. Of these new infections, 70 percent are males, 30 percent females, and 1 percent children younger than thirteen years (Fenton & Silverman, 2004, p. 1030). In developing countries, infections in females are growing more rapid than in males (Piwoz & Preble, 2000), with women of childbearing age the

fastest growing subgroup of the HIV infected population. The greater risk for HIV infection amongst women is caused by biologic, social (Piwoz & Preble, 2000; FAO, 2001a) economic, and cultural factors (Piwoz & Preble, 2000). Although it is difficult to estimate exact numbers and features of HIV infection and AIDS, UNAIDS (2003) has published the estimates as depicted in Table 1.1.

Table 1.1: Regional HIV/AIDS statistics and features, end of 2003 (UNAIDS, 2003)

Region	Adults and children living with HIV/AIDS	Adults and children newly infected with HIV	Adult prevalence (%)	Adult and child deaths due to AIDS
Sub-Saharan Africa	25.0-28.2 million	3.0-3.4 million	7.5-8.5	2.2-2.4 million
North Africa & Middle East	470 000-730 000	43 000-67 000	0.2-0.4	35 000-50 000
South & South East Asia	4.6-8.2 million	610 000-1.1 million	0.4-0.8	330 000-590 000
East Asia & Pacific	700 000-1.3 million	150 000-270 000	0.1-0.1	32 000-58 000
Latin America	1.3-1.9 million	120 000-180 000	0.5-0.7	49 000-70 000
Caribbean	350 000-590 000	45 000-80 000	1.9-3.1	30 000-50 000
Eastern Europe & Central Asia	1.2-1.8 million	180 000-280 000	0.5-0.9	23 000-37 000
Western Europe	520 000-680 000	30 000-40 000	0.3-0.3	2 600-3 400
North America	790 000-1.2 million	36 000-54 000	0.5-0.7	12 000-18 000
Australia & New Zealand	12 000-18 000	700-1 000	0.1-0.1	<100
TOTAL	40 million	5 million	1.1%	3 million

From the statistics it is clear that Sub-Saharan Africa is the most severely affected.

1.3 HIV/AIDS IN AFRICA

The seriousness of the HIV/AIDS pandemic in Africa is well documented. This part of the world accounts for nine out of ten new cases of HIV infection and 83 percent of all AIDS deaths; more than the number of people killed by any war (FAO, [s.a.]).

The World Health Organization (WHO, 1995) described HIV infection as one of the major public health concerns in Sub-Saharan Africa, where the epidemic is still raging (UNAIDS, 2003). During 2003, between 2.2 and 2.4 million African people died of AIDS, while 3.0 to 3.4 million were estimated to be newly infected (see Table 1.1), bringing the total number of people living with AIDS to between 25.0 and 28.2 million (UNAIDS, 2003).

Dissimilar to women in other regions of the world, African women residing in Sub-Saharan Africa are at least 1.2 times more likely to be infected with HIV than men. Six recent surveys have shown that among people aged fifteen to twenty four, women were 2.5 times more likely to become HIV infected than young men of the same age group (UNAIDS, 2003).

The first cases of HIV-infection were reported in South Africa in 1982 (Puren, 2002). Although the South African AIDS epidemic has been the last to develop in Africa (National Institute Community Development and Management (NICDAM), 2000), this country was experiencing the fastest growing HIV rates in the world by the turn of the millennium (UNAIDS, 2001), with 4.7 million people living with AIDS, and over 1 500 new infections occurring every day (NICDAM, 2000). AIDS deaths will continue to increase rapidly over the next five years – the worst is still expected (UNAIDS, 2003). The highest prevalence rate by province among antenatal clinic attendees in South Africa for 2002 was reported for KwaZulu-Natal (36.5 percent), followed by Gauteng (31.6 percent). The Free State province ranked third on the list, with 28.8 percent (Department of Health, South Africa (DoH, SA), 2002). Although approximately 55 percent of sexually active teenage girls in a recent survey reported they use a condom during sex, this progress is accompanied by a distressing increase in prevalence among South Africans between twenty and thirty four years of age (UNAIDS, 2001).

In South Africa's neighbouring countries - Botswana, Lesotho, Namibia and Swaziland - the HIV epidemic has also reached extremely high levels, without any signs of leveling off (UNAIDS, 2003).

In developing countries including South Africa, life expectancy has already decreased by 20 to 40 percent as a result of the HIV/AIDS pandemic (Piwoz & Preble, 2000). Walker (2001) predicted that life expectancy could fall to forty to forty-five years by 2010, with the AIDS epidemic being the cause of half of all deaths. The Medical Research Council of South Africa (MRC, SA, 2000) reports a study which found that African employees were 4.76 times more likely to be HIV positive than their Caucasian counterparts. The study sampled 5 634 employees of a South African company with more than 350 thousand employees of all race groups and sexes, in all nine provinces. Prevalence in the African groups was the highest at 13.9 percent, followed by Indians (3.6 percent), mixed ethnic origin (2.3 percent) and Caucasians (2.1 percent).

1.4 FACTORS PLACING INDIVIDUALS AND GROUPS AT RISK OF HIV/AIDS

Although no community is immune to the HIV virus, and "HIV respects no boundaries in terms of age, race, gender, sexual orientation or social status", certain people are more susceptible to HIV infection (NICDAM, 2000).

Factors and co-factors placing individuals and groups at risk of developing HIV/AIDS include economic factors such as poverty (Butler, 2000; FAO, 2001a); lack of knowledge and education (Butler, 2000); cultural (Passwater, [s.a.]), political (Butler, 2000), and demographic factors; dangers in human behaviour (Gordon, 2000), including commercial sex work (Ulin, 1992); gender (Piwoz & Preble, 2000; FAO, 2001a); race (Fenton &

Silverman, 2004, pp. 1030), and the poor availability and un-affordability of medication and medical advice (Butler, 2000).

1.4.1 POVERTY

Poverty has been described as “a major underlying causal factor for the scale of the African AIDS epidemic” (Passwater, [s.a.]). Although poverty as such does not cause HIV/AIDS, it seems to create the ideal climate for this disease to thrive. People of all income groups are vulnerable to HIV/AIDS, but the poor are hit hardest (UNAIDS, 2001). Furthermore, poverty goes hand in hand with poor hygiene, and where women live under these conditions, an AIDS epidemic is more likely to develop (FAO, 2001a). Poverty leads to poor nutrition and poor health, making people more vulnerable to infection with HIV (FAO, 2001b). In hard-hit areas, people spend less money on food, clothes and shelter, and even tend to sell their assets, in order to cope with costs of health care and funerals due to AIDS (UNAIDS, 2001). According to the South African Treatment Action Campaign (TAC, 2001), the government’s current economic policies result in the majority of poor people becoming poorer, causing the poor to die of AIDS without dignity or access to health care services.

Although poverty is not the necessary nor the only reason for an individual to contract HIV infection or AIDS, it might explain the scale of the epidemic currently experienced in parts of Sub-Saharan Africa. The economic consequences of an epidemic such as HIV/AIDS trap populations in the vicious circle of further disease and poverty (Butler, 2000).

1.4.2 EDUCATION

Millions of young people worldwide are uninformed about AIDS. Fifty percent of young people (15-24 years) living in countries including Bolivia, Botswana, Côte D'Ivoire, the Dominican Republic, Ukraine, Uzbekistan and Vietnam, have never heard of AIDS, or have misconceptions about the transmittance of HIV (UNAIDS, 2001). Furthermore, people often don't have access to schools and media, which limits their access to information and education about HIV.

1.4.3 CULTURAL FACTORS

Although international AIDS campaigns to educate people about this disease have achieved success in some developed countries, education has just about failed in areas where cultural beliefs actually contribute to the spread of HIV. In some areas culture prescribes that women are not allowed to refuse sexual contact with men (Passwater, [s.a.]). Some traditional mechanisms such as the custom that makes it compulsory for a man to marry his brother's wife after her husband's death, contribute to the spread of HIV (FAO, 2001a).

1.4.4 GEOGRAPHIC FACTORS

Urbanization, particularly in developing countries, plays a major role in the spreading of diseases such as HIV. In these countries, demographic and social conditions, such as urbanization, contribute to the extent of the AIDS epidemic (Gordon, 2000).

Migrants who live away from their families for extended periods, often become involved in sex with commercial sex workers or multiple partners, placing them at higher risk of HIV infection (NICDAM, 2000). This vulnerable group includes prisoners, long distance truck drivers, construction workers and members of the military force who are more prone to having sex with multiple partners (NICDAM, 2000). Migration as a major contributing factor to HIV infection was confirmed in a study on migrant men and their rural partners in South Africa (MRC, SA, 2000). The migrant labour system in an era of globalization and integration, and the opening of South Africa's borders to the rest of the world, have resulted in the spreading of the HIV epidemic (MRC, SA, 2001).

People living in rural areas are, of course, not free from the dangers of HIV/AIDS (Halswimmer, 1996; UNAIDS, 2001). The disease is indeed becoming a great threat in these areas (Halswimmer, 1996), with the epidemic spreading at an alarming pace into the most isolated villages, limiting food production and threatening the life of rural communities (FAO, [s.a.]). Since 1985, seven million workers in the agricultural sector in the twenty-five most-affected African countries have died from AIDS-related causes, and 16 million more are expected to die in the next twenty years. In these circumstances, agricultural production of especially staple products cannot be sustained (UNAIDS, 2001). When these farmers die, knowledge about indigenous farming methods is lost (FAO, 2001b; FAO, [s.a.]). In addition, many urban dwellers and migrant workers return to the home village when they fall ill, contributing to a further increase of living expenses in communities (FAO, [s.a.]). People living in rural areas in developing countries with low literacy levels and who traditionally have less access to information, are also more vulnerable to being infected with HIV (FAO, 2001a).

1.4.5 HUMAN BEHAVIOUR

Dangerous human behaviour, such as commercial sex practices, provide ideal circumstances for spreading the virus (NICDAM, 2000; Gordon, 2000; UNAIDS, 2001). Uninfected sex clients become infected, eventually transmitting the virus to spouses (UNAIDS, 2001).

1.4.6 GENDER

The number of new infections in females in developing countries is growing faster than in males. Especially in young women and adolescents, biological and social aspects make women more vulnerable to HIV infection (FAO, 2001a). The low status of women in society that often prevents them from taking the necessary precautionary measures against unsafe sex, makes women particularly vulnerable to HIV infection (NICDAM, 2000). In many parts of the developing world, HIV infection rates are three to five times higher in young women than in young men. In Sub-Saharan Africa, 55 percent of persons living with HIV/AIDS are women (FAO, 2001a).

1.4.7 RACE

In America, non-Europeans are now constituting more than half of the total number of people with AIDS. Four out of every five new HIV infections in America are in women of colour, particularly in Latino and African American women (Fenton & Silverman, 2004, p. 1032).

Although prevalence of HIV infection in developing countries is also higher in non-Europeans, a project based on 5 634 employees of a South African company indicated that crude figures of HIV prevalence in Caucasians were the highest in the world for a general Caucasian population (MRC, SA, 2000). In this context, an increase in the number of HIV infected European women seems probable.

1.4.8 HEALTH CARE SYSTEMS

The poor health care services contribute towards the spread of AIDS in Africa. In most poor countries, the availability of health care services remains limited. Only 50 to 70 percent of South Africans have access to basic medical care, with African populations at the low end of the scale (Gordon, 2000).

In addition to poor health care systems with limited availability of counselling and testing services, the stigma and discrimination against HIV/AIDS sufferers, may prevent people from discovering their HIV status (UNAIDS, 2001). In any case, many Africans have agreed to be tested for HIV/AIDS, but prefer not to know the results of their status (UNAIDS, 2001).

1.4.9 OTHER FACTORS

Infants of infected mothers are particularly vulnerable to HIV infection. Adolescents who become sexually active at an early age, and street children who may have high-risk sex as a means of survival, are exposed to a greater likelihood of infection with the virus (NICDAM, 2000).

The HIV virus is also more easily transmitted during sexual intercourse in persons who have STD's. People with STD's other than HIV/AIDS are estimated to be three to five times more likely to be infected with HIV than those without these diseases (NICDAM, 2000).

Other high risk factors for becoming infected with HIV include blood transfusion and needle prick injury (Lisanti & Zwolski, 1997).

1.5 THE SOCIAL IMPACT OF HIV/AIDS

The potential of HIV/AIDS to disrupt society is far-reaching and multi-faceted (NICDAM, 2000).

1.5.1 IMPACT ON FAMILY WELL-BEING AND ECONOMIC SECURITY

From a social perspective, HIV/AIDS may have serious and direct implications on the quality of life for people living with HIV and AIDS (Piwoz & Preble, 2000), as infected members of households are mostly those who are in their productive years, breadwinners, caregivers and nurturers (UNAIDS, 2000).

Food insecurity may be experienced in households with HIV infected individuals. When adults become too incapacitated to work and provide food for themselves and the family (Piwoz & Preble, 2000; USAID, 2001), it results in a decrease in income and fewer resources such as labour and money to obtain food (USAID, 2001). In addition, household savings, assets and remittances will be reduced, medical expenses for treatment and transportation will increase, and an increase in the number of dependents

relying on fewer productive household workers, will drain the family of the little income they have (Topouzis & Hemrich, 1996).

The growing number of AIDS orphans is a matter of concern (Piwoz & Preble, 2000). It is estimated that there are between 197 490 and 250 330 AIDS orphans in KwaZulu-Natal alone. It is projected that in 2005 almost 1 million children under the age of fifteen will have lost their mothers due to AIDS (NICDAM, 2000). These children lose their parents before they have obtained the basic knowledge about nutrition and health. This has resulted in a dramatic increase in the number of child-headed households (FAO, 2001a), with severe implications for those concerned (NICDAM, 2000).

The stigma associated with HIV/AIDS and the prejudice experienced by AIDS sufferers at work, in the community and at home, result in a lack of the support mechanisms that are available for people with other fatal diseases (NICDAM, 2000).

Moreover, people infected with HIV may experience difficulties in having access to sufficient and nourishing food, either because of lack of money, inadequate kitchen facilities, lack of knowledge about food purchase and preparation, or poor social support at mealtimes (Mayer *et al.*, 2001).

1.5.2 IMPACT ON AGRICULTURE

HIV/AIDS has a far-reaching impact on small farmers in rural communities in Sub-Saharan Africa. These small farmers who are not members of a medical aid system, are confronted with the burden of increased costs involved in caring for the ill, and funerals of family members. Indeed, livestock are often sold for medical and funeral expenses.

Furthermore, expenses are increased by the costs of traditional medicine, together with special foods for the ill (Halswimmer, 1996).

The potential loss of income resulting from illness and death does not only place a heavy burden on rural households, but also reduces the availability of labour for farm and domestic work (Halswimmer, 1996; Piwoz & Preble, 2000). Skilled labour often has to be replaced by alternative employees at high costs. Family members often neglect their work when caring for ill members, further contributing to loss of income. Long mourning periods following the death of a family member also have a negative impact on labour availability (Halswimmer, 1996).

HIV/AIDS related morbidity and mortality may partly be responsible for the loss of traditional farming skills and cultural practices. Agricultural skills that are lost when a parent or both parents die, or are seriously ill, have far-reaching consequences for agricultural production (Halswimmer, 1996).

1.5.3 IMPACT ON POPULATION SIZE AND STRUCTURE

The average life expectancy in South Africa, without taking HIV/AIDS into consideration, would be approximately sixty six years. This has been drastically affected by the disease (UNAIDS, 2001), and is currently estimated to be only forty seven years. The most drastically affected countries in Sub-Saharan Africa, are Botswana, Malawi, Mozambique and Swaziland, all of which now have a life expectancy below forty years (UNAIDS, 2001).

Africa has also experienced a decline in birth rates, and a reduction in fertility of HIV/AIDS infected women (Pisani, 1997), while child mortality rates are increasing as a result of more children being born HIV positive (UNAIDS, 2001). AIDS is predicted to account for a hundred percent increase in child mortality in developing countries (NICDAM, 2000).

In some communities, antiretroviral therapy (ART) has changed HIV/AIDS from a fatal condition to a chronic, controllable viral infection. In this way, the impact of HIV/AIDS on population size is softened. Many people with HIV/AIDS can now live a normal, healthy life, instead of dying of the disease (Roberts, 1996; Jones, 2001). There has been a dramatic decrease in AIDS deaths in the USA since the introduction of ART (Fenton & Silverman, 2004, p. 1039). The delivery of ART in resource-poor settings once thought impossible, has been shown to be feasible. Therefore, the WHO (2003) challenge to treat 3 million people in poor countries by 2005 with antiretroviral drugs, brings new hope for people living with HIV/AIDS.

1.5.4 IMPACT ON EDUCATION

The AIDS epidemic has a profound impact on the educational systems of many countries. Many teachers and students die or leave school as a result of HIV/AIDS, leading to a decrease in the quality and efficacy of these systems. In Sub-Saharan Africa, it is estimated that 860 thousand children have already lost their teachers as a result of AIDS (UNAIDS, 2001).

Furthermore, young girls are often deprived of education, because they are taken out of school to take over family responsibilities. School enrolment in Swaziland was reported

to have dropped by 36 percent due to AIDS, with girls being most affected (UNAIDS, 2001).

1.5.5 IMPACT ON DEVELOPMENT AND STABILITY

South Africa's workforce is suffering as a result of HIV/AIDS. The AIDS epidemic is claiming the lives of many doctors, extension workers (UNAIDS, 2001), skilled workers and managers, which in turn has a negative influence on the economy (Steyn & Walker, 2000) and health services of the country (Steyn & Walker, 2000; UNAIDS, 2001). In some African countries, and probably also in South Africa, the loss of teachers to AIDS contributes to illiteracy and lack of skills. In addition, the absence of a single teacher has an influence on large numbers of children (NICDAM, 2000). The decimation of civil servants weakens government functions, threatening security (WHO, 2003). In hard-hit areas or countries including South Africa, the loss of these professionals raises the cost of recruitment, training and replacement (UNAIDS, 2001).

It is likely that illness due to HIV/AIDS-related diseases will further increase South Africa's unemployment rate that is already high. Bachmann and Booyesen (2003) recently reported unemployment rates of 83 percent and 80 percent respectively in HIV-affected versus unaffected households for one urban and one rural area in the Free State Province of South Africa.

1.5.6 IMPACT ON WOMEN

Women and female-headed households are particularly vulnerable to the impact of HIV/AIDS. Female-headed households are also generally poorer. Factors including

sexual abuse, pressure on teenage girls to have relationships with older men, and economic dependence on men increase women's vulnerability to HIV and other infectious diseases. Additionally, women and girls are generally responsible for taking care of ill family members, and often lack care and support when they themselves become HIV-infected (NICDAM, 2000).

1.5.7 IMPACT ON HEALTH AND NUTRITIONAL STATUS

The burden of infections including HIV and AIDS will continue to have a significant influence on the health of African populations (Steyn & Walker, 2000), also resulting in new epidemics of malaria, tuberculosis (TB) and cholera (TAC, 2001). HIV/AIDS has led to a new famine-variant, with malnourished individuals being more susceptible to HIV infection than those who are well nourished (de Waal & Whiteside, 2003). HIV has a devastating impact on immune function, making infections more virulent (Semba & Tang, 1999). As more health workers die from AIDS, health care systems cannot deliver the basic health services that these patients require (WHO, 2003).

Although progress in HIV/AIDS treatment has been made with the use of ART, these advances have been limited to the developed world, with developing countries barely benefiting from these expensive drugs. In developing countries, the benefits are limited to those patients who receive regular medical care (Carpenter *et al.*, 2000; Salas-Salvadó & Garcia-Lorda, 2001). Furthermore, treatments and interventions are more effective during the early stages of HIV infection, while patients in poor countries rarely seek timely medical advice (Niyongabo *et al.*, 1999).

For the past couple of years, the “image of AIDS has been the image of death, with the devastation that the epidemic has wreaked on individuals, families, communities and nations being imponderable” (Chaisson, 1990). The Government has developed an “Operational plan for comprehensive HIV/AIDS care, management and treatment for South Africa” (DoH, SA, 2003). According to this plan, ART will be initiated in adults and adolescents with CD4+ cell counts $\leq 200/\text{mm}^3$. This plan will enable South Africans to access a full array of interventions (including nutrition-related interventions) and services to address HIV and AIDS within the context of a continued care programme.

The statement by UNAIDS (2001) that “AIDS has become the biggest threat to the continent’s development and its quest to bring about an African Renaissance”, summarises the seriousness of the HIV/AIDS pandemic.

1.6 OBJECTIVE

During 2000, an epidemiological study was undertaken with the main objective of investigating the prevalence of diseases of lifestyle in urbanized African women in Mangaung. In order to be able to attribute the health status of the women to lifestyle (especially diet and physical activity), it was necessary to determine HIV status. The high prevalence of HIV infection in the sample was unexpected, but afforded the researchers the opportunity of extending the study to investigate the relationship between HIV status, health and nutritional status. Individuals suffering from malnutrition are more susceptible to HIV infection than those who are well nourished. Furthermore, HIV/AIDS has a severe impact on the nutritional status and immune function of the individual living with the disease, emphasizing the importance of timely diagnosis and treatment.

The following sub-aims are set for this study:

1.6.1 SUB-AIMS NECESSARY TO ACHIEVE THE MAIN OBJECTIVE

To determine:

- 1.6.2.1 Socio-demographic status;
- 1.6.2.2 Anthropometric status;
- 1.6.2.3 Dietary intake;
- 1.6.2.4 Physical activity levels;
- 1.6.2.5 Iron status;
- 1.6.2.6 Metabolic profile;
- 1.6.2.7 The relationship between HIV status and the mentioned parameters;
- 1.6.2.8 To classify HIV positive and HIV negative subjects into two groups each, one with poor prognostic markers (level of education, marital status, head of household, smoke, urbanized, total lymphocytes, haemoglobin, total serum iron, transferrin, total serum protein, serum albumin), and one without poor prognostic markers.

1.7 OUTLINE OF THESIS

Chapter 1 provides a motivation for the study, as well as a description of the problem statement, objectives and an outline of the thesis.

A literature review in support of the study is done in Chapter 2.

Chapter 3 contains a methodological description of the operational definitions, choice and standardisation of apparatus, measuring techniques, validity and reliability,

population and sampling, study procedures, statistical analysis and relations applicable to the study.

Chapters 4 to 12 represent the body of the discussion. Chapter 4 investigates the socio-demographic profile of HIV positive women (25-44 years) from Mangaung. In Chapter 5, the anthropometric nutritional status of HIV positive women (25-44 years) in Mangaung, is discussed. Chapters 6 and 7 respectively, investigate the macronutrient and micronutrient dietary intake of the subjects. Chapter 8 deals with the physical activity levels of the subjects. In Chapter 9, the iron status of HIV positive and HIV negative women is discussed. In Chapter 10 the metabolic profile (biochemical status of macronutrients) of the subjects is investigated. Chapters 11 and 12 investigate the possible factors associated with HIV infection in these subjects (Chapter 11: mainly continuous variables and Chapter 12 mainly categorical variables).

The conclusion and recommendations are provided in Chapter 13.

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CHAPTER 2

HIV/AIDS: CAUSES, CONSEQUENCES AND CONTROL

2.1 INTRODUCTION

More than twenty years ago, a small article in a medical journal reported on a strange incident of pneumocystis carinii pneumonia in previously healthy homosexual men. This article prefigured a global epidemic, today known as Human Immunodeficiency Virus (HIV), with its resulting disease, Acquired Immune Deficiency Syndrome (AIDS) (Jones, 2001). The oldest known case of human infection by the virus was confirmed in 1998, in the examination of a blood sample dating back to 1959, of a man from the Belgian Congo (Fenton & Silverman, 2004, p. 1028). HIV interacts with malnutrition in a vicious and devastating cycle, that if left untreated, progresses to AIDS. The HIV virus destroys its victim's immune system, and depletes marginal nutrient stores, thus accelerating the process of malnutrition, ending in death. Malnutrition and AIDS interact on several levels in the case of a patient living with this disease (Insel *et al.*, 2001, p. 718), making the disease a major health problem (Jones, 2001).

In this chapter, the pathogenesis of HIV/AIDS, its clinical manifestations, its effect on various levels of the human body, including nutritional status and the management thereof will be reviewed.

2.2 THE PATHOGENESIS OF HIV/AIDS

In the following section, the etiology, viral transmission, replication of the virus, and the HIV classification system for adolescents and adults are provided.

2.2.1 ETIOLOGY

The etiologic agent of AIDS is HIV. This virus belongs to a group of human retroviruses and a subgroup of lentiviruses, with the latter causing diseases in animals such as sheep, horses, goats, cattle and monkeys. The four human retroviruses belong to two groups, namely the human T lymphotropic viruses 1 and 2, which are transforming retroviruses, and the human immunodeficiency viruses HIV-1 and HIV-2, which are cytopathic viruses. HIV-1 consists of several subtypes with different geographic distributions. HIV-2 was first identified in West Africa, to which it was originally confined. HIV-1 originated from a species of chimpanzees in which the virus had co-evolved over centuries (Fauci & Lane, 2001, pp. 1852-1853).

2.2.2 VIRAL TRANSMISSION

HIV is primarily a sexually transmitted disease, and is transmitted by both homosexual and heterosexual contact. Heterosexual transmission is globally the most common way of infection, particularly in developing countries (Fauci & Lane, 2001, p. 1855). Blood and seminal fluids, including semen, preseminal fluid, vaginal fluid and breast milk (Lisanti & Zwolski, 1997; Fenton & Silverman, 2004, p. 1030), represent the highest concentrations of infectious HIV particles, as these fluids contain large numbers of infectable target cells (Keithley, 1998). Sharing of contaminated needles and injection of

contaminated blood products, and transfer across the placenta from an infected mother to her baby can also transmit the virus (Lisanti & Zwolski, 1997; Fenton & Silverman, 2004, p. 1030). Extremely high infection risks include needle sharing and unprotected anal or vaginal sexual intercourse. Tissue transplantation, including artificial insemination, blood transfusion and needle prick injury are considered high risk factors, while oral-genital sexual practices are seen as lower risk factors for HIV infection (Lisanti & Zwolski, 1997). Body fluids with scant numbers of target cells such as tears, saliva, and urine, have low concentrations of infectious virus particles, and carry a low risk of transmission (Fenton & Silverman, 2004, p. 1030).

The virus is unlikely to be transferred by causal contact, such as touching, hugging or kissing, sharing eating or cooking utensils (National Institute Community Development and Management (NICDAM), 2000; Fenton & Silverman, 2004, p. 1030), sharing a house, towels, bed linen, clothes, or public transport, handshaking (NICDAM, 2000; United States Agency for International Development (USAID), 2001), coughing, sneezing, talking or laughing (NICDAM, 2000). There is no evidence that HIV can be transmitted by insects, such as by a mosquito bite (NICDAM, 2000; USAID, 2001).

2.2.3 REPLICATION CYCLE OF HIV

The names of retroviruses are derived from the process by which they duplicate their genetic material (Lisanti & Zwolski, 1997). The hallmark of HIV, a ribonucleic acid (RNA) virus, is the reverse transcription of its genomic RNA to deoxyribonucleic acid (DNA) by the enzyme transcriptase (Fauci & Lane, 2001, p. 1853). The HIV virus gains entry into target cells through binding of glycoproteins known as gp120, to two surface receptors, namely the CD4 receptor and a chemokine receptor. The CD4 receptor is a protein

mainly found on the surface of certain T lymphocytes that assists these cells in recognizing foreign substances (Fauci & Lane, 2001, p. 1853). Chemokine receptors facilitate the movement of leukocytes from the circulation to inflammatory sites in the tissue (Wu *et al.*, 1997). The HIV virus attacks the genetic core of the CD4+ or T-helper lymphocyte cells (Lisanti & Zwolski, 1997; NICDAM, 2000; USAID, 2001; Fenton & Silverman, 2004, p.1028). These cells are essential in the functioning of the immune system and for the protection against infection (Piwoz & Preble, 2000; USAID, 2001; Fenton & Silverman, 2004, p. 1028).

In the healthy individual, the CD4+ cell count exceeds 500/mm³ (Pollard, 1995). CD4+ lymphocytes regulate both the cell-mediated and humoral immunity, therefore their depletion in HIV infection leads to severe immunosuppression (Pollard, 1995; Piwoz & Preble, 2000; NICDAM, 2000; Fenton & Silverman, 2004, p.1028). After binding to the target cells receptors, HIV fuses with the host cell, enters the cytoplasm and releases its RNA and replication enzymes (Levy, 1996). One replication enzyme, reverse transcriptase, transcribes the viral RNA into double-stranded DNA, which is transported into the nucleus and integrated into the host's chromosomes. The integrated viral DNA is known as the provirus. Stimuli that activate the infected cell, such as opportunistic pathogens or immunisations, induce the production of cytokines, which are chemical messengers that regulate the immune response. These cytokines also act to promote proviral transcription and subsequent viral replication. Since HIV infection is associated with chronic immune activation, the infected host provides a permissive environment for viral replication. Upon cellular activation, the provirus is transcribed into strands of messenger RNA and genomic RNA. The messenger RNA strands are transported to ribosomes in the cytoplasm where they are translated into large proteins called polyproteins, that will serve as the structural proteins of new viral particles. The viral

polyproteins and two genomic RNA copies accumulate at the host cell lipid membrane and begin to bud. During and immediately after budding, a viral enzyme, protease, cleaves the polyproteins into individual active proteins, creating mature, infectious new virus particles (Keithley, 1998).

HIV is a slow-acting virus that, depending on the general health and nutritional status of the individual before and after HIV infection, may take years before the individual becomes ill. The average time for HIV infection to develop in AIDS in an adult, is approximately ten years. During this period, other viruses, bacteria, fungi and protozoa take advantage of the opportunity to further weaken the body, causing other illnesses (USAID, 2001; Fenton & Silverman, 2004, p. 1034), including pneumonia, TB and oral thrush. This explains the concept “opportunistic” which is used to refer to the infections and cancers (USAID, 2001) commonly observed in HIV positive individuals (Fenton & Silverman, 2004, p. 1034). These infections can appear in almost every organ system of the patient with a suppressed immune system (Cuff, 1990).

2.2.4 HIV/AIDS CLASSIFICATION SYSTEM FOR ADOLESCENTS AND ADULTS

The 1993 revised classification of the Centers for Disease Control (CDC) of HIV-infected adolescents and adults, categorizes patients on the basis of clinical conditions associated with HIV infection and CD4+ T lymphocyte counts. This classification system is based on three ranges of CD4+ lymphocyte counts and three clinical categories, and is represented by a matrix of nine mutually exclusive categories. When this system is applied, any HIV-infected individual with a CD4+ T cell count $<200/\text{mm}^3$ has AIDS, regardless of the presence of other symptoms or opportunistic diseases. Pulmonary TB, recurrent pneumonia and invasive cervical cancer are now included under the conditions

in clinical category C (see Table 2.1). Once a clinical condition in category B has been diagnosed in the individual, the disease cannot again be classified as category A, even if the condition clears up. The same principle applies for category C in relation to category B (Fauci & Lane, 2001, p. 1852). The revised classification system for HIV infection for adolescents and adults is presented in Table 2.1.

Table 2.1: Classification system for HIV infection and expanded AIDS surveillance case definition for adolescents and adults (Centers for Disease Control (CDC), 1993)

<p>CATEGORY A: Consists of one or more of the conditions listed below in an adolescent or adult (>13 years) with documented HIV infection. Conditions listed in categories B and C must not have occurred. Asymptomatic HIV infection; Persistent generalized lymphadenopathy; Acute (primary) HIV infection with accompanying illness or history of acute HIV infection.</p>	<p>CATEGORY B: Consists of symptomatic conditions in an HIV-infected adolescent or adult that are not included among conditions listed in clinical category C and that meet at least one of the following criteria:</p> <ul style="list-style-type: none"> • The conditions are attributed to HIV infection or are indicative of a defect in cell-mediated immunity; or • The conditions are considered by physicians to have a clinical course or to require management that is complicated by HIV infection. Examples include, but are not limited to, the following: Bacillary angiomatosis; Candidiasis, oropharyngeal (thrush); Candidiasis, vulvovaginal: persistent, frequent, or poorly responsive to therapy; Cervical dysplasia (moderate or severe)/ cervical carcinoma in situ; Constitutional symptoms, such as fever (38.5 °C) or diarrhea lasting >1 month; Hairy leukoplakia, oral; 	<p>CATEGORY C: Conditions listed in the AIDS surveillance case definition. Candidiasis of bronchi, trachea, or lungs; Candidiasis, esophageal; Cervical cancer, invasive; Coccidioidomycosis, disseminated or extrapulmonary; Cryptococcosis, extrapulmonary; Cryptosporidiosis, chronic intestinal (>1 month's duration); Cytomegalovirus disease (other than liver, spleen or nodes); Cytomegalovirus, retinitis (with loss of vision); Encephalopathy, HIV-related; Herpes simplex: chronic ulcer(s) (>1 month's duration): or bronchitis, pneumonia, or esophagitis; Histoplasmosis, disseminated or extrapulmonary; Isosporiasis, chronic intestinal (>1 month's duration); Kaposi's sarcoma; Lymphoma, Burkitt's (or equivalent term); Lymphoma, primary, of brain; Mycobacterium avium complex or M. kansasii,</p>
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Table 2.1: Classification system for HIV infection and expanded AIDS surveillance case definition for adolescents and adults (Centers for Disease Control (CDC), 1993) (Continued)

	<p>Herpes Zoster (shingles), involving at least two distinct episodes or more than one dermatome; Idiopathic thrombocytopenic purpura; Listeriosis; Pelvic inflammatory disease, particularly if complicated by tuboovarian abscess; Peripheral neuropathy.</p>	<p>disseminated or extrapulmonary; Mycobacterium TB, any site (pulmonary or extrapulmonary); Mycobacterium, other species or unidentified species, disseminated or extrapulmonary; Pneumocystis carinii pneumonia; Pneumonia, recurrent; Progressive multifocal leukoencephalopathy; Salmonella septicemia, recurrent; Toxoplasmosis of brain; Wasting syndrome due to HIV.</p>	
CLINICAL CATEGORIES			
CD4+ T Cell Categories	A Asymptomatic, (Primary) HIV OR PGL	B Symptomatic, Not A or C Conditions	C AIDS-Indicator Conditions
>500/ μ L	A1	B1	C1
200-499/ μ L	A2	B2	C2
<200/ μ L	A3	B3	C3

PGL: Progressive generalized lymphadenopathy

2.3 CLINICAL MANIFESTATIONS OF HIV INFECTION

Four stages of the disease have been distinguished and described, ranging from acute infection, asymptomatic HIV infection, symptomatic HIV infection, to AIDS or advanced HIV (Fenton & Silverman, 2004, p. 1034). These are described below, as well as the diagnostic procedures employed to measure disease progression.

2.3.1 ACUTE HIV INFECTION

After entering the host, HIV is rapidly circulated to the lymphoid tissues. This period, also called the initial stage (NICDAM, 2000), is estimated to be experienced by 50 to 70 percent of HIV-infected individuals approximately three to six weeks after primary infection (Fauci & Lane, 2001, p. 1879). During the acute phase, the host has not yet developed an immune response, concentration of the virus in the blood is high and CD4+ lymphocytes are depleted (Piwoz & Preble, 2000; Fenton & Silverman, 2004, p. 1034). Thirty to 60 percent of newly infected patients develop symptoms such as fever, malaise, lymphadenopathy syndrome, pharyngitis, headache, myalgia and sometimes rash, lasting between one week and one month (NICDAM, 2000; Fenton & Silverman, 2004, p. 1034). These flu-like symptoms that may be considered as not serious, are sometimes wrongly diagnosed as glandular fever (NICDAM, 2000). Since the body has not yet produced antibodies to fight the virus, HIV antibody tests will be negative (Piwoz & Preble, 2000). After a few weeks, the host develops an immune response to the virus, resulting in a decline of viral load, and a partial restoration of absolute CD4+ lymphocyte numbers (Levy, 1996). The period between the test changing from negative to positive, is known as the “window period” (NICDAM, 2000).

During the period between the initial HIV infection and seroconversion, the HIV antibodies start developing, and the immune system first recognizes the virus (NICDAM, 2000; Piwoz & Preble, 2000; Fenton & Silverman, 2004, p. 1034). These antibodies can however not destroy the HIV virus (NICDAM, 2000). Once these antibodies test positive in the blood, the individual will test positive for HIV (NICDAM, 2000; Piwoz & Preble, 2000). Before this time, a test may be negative despite HIV infection (NICDAM, 2000). During this period, viral load is very high, and the individual is very infectious (Fenton & Silverman, 2004, p. 1034).

2.3.2 ASYMPTOMATIC PHASE

This period, also known as the “silent stage” (NICDAM, 2000), can last several years (NICDAM, 2000; Piwoz & Preble, 2000; Fenton & Silverman, 2004, p. 1034), with the median time for untreated patients approximately ten years (Fauci & Lane, 2001, p. 1880). The infected patient may experience few, if any, noticeable symptoms of infection (NICDAM, 2000; Piwoz & Preble, 2000; Fenton & Silverman, 2004, p. 1034). Changes including a decrease in lean body mass without obvious total body weight change, vitamin B12 deficiency, and increased susceptibility to food- and water related pathogens have however been reported (Fenton & Silverman, 2004, p. 1034). In some patients, little, if any decline is seen in CD4+ cell counts, while others remain asymptomatic, despite the fact that their CD4+ cells decline consistently to extremely low levels. The average decline rate of CD4+ cells is approximately $50/\text{mm}^3$ per year (Fauci & Lane, 2001, p. 1880).

2.3.3 SYMPTOMATIC PHASE

Between five and eight years after the initial infection, symptoms of a more severe HIV-related disease start to appear (Category B in Table 2.1), as the immune system further deteriorates, making the infected patient more susceptible to other infections. Swollen glands, weight loss of more than 10 percent of the usual body weight, chronic fatigue and diarrhea, herpes zoster, fevers, chills and night sweats, thrush, skin rashes or infections, TB and severe pneumonia are amongst the typical symptoms associated with this phase (NICDAM, 2000). Nutritional status may also be affected (Fenton & Silverman, 2004, p. 1034).

2.3.4 AIDS STAGE

This stage officially constitutes the condition called AIDS, when a blood test confirms a low number of immune cells (Piwoz & Preble (2000). During this stage, the individual has at least one well-defined life-threatening clinical condition (Category C in Table 2.1) that is clearly associated with HIV-induced immunosuppression (Fenton & Silverman, 2004, p. 1034). At this stage the body can no longer combat the infection (Piwoz & Preble, 2000; NICDAM, 2000).

Although the signs and symptoms of AIDS may differ amongst individuals, some diseases and symptoms that may be experienced include the following:

- Serious lung infections, causing a chronic dry cough, and shortness of breath (NICDAM, 2000), and pneumocystis carinii pneumonia. This form of pneumonia develops in about 80 percent of HIV-infected individuals, and is caused by a

protozoan (Pollard, 1995). HIV infection increases the risk of TB, which is caused by Mycobacterium TB, and may occur in extrapulmonary sites such as the larynx, lymph nodes, brain, kidneys or bones (Fenton & Silverman, 2004, p. 1036);

- Wasting syndrome, with the patient losing more than 10 percent body weight resulting from degeneration of body muscle and tissues (NICDAM, 2000);
- Kaposi's sarcoma, defined as "a malignant neoplastic vascular proliferation characterised by the development of bluish-red cutaneous nodules, usually on the surface of the skin or oral cavities. Lesions of this malignant disease in the oral cavity or esophagus may cause pain, and difficulties in chewing and swallowing";
- Lymphomas such as non-Hodgkin's lymphoma and Burkitt's lymphoma which can cause malabsorption, diarrhea or intestinal obstruction;
- Neurologic diseases such as severe brain damage which may manifest in some patients when the virus enters the brain, and may result in dementia, also known as encephalopathy, myelopathy (disease of the spinal cord), peripheral neuropathy, and myopathy or progressive muscle weakness (Fenton & Silverman, 2004, p. 1036);
- Chronic diarrhea, resulting from AIDS enteropathy, with subtotal villous atrophy and abnormal test results of small bowel function (Fenton & Silverman, 2004, p. 1037);
- Severe fatigue and weakness;
- Nausea, vomiting, and difficulties in swallowing;
- Blindness (NICDAM, 2000). Cytomegalovirus which can affect the eye, and can cause retinitis; may lead to blindness if not treated;
- Progressive renal failure, identified as HIV-associated nephropathy;
- Mycobacterium Avium Complex, seen in the lymph nodes, liver, bone marrow, blood and urine;
- HIV-liver disease, compromised through the use of highly active antiretroviral therapy, and by infection with cytomegalovirus, cryptosporidia and hepatitis B or

hepatic malignant diseases such as Kaposi's sarcoma or lymphoma. Hepatitis-C virus infection is common among HIV-infected patients, and leads to faster disease progression and death (Fenton & Silverman, 2004, p. 1037).

2.3.5 DIAGNOSTIC TESTS AND SCREENING

Various tests are used to diagnose HIV and the degree of disease progression (Table 2.2). The ideal is to screen the patient for nutritional problems when first diagnosed as HIV positive, with most emphasis on avoiding malnutrition. This should be followed by routine and continuous nutritional assessment to identify symptoms characteristic of malnutrition (Casey, 1997b; Fenton & Silverman, 2004, p. 1047). The components of nutritional assessment firstly include the patient's past and present dietary history and calculation of nutrient intake (Casey, 1997b). Screening of the patient every six months, or more often in cases of status change, is important. Criteria to monitor include oral and/or gastrointestinal problems, such as appetite loss and poor food or fluid intake for more than three days, difficulty in chewing or swallowing, mouth sores, persistent diarrhea, constipation, nausea or vomiting, gas, bloating or heartburn, alterations in taste or smell, and food allergies or intolerances (Fenton & Silverman, 2004, p. 1048).

Secondly, anthropometric measurements including weight, height, skinfold thickness and midarm circumference should be determined (Casey, 1997b). Important aspects to consider in this regard include an unintentional weight loss of more than 3 percent in the last six months or since the last visit to the health expert, signs of visible wasting, a body weight below 90 percent of the ideal, a body mass index (BMI) <20, or a decrease in body cell mass (Fenton & Silverman, 2004, p. 1048).

Table 2.2: Tests to diagnose HIV and to measure its progression (Piwoz & Preble, 2000)

HIV antibody test	These tests (initially performed with blood samples, but now also with saliva samples) measure the presence of antibodies to HIV, and include HIV ELISA, immunofluorescence and western blot assays.
P24 antigen test	This test measures the actual HIV virus in the blood, and is a useful measure of infection during the period before which the body has developed measurable antibodies to HIV.
Virologic assays	These tests include HIV DNA Polymerase Chain Reaction (PCR) and HIV RNA detection methods and culture. These tests are especially useful in defining or ruling out HIV infection in infants less than 18 months of age. (Antibody tests cannot be reliably used in infants, since they cannot differentiate between the infant's own HIV antibodies and transplacentally-acquired maternal antibodies).
CD4 cell count	<p>CD4 cells are also referred to as T4 cell and T-helper cells. CD4 cell count is measured from blood samples. CD4 cell count measures the number of CD4 cells, which are critical to the immune system's functioning, and that are infected and destroyed by HIV. This test measures the state of the immune system and its rate of deterioration. The higher the CD4 cell count, the better the individual's condition and prognosis. The following levels of CD4 cell counts indicate the various conditions:</p> <p>500-1400 average counts in healthy, HIV negative individuals <500 immune system is damaged <350 damage is moderately severe <200 damage is severe, patient is officially diagnosed as having AIDS <50 disease is advanced and damage may be irreparable</p> <p>The CD4 cell count and viral load test are often used in a complementary fashion for clinical purposes.</p>
Viral load test	The HIV virus has been found, and, for research purposes, measured in many body fluids including blood, saliva, breast milk, semen and vaginal secretions. For clinical purposes, the viral load test measures the number of viruses in one milliliter of blood, and is reported as "copies per milliliter". Viral load can measure the rapidity with which HIV disease is progressing – the higher the viral load, the faster and more severe the progression.

Laboratory tests, including cholesterol tests (Fenton & Silverman, 2004, p. 1048), and tests for anemia and long-term protein-energy-malnutrition (serum albumin) should be performed. When protein-energy-malnutrition is suspected, functional measurements of

muscle power, and short-term visceral protein deficiency such as serum retinol-binding protein and prealbumin, should be determined (Casey, 1997b).

2.4 THE IMMUNE SYSTEM

2.4.1 INNATE AND ANTIGEN SPECIFIC IMMUNITY

Dissimilar to other systems in the body, the immune system is not seen as an organ, but rather appears as separate collections of cells throughout the body. The leukocytes that are produced in the bone marrow, are the most abundant of these cells. These cells defend the body against invading pathogens, and are very sensitive indicators of the body's nutritional status. The body continually fights microorganisms such as bacteria, viruses, fungi and parasites, and other substances. Of these, bacteria and viruses are the most common invaders. Since viruses lack ribosomes for protein synthesis, they cannot multiply by themselves. In order to survive, they take over a cell and instruct the host to produce the proteins and energy necessary for survival (Wardlaw & Kessel, 2002, p. 95).

The immune system can be divided into two main types, namely innate (nonspecific or non-adaptive) and antigen specific (acquired or adaptive) immunity (Chandra, 1997). Innate immunity includes a range of mechanisms that are present at birth, including barriers such as the skin and mucous membranes of the gastrointestinal tract, the reproductive system, urinary tract, and the respiratory tract (Wardlaw & Kessel, 2002, p. 96). Other forms of innate immunity include cilia, complement, lysozyme, interferon, and phagocytic cells (Chandra, 1997). These innate processes are naturally present, and are not affected by previous contact with the infection agent. They act as the first line of

protection, and delay overt infection. Phagocytic cells mediate the killing of microorganisms through engulfment, oxygen-dependent killing and digestion. The activation of serum proteins, known as the complement system, assists the phagocytic cells to become more successful in host defense. Components of complement help to clear antigens (molecules recognized by the immune system that induce immune reaction) by direct killing (lysis), attraction of, and recognition by phagocytic cells. In an interaction between the innate system and immunoglobulins (antibodies), the surfaces of microorganisms can be coated in order for specific cells to recognize and destroy them (Harbige, 1996).

The antigen immune system consists of T-cells (cell-mediated immunity) and B-cells (humoral immunity), known as lymphocytes (Harbige, 1996, Chandra, 1997). These mechanisms are adaptive and acquired in that they are specific reactions induced by prior exposure to the microorganism or its antigenic determinants. They are effective in slowing down the spread of infection and destroying the invading organism. Nonspecific and antigen-specific defenses act together (Chandra, 1997). The cellular and humoral immune mechanisms are activated when the virus enters the bloodstream (Harbige, 1996; Lisanti & Zwolski, 1997).

2.4.2 CELL-MEDIATED IMMUNITY

T-lymphocytes are involved in cell-mediated immunity. These cells are primarily responsible for destroying specific cells that are identified by antigens on the cell surface. The actual T-lymphocytes, T-cell, that are killers are known as cytotoxic cells (Lisanti & Zwolski, 1997; Wardlaw & Kessel, 2002, p. 97). These cells recognize the infected cell through a CD8 receptor. Another group, the helper T-cells, attach themselves to an

infected cell through a CD8 receptor, and promote phagocytic activity. The cytotoxic and helper T-cells bind to and destroy the infected cell (Wardlaw & Kessel, 2002, p. 97). The CD4 cells have a high affinity for binding to HIV-infected cells, and may be among the first to be infected and destroyed by HIV infection (Fauci & Lane, 2001, p. 1875).

2.4.3 HUMORAL IMMUNITY

Humoral immunity, provided by the B-lymphocytes, involves the production of antibodies (Lisanti & Zwolski, 1997), which assist in the battle against foreign antigens, including bacterial infections, some viral infections and parasites. B-lymphocytes and antibodies (immunoglobulins) bind to, and start attacking the antigen. The antibody-antigen interaction produces plasma cells, resulting in the production of more antibodies to assist in the attack. Memory cells that provide active immunity are then produced by the B-cells. Complement proteins are also produced by the antibody-antigen interaction. The complement proteins are set free into the infected area and attach to the pathogen invader to be destroyed (Wardlaw & Kessel, 2002, p. 97).

2.4.4 IMMUNE RESPONSE IN HIV/AIDS INFECTION

The hallmark of HIV disease is an extreme immunodeficiency resulting primarily from a progressive quantitative and qualitative deficiency of the subset of T lymphocytes or T-helper cells (Fauci & Lane, 2001, p. 1861).

With HIV infection, the immune response occurs as usual, but the antigen (HIV) is not neutralized by antibodies. The virus binds to the T-helper cells by inserting its RNA and enzymes into the cytoplasm of the cell. Then, through the action of reverse

transcriptase, a DNA copy of the virus RNA is made. DNA enters the nucleus of the cell, and is incorporated randomly into the host chromosomes (Lisanti & Zwolski, 1997) through the action of integrase, another virally encoded enzyme. This provirus may remain transcriptionally inactive, or it may become obvious in varying levels of gene expression, up to active production of the virus (Fauci & Lane, 2001, p. 1853).

2.4.5 NUTRITION AND IMMUNITY IN HIV/AIDS

Nutrition has been acknowledged as an important factor in HIV infection since early in the history of the HIV/AIDS epidemic (Woods *et al.*, 2002), and in recent years, the relationship between AIDS and nutrition has enjoyed substantial attention of scientists and people living with HIV/AIDS (Harbige, 1996; Baum & Shor-Posner, 1998; Salas-Salvadó & Garcia-Lorda, 2001). Nutrition is now generally accepted as a major determinant of immune functioning (Chandra, 1997). Humoral immunity and cellular immunity are impaired by both malnutrition and by HIV infection. Normal antibody production, phagocytic cell function, complement levels, and T-lymphocyte function depend on the adequate intake of energy, protein, fat, minerals and vitamins (Scrimshaw & SanGiovanni, 1997). Malnutrition may change immune function to facilitate disease progression, influence viral expression, and play a significant role in disease processes and related morbidity and mortality (Baum & Shor-Posner, 1998), as well as in functional status and quality of life (Scrimshaw & SanGiovanni, 1997). Good nutritional health on the other hand, has a positive influence on both the cell-mediated immunity and humoral immunity of the HIV/AIDS patient (Harbige, 1996; Cimoch, 1997), in that certain nutrients affect antibody production and T-lymphocyte function, particularly of the CD4+ lymphocytes (Cimoch, 1997).

Malnutrition is one of the most important, but puzzling consequences of HIV infection (Niyongabo *et al.*, 1999a; Fenton & Silverman, 2004 p. 1044). A vicious cycle develops, in which under-nourished HIV infected patients have micronutrient deficiencies that lead to immunosuppression and oxidative stress, faster disease progression and depletion of CD4+ cells (Timbo & Tollefson, 1994; Baum & Shor-Posner, 1998; Macallan, 1999, Semba & Tang, 1999). Figure 2.1 represents the vicious cycle of micronutrient deficiencies and HIV pathogenesis.

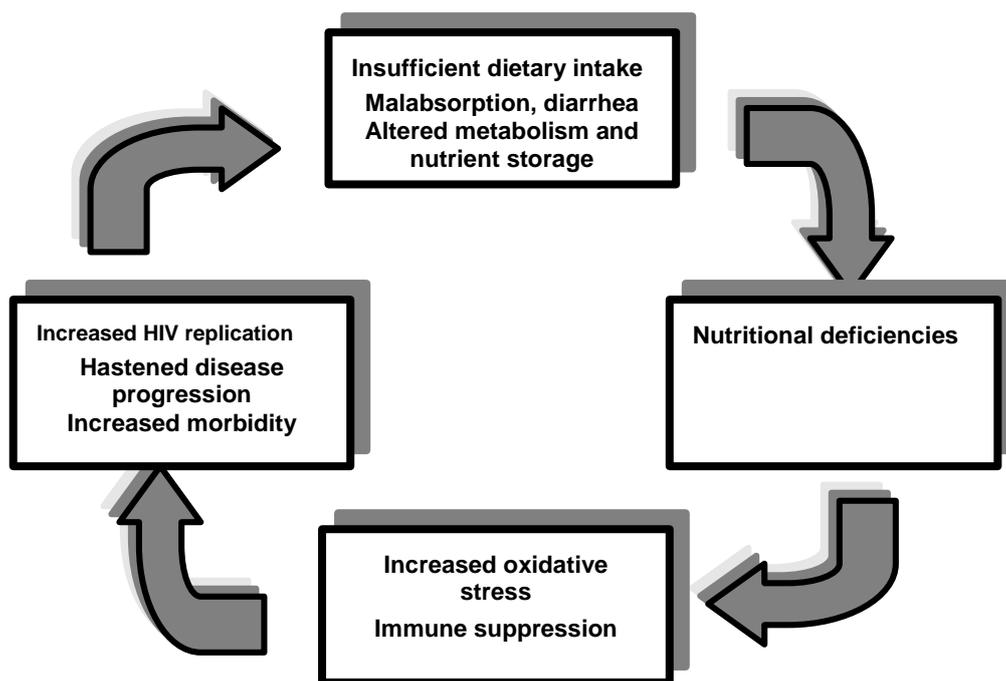


Figure 2.1: Model of vicious cycle of micronutrient deficiencies and human immunodeficiency virus pathogenesis (Semba & Tang, 1999)

The symptoms associated with malnutrition in people living with HIV/AIDS include weight loss, loss of muscle tissue and subcutaneous fat, vitamin and mineral deficiencies, reduced immune function, and greater susceptibility to infection (Piwoz & Preble, 2000).

The pathogenesis of HIV-related nutritional status abnormalities is multifaceted, often interdependent, and their contributions can vary during the clinical course of the disease

(Babameto & Kotler, 1997). These abnormalities may be the result of various dysfunctions in organs, such as changes in the gastrointestinal tract, nervous system, lungs, kidneys and bone marrow. Over time these abnormalities have been associated with adverse clinical outcomes (Baum & Shor-Posner, 1998) in subgroups, such as those with a low socio-economic status (Kim *et al.*, 2001).

Amongst the range of immune abnormalities induced by malnutrition, is a state of anergy, which refers to the failure to respond to any antigen, and indicates increased risk for sepsis. This state is due to a decrease in CD4+ helper cells, and reductions in cytotoxic cell activity and production of lymphokines, that are essential for signal transfer. HIV disease causes comparable immunologic changes (Hegde *et al.*, 1999).

Notwithstanding the major advances in knowledge of the biology of HIV infection and significant progress in therapy in the last few years, the basic role of nutrition in the pathogenesis of HIV infection remains unanswered. Questions such as which micronutrient deficiencies occur commonly in HIV-infected populations in developing countries, which factors contribute to the development of these deficiencies, and whether HIV-infected individuals have the same nutrient requirements as healthy individuals (Semba & Tang, 1999), also have to be ascertained.

It is almost globally accepted that a malnourished host is more susceptible to infections, with a relatively worse prognosis. It is however difficult to demonstrate that specific nutritional deficiencies contribute to poor clinical outcomes. The identification and correction of micronutrient deficiencies may thus become more important in developing countries where AIDS is spreading rapidly, nutritional problems occur commonly, and expensive drugs are generally unavailable (Semba & Tang, 1999).

Several studies have confirmed that HIV patients seem likely to be deficient in macro- and micronutrients, which can be threatening to the immune function (Jariwalla, 1995; Gay & Meydani, 2001). Deficiencies of this nature may intensify haematologic and neurologic deficits that are common in advanced HIV-associated disease (Coodley & Girard, 1991). Although data on the interaction between nutritional status and HIV/AIDS is widely available in Western countries, it is often not available in African countries, where food availability differs greatly from that in industrialized countries, and where endemic malnutrition and poor nutritional management are common (Castetbon et al., 1997). The results from studies performed in Western societies can thus not be used to forecast the conditions in African populations (van Staden et al., 1998). Further studies have been suggested to determine the possibility of acausal relationship between dietary intakes and nutritional status in HIV-infected patients within the African milieu (Castetbon et al., 1997).

Nutritional deficiencies may develop during any stage in the HIV-infected individual. Many subclinical deficiencies are however not noticed until they have progressed to degrees of severe body depletion, because the early signs and symptoms of nutritional deficiencies, such as fatigue, irritability and dry skin, are often non-specific (Cimoch, 1997).

Optimal nutritional health will decrease the occurrence of opportunistic infections, which in turn will reduce medical care expenses (Kotler, 1992), maximize the advantages from drug therapies (Coodley et al., 1994), and improve the patient's quality of life (Kotler, 1992).

Despite the fact that more affordable, and in some instances even free antiretroviral drugs have become available (Kupka & Fawzi, 2002), nutrition evaluation and counselling must still form a fundamental part of the clinical care of HIV-infected patients (Baum *et al.*, 1995; Woods & Gorbach, 1999). Furthermore, the importance of addressing and maintaining optimal health early in the asymptomatic stage of HIV infection needs to be emphasized (Cimoch, 1997).

2.5 ANTHROPOMETRIC PROFILE IN HIV/AIDS INFECTION

Extensive research that has been performed to determine the effects of HIV infection on body composition, has led to an improved understanding of anthropometric changes in these patients. In the following section, available literature on the changes in body composition in HIV/AIDS patients will be reviewed.

2.5.1 WEIGHT LOSS AND WASTING

Weight loss and wasting, which in parts of Africa have been known as “slim disease”, (Kotler *et al.*, 1989; Marston & De Cock, 2004) are associated with poor health and earlier morbidity, and therefore constitute a major problem in HIV-infected individuals (Kotler *et al.*, 1989; Fenton & Silverman, 2004, p. 1044; Marston & De Cock, 2004). In developing countries, particularly in Africa, weight loss in HIV-infected individuals is a prominent feature of the disease (Piwoz & Preble, 2000). Weight loss and often extreme wasting develop with progression from HIV infection to AIDS (Bell *et al.*, 1997).

The weight loss typically found in adult AIDS patients (Summerbell, 1994; Gramlich & Mascioli, 1995; Macallan *et al.*, 1995; Babameto & Kotler, 1997; Casey, 1997a; Fenton &

Silverman, 2004, p. 1044), is a severe nutritional manifestation of the disease (Babameto & Kotler, 1997). Before widespread use of powerful antiretroviral drugs, AIDS wasting syndrome was the second most commonly reported AIDS-related condition for adults in the USA (Fenton & Silverman, 2004, p. 1044), and approximately 90 percent of patients experience weight loss that often reaches 30 percent of the usual body weight at the time of death (Pollard, 1995). The extent of weight loss can become so severe that patients may need complete nursing care (Cuff, 1990).

Early in the AIDS epidemic, Chlebowski et al. (1989) determined that 98 percent of the seventy one AIDS patients who took part in their study, lost a mean of 14 percent of their usual body weight, and 68 percent lost 10 percent or more over a two year period. Kotler et al. (1989) reported that body cell mass depletion and weight loss were progressive until death. Extrapolation values for body cell mass at the time of death were 54 percent of the normal, and for body weight, 66 percent of the ideal. These levels for body cell mass and weight are at the lowest limits necessary for survival, and was linked to the timing of death in these AIDS patients.

Weight loss is often the event that begins a vicious circle of increased fatigue and a decrease in physical activity, including the inability to prepare and consume food for the patient living with HIV/AIDS (Babameto & Kotler, 1997). The CDC (1987) defined wasting as “an involuntary weight loss of more than 10 percent of baseline body weight, plus either chronic diarrhea (at least two loose stools per day for thirty or more days), or chronic weakness and documented fever (for thirty or more days, intermittent or constant) in the absence of concurrent illness or condition other than HIV infection that could explain the findings”. Despite this requirement of a net weight loss of at least 10 percent, a weight loss of even 5 percent has been associated with increased mortality

and morbidity (Wheeler et al., 1998). More recently, HIV wasting syndrome has been defined as individuals meeting one of the following criteria:

- Unintentional weight loss of 10 percent over twelve months;
- Unintentional loss of 10 percent of body weight over six months;
- Loss of 5 percent of lean body mass within six months;
- In men: body cell mass <35 percent of total body weight and BMI <27 kg/m²;
- In women: body cell mass <23 percent of total body weight and BMI <27 kg/m²;
- BMI <20 kg/m² (Fenton & Silverman, 2004, p. 1044).

Weight loss and wasting in AIDS patients are multi-factorial in etiology (Fenton & Silverman, 2004, p. 1044), and develop as a result of three determining processes (Macallan, 1999) that may be present individually, or act simultaneously (Lakshmipathi & Jastremski, 1989; Cimoch, 1997). These components are firstly an inadequate intake of macronutrients (Lakshmipathi & Jastremski, 1989; Macallan et al., 1995; Gramlich & Mascioli, 1995; Macallan, 1999; USAID, 2001); secondly, nutrient malabsorption (Lakshmipathi & Jastremski, 1989; Gramlich & Mascioli, 1995; Macallan, 1999) and in the third place, metabolic disturbances (Lakshmipathi & Jastremski, 1989; Melchior et al., 1991; Gramlich & Mascioli, 1995; Macallan, 1999) in the presence of chronic and periodic infections (Gramlich & Mascioli, 1995). These disturbances cause an increase in resting energy expenditure (REE), resulting from either a hypermetabolic state with active infection, or a higher mechanical workload, such as the increased use of energy for breathing in patients with respiratory discomfort (Lakshmipathi & Jastremski, 1989; Mayer et al., 2001). The hypermetabolic state thus increases energy and nutrient requirements (Cuff, 1990).

Weight loss typically follows two patterns, namely slow and persistent weight loss from anorexia and gastrointestinal disorders, and rapid, intermittent weight loss from secondary infections (Macallan, 1999). The first weight loss pattern is consistent with decreased energy intake (Gorbach et al., 1993), where individuals with a higher body fat content at the commencement of wasting, lose relatively more fat, and individuals with a lower body fat content lose relatively more muscle mass (Mulligan et al., 1997). The second weight loss pattern is typical of cachexia, a wasting state that is irreversible by feeding (Gorbach et al., 1993), and is characterized by a predominant loss of lean body mass, while fat stores are relatively spared. Cachexia has been described as one of the major causes of morbidity and mortality in relation to HIV infection (Castetbon et al., 1997). Adipose tissue serves as an important energy reserve to help reserve body cell mass when there is a deficit of energy balance. During episodes of acute infection, the acute phase reaction driven by the hormonal response cannot spare the protein mass, and wasting mainly bears on muscular protein stores. This pattern of wasting is seen during stress states, such as sepsis, trauma, or surgery, when body fat is reserved, and protein is used preferentially for energy. Although clinically stable HIV/AIDS patients can usually maintain their body weight (Grunfeld, 1995; Coors et al., 2001), anorexia, often mediated by the appetite-suppressing effects of cytokines, causes weight loss during acute secondary infections (Macallan et al., 1993).

It has been suggested that HIV *per se* does not cause wasting. Weight may remain unchanged even without antiretroviral therapy (ART). Although opportunistic infections seem to be a prime determinant in weight loss, weight recovery is still possible with successful treatment of infections (Macallan et al., 1993). Weight loss and wasting due to metabolic disorders can however not be reversed by dietary intake alone, as therapeutic strategies to increase body weight have been reported to be mainly

increases in fat and water, and not in lean body mass (Cimoch, 1997; Pichard et al., 1998; Miller et al., 1998; Macallan, 1999).

It is critically important to identify and characterize early risk factors for wasting in HIV infected patients and to monitor wasting with a standardized set of strategies for diagnosis, surveillance and appropriate treatment” (Salomon et al., 2002).

2.5.2 FACTORS THAT CONTRIBUTE TO HIV/AIDS MALNUTRITION

The origin of malnutrition in HIV/AIDS is considered multi-factorial, and broadly includes decreased nutrient intake, nutrient malabsorption, metabolic alterations (Gramlich & Mascioli, 1995; Jariwalla, 1995; Cimoch, 1997; Gasparis & Tassiopoulos, 2001; Coors et al., 2001), and depletion of antioxidant nutrients (Jariwalla, 1995). These factors will be reviewed in the following sections.

2.5.2.1 INSUFFICIENT NUTRIENT INTAKE AND INCREASED NUTRIENT LOSSES

A decreased food intake is quantitatively the most important factor in forecasting short-term weight loss in HIV infection (Kotler, 1997; Macallan, 1999). When energy expenditure exceeds energy intake, resulting from an inadequate intake of macronutrients (Lakshmi pathi & Jastremski, 1989; Macallan et al., 1995; Gramlich & Mascioli, 1995; Macallan, 1999; USAID, 2001), weight loss occurs. The causes of impaired food intake in HIV disease are multi-factorial (Cuff, 1990; Gramlich & Mascioli, 1995), and can result in severe depletion of body cell mass, eventually leading to death (Cuff, 1990).

Economic factors, in particular poverty (Grunfeld & Feingold, 1992; Hurley & Ungvarski, 1994; Babameto & Kotler, 1997), accompanied by lack of transportation to obtain food (Hurley & Ungvarski, 1994; Babameto & Kotler, 1997), and limited food preparation facilities (Cimoch, 1997), may limit the HIV patient's ability to prepare foods, thus influencing food and nutrient intake adversely.

Emotional instabilities such as depression following diagnosis with the disease, will further impact negatively on food intake (Grunfeld & Feingold, 1992; USAID, 2001).

Anorexia, nausea and vomiting may be common and severe among patients with advanced HIV infection and AIDS (Niyongabo *et al.*, 1997). Anorexia, central nervous system disease, dysphagia and odynophagia may affect micronutrient intake during HIV infection (Semba & Tang, 1999), causing failure in meeting dietary requirements (USAID, 2001).

Fever and commonly occurring infections (USAID, 2001) may alter the patient's appetite (Grunfeld & Feingold, 1992; USAID, 2001). Some patients limit their food intake due to discomfort. Patients often experience physical impairments in the oropharyngeal or esophageal area (Fenton & Silverman, 2004, p. 1044), and smell and taste alterations (Grunfeld & Feingold, 1992; Hurley & Ungvarski, 1994; Babameto & Kotler, 1997), letting them opt not to eat (Cimoch, 1997; Fenton & Silverman, 2004, p. 1044). Herpes simplex, aphthous ulcers, or cytomegalovirus may play a role in this regard (Fenton & Silverman, 2004, p. 1044), while Candidiasis, an infection caused by *Candida* yeast, can cause discomfort of the mouth and tongue (USAID, 2001). Pain or difficulty with eating and swallowing therefore result in reduced food intake and weight loss (USAID, 2001; Fenton & Silverman, 2004, p. 1044).

Diarrhea is a common event during HIV/AIDS infection, and leads to appetite and water loss, and nutrient malabsorption, resulting in severe malnutrition if left unattended for a prolonged period (USAID, 2001). Diarrhea can be the result of unhygienic drinking water, infections, some drug therapies, bacteria and protozoa such as *Cryptosporidium*, *Microsporidium*, atypical *Mycobacteria* (Gazzard, 1992; Sharpstone & Gazzard, 1996), *Giardia*, *Salmonella* and *Campylobacter* (Gazzard, 1992). Viral pathogens such as Herpes simplex (Grohmann et al., 1993) and Cytomegalovirus, and the HIV virus *per se* have also been associated with diarrhea (Grohmann et al., 1993; Sharpstone & Gazzard, 1996). Numerous pathogens are resistant to treatment and lead to severe weight loss and death (Sharpstone & Gazzard, 1996).

In some instances, lactose intolerance, accompanied by cramps, bloating or diarrhea develops, consequently leading to food avoidance (Jariwalla, 1995). In addition, medication (Grunfeld & Feingold, 1992; Jariwalla, 1995; USAID, 2001) may cause anorexia and gastrointestinal disorders (Grunfeld & Feingold, 1992).

The impact of dietary intake on disease progression has been investigated, amongst others, by Abrams et al. (1993). These researchers studied the relationship between dietary intake at baseline and the development of AIDS over a six-year period in HIV seropositive homosexual men. In this study, a high nutrient intake was associated with a significantly reduced risk of developing AIDS, which was directly related to a higher CD4+ cell count at baseline. A statistically significant association with a reduced risk of AIDS was reported for iron, vitamin E, riboflavin and the use of a multi-vitamin supplement. A higher micronutrient intake correlated with higher CD4+ cell counts at baseline, and this association was significant for vitamin A, retinol, vitamin E, riboflavin,

thiamin and niacin. In addition, the daily intake of a multi-vitamin was also associated with a 40 percent reduction in the risk of a low CD4+ cell count.

Although weight loss has been associated with decreased oral intake in some studies, results from other studies indicated that the energy intake of some HIV-infected patients exceeded their calculated requirement, with no correlation between energy intake and weight loss (Coodley et al., 1994). In a cross-sectional study by Luder et al. (1995), no correlation between weight loss and nutrient intake, CD4+ cells or absolute lymphocyte counts was found. Sharkey et al. (1992) reported a correlation between weight loss, CD4+ cells and energy intake only in the lowest CD4+ count strata, in which decreased energy intake correlated with decreased weight. Woods et al. (2002) stated that women are particularly at risk of inadequate dietary intake, but information about HIV-infected women, their dietary intake and weight loss is scarce. In the study of these researchers, the group of participants (men and women) with the lowest CD4+ cell counts and body weights, had the highest intake of energy. This phenomenon was ascribed to metabolic changes and an increased viral load with disease progression, with weight maintenance or increase impossible even with an increased energy intake.

In a study by Castetbon et al. (1997) in HIV-infected outpatients in Abidjan, Côte D'Ivoire, West Africa (Castetbon et al., 1997), 45 percent of the patients reported appetite problems, and these patients also demonstrated impaired anthropometric indicators. Dysphagia was reported by 10 percent of the patients, but this dysfunction had no influence on anthropometric indicators. Thirty five percent of the patients had an aversion to food, which was more frequent in symptomatic than in asymptomatic patients. Typically, patients with food aversion suffered greater weight losses than those without an aversion to food.

Studies however show discordance regarding energy and macronutrient intakes of HIV positive patients. Reported energy intakes ranged from inadequate (Carbonnel et al., 1997; McCorkindale et al., 1990; Castetbon et al., 1997; Kim et al., 2001), to adequate (Dworkin et al., 1990), to high (Hogg et al., 1995; Grinspoon et al., 1998; Izquierdo et al., 2002). The same trend was observed for protein intakes, ranging from being inadequate (Kim et al., 2001; Izquierdo et al., 2002), to above recommendations (Dworkin et al., 1990; Hogg et al., 1995). High fat intakes, but inadequate intakes of carbohydrates were observed by Izquierdo et al. (2002). In the study among HIV-1 seropositive patients in the Free State, the majority of participating subjects showed adequate energy and protein intakes (Dannhauser et al., 1999), confirming that energy and protein intakes of clinically stable AIDS and HIV-seropositive patients can be sufficient.

2.5.2.2 MALABSORPTION

Malabsorption is a common indication of HIV infection (Jiménez-Expósito et al., 1998), with 50 percent of patients with HIV/AIDS suffering from diarrhea at some stage during the clinical course of the disease (Cimoch, 1997; Fenton & Silverman, 2004, p. 1051). Patients with a CD4+ cell count of less than 200 to 250/mm³ are at the greatest risk of developing diarrhea. Malabsorption and diarrhea are the most prominent and difficult nutritional problems in HIV/AIDS patients to resolve (Fenton & Silverman, 2004, p. 1051). The gut is a major lymphoid organ, with 50 to 60 percent of the total body lymphocytes contained in gut-associated lymphoid tissue. This organ is therefore the largest reservoir for HIV (Cimoch, 1997). Malabsorption can be the result of HIV-induced enteropathy, which is associated with damage to the lining of the intestinal epithelium (Jariwalla, 1995), and has been associated with nutritional depletion in healthy subjects

(van der Hulst et al., 1998). Increased intestinal permeability may increase with disease progression (Keating et al., 1995). Lactose intolerance, malignancies, abnormally high levels of cytokines, and bacterial abnormalities can also be involved in malabsorption (Jariwalla, 1995).

HIV/AIDS influences the utilization of all the nutrients in the body. Malabsorption of carbohydrates (Castaldo et al., 1996; Jiménez-Expósito et al., 1998; Semba & Tang, 1999), fats (Jiménez-Expósito et al., 1998; Semba & Tang, 1999), proteins, minerals, water and vitamins (USAID, 2001), accompanied by diarrhea (Gramlich & Mascioli, 1995; Semba & Tang, 1999; USAID, 2001), appear commonly in patients with intestinal infection of the small bowel. Large bowel infections are associated with malabsorption of fluids and electrolytes (Fenton & Silverman, 2004. p. 1051).

Fat malabsorption was previously reported in 95 percent of HIV patients not receiving ART, confirming that this malfunction is a common phenomenon in HIV-infected individuals (Poles et al., 2001). Malabsorption of fat probably reduces the absorption of the fat-soluble vitamins A and E, which both play a central role in maintaining the immune system (Semba & Tang, 1999; USAID, 2001). Steatorrhea was found to be present in 50 percent of the sixty-one HIV-infected adults with or without diarrhea, who participated in a previous study (Koch et al., 1996).

Nausea and frequent vomiting may result from drug therapy used to treat HIV/AIDS or opportunistic infections. Besides reduced appetite loss, nausea also leads to malabsorption in these patients (USAID, 2001).

Nutrient malabsorption is a major etiology of HIV-associated weight loss and wasting (Lakshmipathi & Jastremski, 1989; Coodley et al., 1994; Gramlich & Mascioli, 1995; Jiménez-Expósito et al., 1998; Macallan, 1999). Patients with malabsorption can consume more than their estimated energy needs without gaining weight (Lakshmipathi & Jastremski, 1989; Cuff, 1990).

It is worthwhile to mention that the ingestion of contaminated food may lead to infections with enteric pathogens such as Salmonella, Clostridium perfringens, Staphylococcal aureus, and Clostridium botulinum, that can further lead to malabsorption and diarrhea (Cuff, 1990). However, in many instances, malabsorption and diarrhea occur in the absence of any identified pathogens, suggesting that malabsorption may be the result of the HIV *per se*, or HIV enteropathy (Hellerstein et al., 1993).

2.5.2.3 METABOLIC ALTERATIONS

Metabolism is frequently altered in HIV disease, due to the effects of the virus itself, opportunistic infections, and changes in endocrine, liver, kidney, pancreatic and adrenal function (Hellerstein et al., 1993).

Salas-Salvadó and Garcia-Lorda (2001) refer to the complexity of the metabolic abnormalities associated with HIV/AIDS, as the “metabolic puzzle”. Abnormalities in energy, protein, lipid and glucose metabolism have been described in HIV patients since the beginning of the AIDS epidemic (Salas-Salvadó & Garcia-Lorda, 2001). These abnormalities are likely induced by elevated levels of serum cytokines such as tumor necrosis factor-alpha (TNF- α , interleukin-1, and α -interferon, hypermetabolism, whole body protein turnover, and insufficient circulation and utilization of metabolic substrates

(Ducobu & Payen, 2000; Salas-Salvadó & Garcia-Lorda, 2001). Inappropriate metabolism of the macronutrients limits their use as an energy source for the cells, and therefore may potentially be contributing to wasting (Keithley, 1998; Ware *et al.*, 2002). HIV infection also affects the production of hormones, such as glucagon, insulin, epinephrine and cortisol (Piwoz & Preble, 2000), which are involved in the metabolism of carbohydrates, proteins and fats. When the levels of these hormones are increased, it contributes to weight loss and wasting (Young, 1997).

The protein profile of the HIV/AIDS-infected patient is characterised by increased urinary nitrogen loss, increased protein turnover, decreased skeletal muscle protein synthesis, increased skeletal muscle catabolism, and increased hepatic protein synthesis (Babameto & Kotler, 1997). Abnormal levels of serum protein such as albumin (Zumvalt & Schmidt, 1989; Coodley & Girard, 1991; Gramlich & Mascioli, 1995; van Staden *et al.*, 1998), prealbumin and transferrin have been reported in AIDS patients (Evans-Stoner, 1997). Albumin levels may range between normal and lower than normal in asymptomatic HIV infection, and lower than normal in AIDS patients (Gramlich & Mascioli, 1995). When these levels are increased, an increase in survival rate of AIDS patients can be expected (Zumvalt & Schmidt, 1989).

It is apparent that increased fibrinogen levels cause hypercoagulation states, and involves complicated and multi-faceted processes (Lowe, 1993, p. 24). Fibrinogen is an acute phase protein that may be affected by the HIV virus. The acute-phase response, which is the primary mechanism used by the body to restore homeostasis following infection, is characterised by increased levels of circulating fibrinogen in HIV-infected patients (Simpson-Haidaris *et al.*, 1998). Coors *et al.* (2001) reported from a study performed on HIV-infected men, that fibrinogen levels as a parameter of the acute phase

response were higher than the concentrations in the control group (4.3 gram per Liter (g/L) versus 2.5 g/L).

Although factors such as urbanization, obesity, alcohol consumption, smoking, age, gender and physical activity are all related to increased fibrinogen levels, nutritional status is one of the major determinants thereof. Both under- and overnutrition seem to be associated with increased fibrinogen levels, placing individuals at greater risk of coronary heart disease and stroke. In the Transition and Health during Urbanization of South Africans (THUSA) study performed in the Northwest Province of South Africa, high fibrinogen concentrations were found in both HIV negative and HIV positive men and women, and HIV infection showed no significant influence on fibrinogen levels (James et al., 2000).

Lipid laboratory features include hypertriglyceridemia (Salas-Salvadó & Garcia-Lorda, 2001; Gomez et al., 2002), and in HIV and AIDS patients respectively, normal to high free fatty acids (Grunfeld et al., 1992; Salas-Salvadó & Garcia-Lorda, 2001), and normal to low total cholesterol levels (Grunfeld et al., 1992; Pollard, 1995; Chlebowski et al., 1995; Salas-Salvadó & Garcia-Lorda, 2001). A decrease in high-density lipoprotein (HDL)-cholesterol (Grunfeld et al., 1992; Salas-Salvadó & Garcia-Lorda, 2001) early in HIV infection, which is later followed by a decrease in low-density lipoprotein (LDL)-cholesterol, has also been documented (Grunfeld et al., 1992). When lipoproteins were compared between different groups of HIV-infected patients (without acute inflammatory or malignant disease) according to CD4+ cell count, those patients with CD4+ cell counts $\leq 200/\text{mm}^3$ showed a decrease in HDL-cholesterol levels. In patients with CD4+ cell counts < 50 , total and very low-density lipoprotein (VLDL)-triglycerides and VLDL-cholesterol were increased, while HDL-cholesterol levels were decreased. Interferon- α ,

beta (β)-2 microglobulin and TNF correlated positively with total and VLDL-triglycerides, and negatively with high-density cholesterol. These lipoprotein changes were related to humoral and cellular immune markers (Fernández-Miranda et al., 1998). According to Ducobu and Payen (2000), HIV infection causes an early decrease of cholesterol, which is later followed by an increase of triglycerides, with a reduction of HDL-cholesterol, which is proportional with the decrease of CD4 cells. These decreased total cholesterol levels should however not be considered favourable, as associations between hypocholesterolemia and adverse clinical outcome from various clinical conditions have been documented. Cholesterol and fat intakes in these patients should therefore be maintained (Chlebowski et al., 1995).

Increased fasting serum or plasma triglyceride levels, which take place at the time of transition to AIDS, are common in HIV/AIDS patients (Pollard, 1995). Like other infections or injuries, HIV infection promotes the release of cytokines that may be responsible for the changed metabolic state in the patient. Cytokine-associated changes include, amongst others, an increased hepatic lipogenesis manifesting as hypertriglyceridemia (Hellerstein et al., 1993).

Carbohydrate metabolism is also changed in HIV-infected subjects (Hellerstein et al., 1993). In the era before highly active antiretroviral therapy (HAART), HIV subjects had normal or lower than normal levels of glucose, without insulin resistance (Hellerstein et al., 1993). In addition, a significant increase in insulin clearance and sensitivity was observed in severe stages of HIV infection, confirming that HIV infection does not contribute to insulin resistance (Hommes et al., 1991).

Cachexia-related wasting is associated with metabolic alterations. Several studies that investigated the REE in HIV-infected patients support the opinion that HIV infection is a hypermetabolic disorder (Selberg et al., 1995; Grinspoon et al., 1998).

Although it has been documented that REE is increased in HIV positive patients even with normal CD4+ cell counts and in the absence of opportunistic infection (Melchior et al., 1991; Macallan et al., 1995; Pollard, 1995; Melchior, 1997), this hypermetabolic response seems to become more severe particularly in the presence of secondary infections (Melchior et al., 1993; Garcia-Lorda et al., 2000). An 11 percent increase in REE among HIV positive patients, a 25 percent increase among AIDS patients, and a 29 percent increase in AIDS patients with secondary infections were earlier noted by Grunfeld et al. (1992). In this study, a correlation between weight and energy intake, but not between weight and REE was found, while an increase in REE, and a correlation between weight loss and decreased energy intake in HIV positive patients were reported by Macallan et al. (1995). The REE furthermore correlates significantly with the whole body protein turnover as measured by C¹³ leucine. This particular and only metabolic situation is associated with increased insulin sensitivity, and an increased level of de novo hepatic lipogenesis. It has been suggested that increased protein catabolism and a negative nitrogen balance occur in AIDS patients with active secondary infections. In these instances, hypermetabolism is partly mediated by elevated concentrations of catecholamines and cortisol, with insulin resistance. The high degree of muscular breakdown produces amino acids that are used in gluconeogenesis. In trauma and various infections, insulin resistance is useful to limit the utilization of glucose by the muscle. In stable HIV-infected patients, insulin sensitivity is however increased (Melchior, 1997).

Energy metabolism in women has however not been well recognized. Grinspoon et al. (1998), who investigated resting energy and energy intake in premenopausal HIV-infected women, documented that energy expenditure was higher in the infected women than in controls, and that fat free mass was the principle determinant of REE in the HIV-infected women. Energy expenditure in the HIV-infected group was higher per kilogram (kg) fat free mass than in the control group. No significant difference was found between energy intake and REE between the two groups.

Coors et al. (2001) measured energy balance, physical activity and acute phase response in stable HIV-infected patients and healthy controls. Total energy expenditure, REE, energy intake, and anthropometric data between patients and controls were very similar. In HIV-infected subjects, physical activity, total body potassium and bioimpedance phase angle were decreased, while mean heart rate, fibrinogen and erythrocyte sedimentation rate were increased. The increase in the acute phase parameters brought the authors to the conclusion that the acute phase response may trigger increases in REE, but elevated REE is probably more related to the acute phase response in patients with acute opportunistic infections.

As metabolic rate increases, energy needs also increase. An increase in dietary intake has thus been recommended to maintain weight in physically active HIV positive patients (Grunfeld et al., 1992; Macallan et al., 1995).

It however seems that hypermetabolism is not a constant phenomenon in HIV infection (Jiménez-Expósito et al., 1998; Garcia-Lorda et al., 2000). The investigation of REE showed various results when differences in body composition were taken into account, with REE increased (Melchior et al., 1991; Sharpstone et al., 1996a), normal (Jiménez-

Expósito *et al.*, 1998), or decreased (Kotler *et al.*, 1990; Sharpstone *et al.*, 1996b). Most studies however reported an increase in REE (Gramlich & Mascioli, 1995), and Melchior (1997) maintained that REE is without any doubt elevated during HIV infection.

Differences according to gender and clinical status have been documented for weight loss and wasting. Evidence from studies has shown that women tend to lose more body fat than lean body mass during early and advanced stages of wasting (Grinspoon *et al.*, 1997; Castetbon *et al.*, 1997). Grinspoon *et al.* (1997) who studied body composition in women with AIDS wasting, found that, similar to men, women lost significant lean body and muscle mass in advanced disease. In women however, loss of fat mass was disproportionately greater than loss of lean mass during the early stages of wasting. In the African study by Castetbon and co-workers (1997) performed in Côte D'Ivoire, muscular circumference between asymptomatic and symptomatic men differed significantly, while in women, triceps skinfold measurements were significantly different between asymptomatic and symptomatic patients. A possible explanation for this pattern is that women naturally store more body fat than men, and would lose it when wasting occurs, while in men it is exhausted more rapidly. Dannhauser *et al.* (1999) found in a South African study that HIV-infected men were leaner than women infected with the virus. The association between disease stage and anthropometric measurements was also confirmed by these authors. Patients with CD4+ cell counts $<200/\text{mm}^3$ had the lowest median values for all anthropometric measurements, indicating that weight loss increased with further disease progression. When Parisien and co-workers (1993) compared anthropometric measures of men with HIV during various disease stages, body weight and fat mass indicators decreased with disease progression. Lean body mass indicators were however the same in asymptomatic and AIDS patients, showing that weight loss in more advanced disease stages was

predominantly depletion of fat mass. In another international study, weight loss was related to a decrease in body fat, with lean body mass being preserved in patients with moderate malnutrition. Among subjects (male and female) with intermediate or severe malnutrition, weight loss was due to a loss of both body fat and lean body mass, which could be related to decreased food intake, increased whole body protein turnover, and the release of cytokines and stress hormones (Niyongabo et al., 1997).

When bioelectrical impedance analysis (BIA) was studied as a predictor of survival in patients with HIV infection, the phase angle α that shows changes in electrical conductivity of the body was significantly correlated to survival of HIV-infected patients over a period of one thousand days. The phase angle α was described as a better single predictor of survival than any other nutritional parameter examined, including body weight, BMI and serum nutritional parameters, and was also superior to the use of CD4+ cell count. Phase angle α can be obtained from tetrapolar BIA. Changes in bioelectrical tissue conductivity therefore have important implications for long-term prognosis and outcome in HIV-infected patients, even before AIDS as such sets in (Ott et al., 1995). Although BIA is used to determine nutritional status in HIV/AIDS patients (Ott et al., 1995; Cimoch, 1997; Casey, 1997b; Keithley, 1998), it has been suggested that skinfold measurements by means of mechanical calipers may be better to detect fat-free mass change in AIDS patients (Paton et al., 1996).

Metabolic changes in HIV infection remain a puzzle, emphasizing the importance of studies to clear these uncertainties (Melchior, 1997; Salas-Salvadó & Garcia-Lorda, 2001).

2.5.2.4 DEPLETION OF ANTIOXIDANT NUTRIENTS/OXIDATIVE STRESS

By definition, oxidative stress refers to a condition that occurs when there are more reactive oxygen molecules than can be neutralized by available antioxidant defenses. It occurs either because excessive amounts of reactive oxygen molecules are generated or because antioxidant defenses are deficient (Smolin & Grosvenor, 2003, p. 243). The confirmed prevalence of oxidative imbalance in HIV infection (Staal et al., 1992; Jariwalla, 1995; Schwarz, 1996), damages the cells, proteins and enzymes (Schwarz, 1996). Increased levels of inflammatory cytokines including TNF- α , interleukin-1 and interleukin-6, and interferon- α that are secreted as a reaction to hyperactivation and inflammation seem, to increase free radical generation (Staal et al., 1992).

Deficiencies of antioxidants such as glutathione (Skurnick et al., 1996; Look et al., 1997), vitamin A (Baum et al., 1995; Skurnick et al., 1996), vitamin E, beta-carotene (Skurnick et al., 1996; Friis & Michaelsen, 1998), zinc (Friis & Michaelsen, 1998), selenium (Cheung, 1995; Look et al., 1997; Friis & Michaelsen, 1998), manganese and copper (Friis & Michaelsen, 1998) have been documented for HIV/AIDS patients. Deficiencies of this nature invariably lead to a micronutrient imbalance (Jariwalla, 1995, increased susceptibility to oxidative stress (van Staden et al., 1998), and possibly alterations in fatty acid metabolism (Constans et al., 1995a).

2.5.3 LEPTIN AND WASTING IN HIV/AIDS INFECTION

The protein leptin, which is the product of the obese gene, is synthesized and secreted from adipocytes (Yarasheski et al., 1997; Sánchez-Margalet et al., 2002). Leptin regulates energy balance and weight control (Yarasheski et al., 1997; Insel et al., 2001,

p. 187) by increasing energy expenditure and by regulating food intake (Insel et al., 2001, p. 287). When given to obese experimental animals that do not produce leptin, their weight normalizes. Human obesity is however associated with increased, rather than decreased leptin levels (Yarasheski et al., 1997; Insel et al., 2001, p. 287). Fasting serum leptin levels are thus closely related to body fat content (Yarasheski et al., 1997).

In recent years, some studies of HIV-infected individuals on HAART have been devoted to possible associations between leptin and disease outcome. Hyperleptinaemia in certain pathologic conditions such as AIDS might contribute to the low body fat content associated with wasting (Yarasheski et al., 1997; Ballinger et al., 1998). Yarasheski et al. (1997), who measured fasting serum leptin levels in HIV positive and healthy men, found that in both groups, serum leptin concentrations correlated with percent body fat and body fat content, and these relationships did not differ between the two groups. In both groups, leptin concentrations did not correlate with lean body mass. These findings extend the hypothesis that circulating leptin concentrations are a direct reflection of adipose tissue mass, even in HIV-infected men with low body fat content. No support was however found for the hypothesis that HIV infection is associated with high circulating leptin concentrations, suggesting that low leptin levels do not stimulate food intake in HIV-infected patients (Yarasheski et al., 1997). In a similar study by Ballinger et al. (1998), serum leptin concentrations highly correlated with percentage body fat in healthy control subjects, but not in patients with AIDS. These researchers concluded that hyperleptinaemia does not appear to mediate the anorexia and weight loss associated with AIDS. AIDS patients with severe wasting showed no relationship between body fat and leptin, which may be related to the rapid weight loss that occurs in these patients. Results from two other studies confirmed that serum leptin does not play a role in HIV-associated wasting (Nowak et al., 1999; van der Merwe et al., 2004).

A negative correlation between leptin and REE has been reported in HIV-infected women. In this study by Grinspoon *et al.* (1998), REE was reported to be the highest in subjects with the lowest leptin concentrations, which provided evidence for the catabolic nature of wasting syndrome of the fat component in these women.

Leptin has also been found to play a role in improving amongst others, immune function (Matarese *et al.*, 2002; Sánchez-Margalet *et al.*, 2002), such as thymocyte survival, proliferation of naive T lymphocytes and the production of pro-inflammatory cytokines (Matarese *et al.*, 2002). The last mentioned authors investigated the role of leptin in immunoreconstitution during HAART in children. Before the therapy was started, serum leptin concentrations were positively associated with CD4+ lymphocyte count. HAART however resulted in a significant increase in leptin levels and CD4+ cell count, indicating a new link among CD4 and T lymphocytes, serum leptin and HAART.

2.5.4 TB AND WASTING IN HIV/AIDS INFECTION

Worldwide, TB is the leading cause of death among HIV-infected patients. In one out of every three people with AIDS, TB is the major cause of death. The risk of developing TB is much higher for those infected with HIV/AIDS, due to the disease-associated immune system depletion (CDC, 1999). A body weight of 10 percent or more below the ideal, and hematologic disorders such as leukemia and lymphomas, increase the risk of TB infection (Fenton & Silverman, 2004, p. 1036).

Co-infection with TB and HIV is one of the major problems in many developing countries, including Sub-Saharan Africa (Lucas *et al.*, 1993; Shah *et al.*, 2001). In this part of the

African continent, TB is often the first opportunistic infection to occur in HIV-infected individuals (Lucas *et al.*, 1993), resulting in immune action, a rapid increase in the rate of HIV replication (Fenton & Silverman, 2004, p. 1036), poor prognosis and a high mortality rate (CDC, 1999). In South Africa, TB is a serious health problem, especially in lower socio-economic groups, which include large numbers of HIV/AIDS patients (Taylor & Benatar, 1989). HIV and TB co-infection has thus become another arising epidemic in South Africa (Wilkinson & Davies, 1997), and timely treatment is essential to control disease progression of both diseases (Fenton & Silverman, 2004, p. 1036). In an East African study in Burundi by Niyongabo *et al.* (1999b), HIV positive patients with TB had more pronounced malnutrition than HIV negative subjects with TB, and the nutritional status of HIV positive TB patients was far worse than that of HIV negative TB patients. Wasting is a principal sign of TB in HIV positive and HIV negative subjects, but it has been documented that adults co-infected with HIV and TB have significantly lower weight, BMI and fat-free mass (Niyongabo *et al.*, 1999a). In another African study in Uganda, Shah *et al.* (2001) compared the nutritional status (anthropometry and BIA) of HIV-infected and uninfected adults with pulmonary TB. No significant differences in BMI, body cell mass, fat mass or fat-free mass were found between HIV positive and HIV negative patients. BMI, the ratio of intracellular water to extra-cellular water, body cell mass, fat mass and phase angle α were however significantly lower in HIV positive subjects with CD4+ cell counts ≤ 200 , compared to subjects who had cell counts $>200/\text{mm}^3$.

2.5.5 OBESITY IN HIV INFECTION

While wasting is a well-recognized problem in AIDS-infected individuals, overweight and obesity have been observed in individuals with HIV. Kim *et al.* (2001) indeed maintain

that obesity in HIV disease is not uncommon, with BMI varying widely in cohorts of individuals with HIV. Data by the above-mentioned authors provided evidence that more than 20 percent of the women participating in their study in the USA were obese, and 50 percent were overweight. Thirty four percent of the overweight patients reported that they were on a weight-loss diet, while from the obese patients, 47 percent restricted their food intake to lose weight. Individuals with a baseline BMI >25 had a much lower death risk than those with a BMI <25. This underscores the importance of weight maintenance in HIV-infected individuals to prevent the detrimental effects of restricted food intake on their long-term prognosis.

Results from another study showed that the BMI of participants ranged between 20 and 38 kg/m². BMI correlated significantly with extra cellular mass/body cell mass ratio, indicating that overweight patients may be more likely to be considered malnourished than patients with normal weight. Malnutrition in this case was characterised by the abnormal extra cellular/body cell mass ratio, which may possibly be linked to hyperinsulinemia, characteristic of obesity, and a profound determinant of sodium and fluid retention. More research on large numbers of obese, HIV-infected patients has however been suggested to determine whether these patients are indeed more malnourished than those with normal body weight (Bell et al., 1997).

2.6 MACRONUTRIENT REQUIREMENTS IN HIV/AIDS INFECTION

Macronutrient deficiencies during HIV/AIDS infection appear commonly. Total energy, protein and amino acids (Baum et al., 1995; Harbige, 1996), such as arginine, glutamine, leucine, valine, iso-leucine, cysteine and methionine (Cimoch, 1997), lipids (omega-3-

and 6 fatty acids, short- and medium chain triglycerides), and nucleotides (Baum et al., 1995; Harbige, 1996) are all related to immune function.

2.6.1 ENERGY AND PROTEINS

Protein malnutrition (Berneis et al., 2000) and energy deficiency are common consequences in HIV/AIDS patients suffering from malabsorption (Lakshmi pathi & Jastremski, 1989). In underdeveloped countries, protein-energy-malnutrition is also the first cause of immunodeficiency (Melchior, 1997). HIV disease affects the immune system in a way similar to that of protein-energy-malnutrition (Cimoch, 1997; Fenton & Silverman, 2004, p. 1045). One of the outstanding features of protein-energy-malnutrition is a reduction in the size and weight of the thymus gland, resulting in lymphoid atrophy (Chandra, 1997). The consequences of protein-energy-malnutrition for the immune system thus include impaired T-cell proliferate responses, low circulating T-lymphocytes, particularly CD4+ cells (Harbige, 1996; Chandra, 1997), impaired phagocyte function, cytokine production, and immunoglobulin secretion (Chandra, 1997), which all lead to faster progression to AIDS (Cimoch, 1997).

It has been suggested that energy requirements for HIV patients are markedly higher than those of healthy subjects and international recommendations for HIV-infected individuals (de Luis Román et al., 2001). An additional energy intake of 10 to 15 percent has been previously recommended for HIV positive patients of normal weight (Macallan et al., 1995). According to the latest World Health Organization (WHO, 2003a) report of nutrient requirements for people living with HIV/AIDS, energy needs should be increased by 10 percent in asymptomatic HIV-infected adults to maintain body weight, in order to compensate for the increase in REE. During periods of opportunistic infection, or in the

symptomatic disease stage, an increased energy intake of about 20 to 30 percent is however recommended. Energy expenditure studies showed no increase in overall total energy expenditure, which could be the result of individuals compensating by reducing activity-related energy expenditure. Since physical activity plays a principle role in preserving quality of life and maintaining muscle tissue, it is undesirable that energy intake should match only a decreased level of activity-related energy expenditure.

It has been previously documented that high-protein diets may assist in improving a positive nitrogen balance and replenishing lean body mass. Protein requirements of 1 to 1.4 g/kg body weight for weight maintenance, and 1.5 to 2 g/kg body weight to replenish lean body mass (excluding persons suffering from severe hepatic or renal disease) have been suggested (Fenton & Silverman, 2004, p. 1047). According to the latest recommendations by the WHO (2003a) a lack of convincing evidence at this stage makes it difficult to recommend intentional increases in protein intake due to HIV infection.

2.6.2 LIPIDS

The quality and type of dietary lipids have been documented to affect immune function. Long-chain omega-6 fatty acids have been reported to have immunosuppressive effects when administered in quantities significantly higher than the amount necessary to prevent fatty acid deficiency. These effects included inhibition of CD8+ T-lymphocyte (cytotoxic cell) function, diminished cytokine secretion, impaired leucocyte migration, and adverse effects on the reticuloendothelial system (Cimoch, 1997).

The omega-3 fatty acids alpha-linolenic acid, eicosapentaenoic acid and docosahexaenoic acid have been found to change eicosanoid metabolism by forming different series of anti-inflammatory prostaglandins and leukotrienes (de Luis Román et al., 2001). Seeing that many of the effects of interleukin-1 and TNF are moderated by eicosanoid, HIV positive patients with increased levels of cytokines may benefit from omega-3 fatty acid supplementation (Woods & Gorbach, 1999). An increase in weight and in CD4+ cells in HIV-patients with or without AIDS were related to an enterotropic peptide and fish oil supplemented formula. The application of this formula resulted in a less inflammatory state, with fewer cytokines being produced (de Luis Román et al., 2001). High doses of omega-3 fish oils could however reduce interleukin-2 production. Low dose omega-6 fatty acid supplementation on the other hand, may be associated with a positive effect on red blood cell and CD4+ T-cell membrane fatty acid alterations in HIV/AIDS patients (Klein et al., 1992).

Medium-chain triglycerides are good sources of energy that are easily absorbed, and have often been used for patients with malabsorption and maldigestion (Cimoch, 1997). The use of medium-chain triglyceride oil rather than long-chain triglyceride-based supplements has further been recommended to decrease stool fat and stool nitrogen content, and the number of bowel movements and abdominal symptoms. Fenton and Silvermann (2004, p. 1049) noted that a combination of omega-3 fatty acids and medium-chain triglyceride oil may aid in improving immune function. Short-chain fatty acids on the other hand, have no immuno-suppressive effects, but they are good energy sources, and may also be used as a dietary supplement (Cimoch, 1997).

Although fat tolerance varies amongst individuals (Fenton & Silvermann 2004, p. 1049), individuals with malabsorption or those experiencing diarrhea may need special advice regarding fat intake.

Although some studies have thus reported on the beneficial role of dietary lipids, there is currently no evidence that HIV infection increases total fat needs beyond normal requirements (WHO, 2003a).

2.6.3 FLUIDS

Fluid needs are calculated as 30 to 35 milliliters (ml)/kg body weight. In cases of diarrhea, nausea, vomiting, night sweats and chronic fever, these amounts should be increased. In addition, replacements of the electrolytes sodium, potassium, and chloride are recommended during periods of vomiting and diarrhea (Fenton & Silverman, 2004, p. 1049) when body fluid losses are increased.

2.7 MICRONUTRIENTS IN HIV/AIDS INFECTION

Although literature on micronutrients and the pathogenesis of HIV is often contradictory (Fenton & Silverman, 2004, p. 1050; Marston & De Cock, 2004), the role of micronutrients in immune function and infectious disease is well established (WHO, 2003a). Blood or serum micronutrient levels may however not reflect true nutritional status, and measurement of dietary intake may be useful in determining nutritional status (Fenton & Silverman, 2004, p. 1050). The prevalence of micronutrient deficiencies in HIV-infected subjects seems to vary widely, depending on the study population and stage of disease progression. Homosexual men and heterosexual adults in

industrialized countries have the lowest prevalence of micronutrient deficiencies, while injection drug users, pregnant women and children are at the highest risk of these deficiencies. Although information regarding micronutrient status from developing countries during HIV infection is limited (Semba & Tang, 1999), underprivileged women in these countries have been identified as particularly vulnerable to such deficiencies (Marston & De Cock, 2004).

Micronutrient deficiencies may be the result of insufficient dietary intake, malabsorption, diarrhea, and impaired storage and altered metabolism thereof (Semba & Tang, 1999). There is compelling evidence that low blood levels and decreased dietary intakes of some micronutrients are associated with faster disease progression and mortality, and increased risk of HIV transmission. Although the consumption of diets that meet recommended dietary allowance (RDA) levels of micronutrients should be prioritized, this may be insufficient to correct nutritional deficiencies in HIV-infected individuals (WHO, 2003a).

The assumption that micronutrient deficiencies play a role in the pathogenesis of HIV infection is broadly based on two theories, namely the free radical theory, and the nutritional immunological theory (Semba & Tang, 1999). According to the free radical theory, activated macrophages and neutrophils that produce reactive oxygen intermediates such as superoxide- and hydroxyl radicals and hydrogen peroxide, play an important role in destroying microorganisms. These reactive oxygen intermediates can also cause cellular injury and lysis, because free radicals can cause oxidation of nucleic acids, chromosomal breaks, peroxidation of lipids in cell membranes, and damage to collagen, proteins, and enzymes. Reactive oxygen intermediates can damage bystander cells and generate pathology. The production of these intermediates by

immune effector cells or injured tissue is balanced by the antioxidant defence system (Baruchel & Wainberg, 1992). Free radicals may also be involved in the pathogenesis of HIV infection through interactions with nuclear factor κ B, a transcriptional promoter of proteins involved in the inflammatory response and acute-phase response (Schreck *et al.*, 1991). Glutathione, a major intracellular thiol which detects free radicals, may inhibit activation of nuclear factor κ B (Staal *et al.*, 1992). Lower survival rates in HIV-infected adults with low levels of glutathione in their CD4+ lymphocytes, have been reported (Herzenberg *et al.*, 1997). The clinical trial of an oral drug form of glutathione during HIV infection has therefore been recommended (Semba & Tang, 1999).

According to the nutritional immunological theory, micronutrient deficiencies compromise the immunity of the host to HIV and other HIV-related infections, leading to clinical disease progression (Semba & Tang, 1999). Although several vitamin and mineral deficiencies have been associated with immune functioning and HIV/AIDS (Jariwalla, 1995; Gay & Meydani, 2001; Lee, 2002), the specific role of single and multiple micronutrients in the prevention, care and treatment of HIV infection and related conditions should be further investigated (WHO, 2003a).

2.7.1 VITAMINS

Both fat- and water-soluble vitamins have been recognized for their involvement in immune function. Fat-soluble vitamins that play key roles in immune function include vitamin A and carotenoids (Baum *et al.*, 1995; Jariwalla, 1995; Harbige, 1996; Chandra, 1997), vitamin D (Baum *et al.*, 1995; Harbige, 1996) and vitamin E (Baum *et al.*, 1995; Harbige, 1996; Chandra, 1997; Gay & Meydani, 2001).

Of the water-soluble vitamins, vitamin B2, vitamin B6 (Baum et al., 1995; Jariwalla, 1995; Harbige, 1996; Chandra, 1997; Gay & Meydani, 2001), folic acid (Jariwalla, 1995; Chandra, 1997), vitamin B12 (Gay & Meydani, 2001), and vitamin C (Baum et al., 1995; Jariwalla, 1995; Harbige, 1996; Chandra, 1997) are of importance in immune functioning. These nutrients may likely assist in maintaining the integrity of immune responses, including peripheral blood lymphocyte response to the mitogens phytohemagglutinin and pokeweed, and the activity of the natural killer cells (Baum et al., 1991).

Studies on the dietary intakes of patients with HIV, revealed that low intakes of vitamin B1, B2, B3, B6 (Tang et al., 1993; Tang et al., 1996) and vitamin E have been associated with faster disease progression (Abrams et al., 1993). These studies support the concept that adequate dietary intake should be the first step in maintaining adequate nutritional status (Woods et al., 2002). The need for increased intakes of beta-carotene, vitamin E, vitamin C, vitamin B12, vitamin B6, and folic acid has been emphasized for HIV/AIDS patients. Although the exact requirements of these nutrients still have to be determined, a vitamin-mineral supplement equalling the RDA, and a basic B-complex supplement have been recommended (Fenton & Silverman, 2004, p. 1050).

In the following section, available published studies on vitamin status of HIV/AIDS patients will be reviewed.

2.7.1.1 VITAMIN A

In Africa, vitamin A is the micronutrient that has been studied most intensely in the context of HIV infection (Piwoz & Preble, 2000), particularly for its role in child morbidity

and mortality, and the increased risk of mother-to-child transmission associated with poor vitamin A status (Semba et al., 1994).

Although vitamin A deficiency is relatively unknown in HIV negative adults in industrialized countries, deficiencies in HIV positive adults (Kennedy et al., 2000) in developing countries are well known (Nimmagadda et al., 1998). Beta-carotene deficiencies are frequent in all stages of HIV/AIDS and may be a sign of malabsorption (Patrick, 1999). According to literature, these deficiencies even occurred when dietary intake exceeded recommendations for retinol (Baum et al., 1994; Karter et al., 1995). In the Free State Province in South Africa, the decreased intake of several micronutrients was reflected in low blood levels of these micronutrients in a large number of the HIV-1 seropositive participants. Amongst others, low blood concentrations of retinol were reported by these authors (van Staden et al., 1998).

Vitamin A deficiency has been associated with faster progression to AIDS (Baum et al., 1995; Tang & Smit, 1998; Rich et al., 2000), an increased risk of developing diarrhea (Ulrich et al., 1994), wasting syndrome (Coodley et al., 1993), decreased circulating CD4+ cells (Abrams et al., 1993; Baum et al., 1995), an increased viral load (Camp et al., 1998), and an increased mortality risk (Semba et al., 1993; Tang et al., 1996; Tang & Smit, 1998). It has been suggested that HIV infection leads to increased utilization of vitamin A in order to stimulate the acute-phase immune response against HIV-1 infection, which may exhaust vitamin A stores in the liver (Nerad & Gorbach, 1994; Maciaszek et al., 1998). A second explanation for this deficiency may be that HIV-1 infection increases malabsorption of vitamin A probably by altering digestion (Constans et al., 1995a).

Bogden and co-workers (1990), who were among the early researchers who determined the status of plasma micronutrient levels in HIV-seropositive individuals, stated that the majority of HIV positive individuals participating in their study were deficient in one or more plasma micronutrients, including carotenoids. Low blood levels of vitamin A during HIV infection were reported by Beach et al. (1992), while Baum et al. (1994), reported similar or lower plasma levels of vitamin A for HIV positive, compared to HIV negative homosexual men, despite micronutrient supplementation in the HIV positive group. It has therefore been suggested that the metabolism of nutrients may be affected by factors other than dietary intake. In a similar study, decreased plasma nutrient levels of vitamin A and carotene were found in HIV positive men, with serum vitamin A and carotene appearing to be the lowest in patients with wasting syndrome. This was ascribed to malabsorption (Coodley et al., 1993).

Tang et al. (1993) who investigated the relationship between micronutrient intake and progression to AIDS in a prospective study on HIV positive men, noted that a median intake of vitamin A was related to slower AIDS progression, while a low (less than 9 000 International Units (IU) and a high (more than 20 000 IU) daily intake was significantly associated with an increased AIDS progression rate.

In a more recent study that determined blood concentrations of various micronutrients and their relationship to the inflammatory response, vitamin A concentrations were significantly lower in AIDS patients, which also correlated with various inflammatory parameters. This finding suggested that these concentrations are more strongly related to the inflammatory response than the nutritional status of the patients (Jiménez-Expósito et al., 2002).

In a cross-sectional study performed among adult patients attending an HIV clinic in Cape Town, South Africa, clinical features including advanced disease and/or weight loss were associated with reduced blood concentrations of vitamin A. None of the participants received supplementation or ART. Low retinol levels were reported for patients with early (39 percent), and advanced disease (stage III: 48 percent and stage IV: 79 percent). Weak positive associations were found between CD4+ lymphocyte count and plasma levels of retinol. According to the authors, socio-economic factors could probably have contributed to a poorer micronutrient intake in patients with advanced disease, who were more likely to be unemployed (Visser et al., 2003).

2.7.1.2 VITAMIN D

Decreased plasma levels of vitamin D in HIV positive men (Coodley et al., 1993), low serum levels of 1.25-vitamin D (Haug et al., 1994), and an insufficient dietary intake of this micronutrient have been noted in HIV/AIDS patients (Dannhauser et al., 1999).

2.7.1.3 VITAMIN E

Vitamin E has been associated with improved cell-mediated and humoral immune responses (Odeleye & Watson, 1991; Gay & Meydani, 2001). Low levels of this vitamin may increase oxidative stress, which increases the utilization of this antioxidant in people living with HIV/AIDS (Lee, 2002). Bogden et al. (1990), and Beach et al. (1992) reported low plasma and blood levels of vitamin E during HIV infection. Similar or lower plasma levels of this vitamin were found in HIV positive, compared to HIV negative homosexual men by Baum et al. (1994). Low blood levels of vitamin E were also

reported in the South African study on HIV-1 seropositive patients by van Staden et al. (1998).

On the contrary, the progression rate to AIDS may be reduced by an increased intake of this vitamin (Tang et al., 1993). In a study in the USA, high serum levels of vitamin E at baseline were associated with decreased HIV progression after considering variables such as HIV-related symptoms, CD4+ cell count, age and antiretroviral use (Tang et al., 1997c).

2.7.1.4 B VITAMINS

Increased intakes of vitamins B1, B2 and niacin have been associated with a significantly reduced rate of progression to AIDS (Tang et al., 1993).

Vitamin B6 deficiency has been indicated as a common accompaniment to HIV infection (Bogden et al., 1990; Beach et al., 1992; Coodley et al., 1993; Baum et al., 1994; Babameto & Kotler, 1997), particularly during early disease stages, and may be multi-factorial in nature (Baum et al., 1991).

It was earlier reported that average vitamin B6 intakes showed a decrease in disease progression rate, while very high and very low intakes did not have the same positive effect (Tang et al., 1993). It was however later reported that low vitamin B6 serum levels were not associated with progression to AIDS or a decline in CD4+ lymphocyte count (Tang et al., 1997b).

A significant association between vitamin B6 status and the *in vitro* peripheral lymphocyte response to T- and B-cell mitogens and natural killer cytotoxicity was reported by Baum et al. (1991), suggesting that vitamin B6 status may represent an important cofactor of immune functioning. Vitamin B6 seems to play a vital role in nucleotide synthesis and cell growth. Insufficient levels of this vitamin would therefore promote the deterioration of the immune system and lymphocyte function (Jariwalla, 1995; Gay & Meydani, 2001).

Vitamin B12 has been recognized as a very common micronutrient deficiency in HIV infection (Babameto & Kotler, 1997), and has been extensively studied in this context (Tang et al., 1997b). This vitamin is associated with nucleotide synthesis and cell growth (Gay & Meydani, 2001), and low levels have been associated with impaired cognitive function (Beach et al., 1992; Tang & Smit, 1998), reduced CD4 T-cell counts, increased mortality (Tang & Smit, 1998), and faster progression to AIDS (Tang et al., 1997b; Tang & Smit, 1998). Improvements in vitamin B12 levels on the other hand were associated with increases in CD4 cell count (Baum et al., 1995).

Early in the AIDS epidemic, decreased whole blood, plasma or serum levels of vitamin B12 (Beach et al., 1992; Baum et al., 1994) were documented. These findings were also supported by the South African study by van Staden et al. (1998). It has been hypothesized that poor dietary intake (Gorbach et al., 1993), gastric secretory failure accompanied by intrinsic factor deficiency, and decreased vitamin B12 absorption (Herzlich et al., 1992) play a role in this regard.

2.7.1.5 FOLATE

Folate deficiencies have been associated with impaired immune function (Jariwalla, 1995). Although low blood concentrations of folate (van Staden *et al.*, 1998) have been reported for HIV-infected people, the role of this nutrient in HIV/AIDS infection is not yet clear (Piwoz & Preble, 2000), with studies showing no relationship between folate deficiency, progression to AIDS, or decline in CD4+ lymphocyte count (Tang *et al.*, 1997a).

2.7.1.6 VITAMIN C

Low vitamin C levels (Coodley *et al.*, 1993; Skurnick *et al.*, 1996) and low dietary intakes have been previously reported in HIV-infected adults (Dannhauser *et al.*, 1999).

Whereas a deficiency of vitamin C seems to interfere with antibody formation (Jariwalla, 1995), an increased intake has been related to improved outcomes in terms of CD4+ cell counts, clinical progression to AIDS and mortality (Abrams *et al.*, 1993; Tang *et al.*, 1993; Tang *et al.*, 1996).

2.7.2 MINERALS AND TRACE ELEMENTS

Zinc (Baum *et al.*, 1995; Jariwalla, 1995; Harbige, 1996; Chandra, 1997;), copper, selenium (Baum *et al.*, 1995; Harbige, 1996; Chandra, 1997), and iron (Baum *et al.*, 1995; Jariwalla, 1995; Harbige, 1996; Chandra, 1997) are all related to immune function.

The prevalence of mineral deficiencies during HIV/AIDS infection has been documented in numerous publications. Decreased whole blood, plasma or serum levels of zinc (Baum et al., 1994), selenium (Bogden et al., 1990; Beach et al., 1992), iron (Blumberg et al., 1984), calcium (Bogden et al., 1990), magnesium (Bogden et al., 1990; Skurnick et al., 1996), copper (Beach et al., 1992), and choline (Skurnick et al., 1996), have been reported in HIV positive patients.

In the following section, a review of available literature on mineral studies conducted in HIV/AIDS infection will be provided.

2.7.2.1 COPPER

Low levels of copper have even been found in the early asymptomatic phase of HIV infection (Beach et al., 1992). In contrast to this, Jiménez-Expósito et al. (2002) reported higher serum copper levels in asymptomatic individuals, which correlated with disease progression, but not with dietary intake. The authors thus concluded that serum copper levels are more related to the inflammatory response than to the nutritional status of the patient.

2.7.2.2 SELENIUM

Selenium forms part of the body's antioxidant defense system. A deficiency of this element is associated with profound nutritional implications for individuals with HIV/AIDS (Lee, 2002), and has shown to be predictive of HIV-related prognosis (Constans et al., 1995b; Patrick, 1999; Lee, 2002). Selenium deficiency may be linked to increased mortality (Baum et al., 1997; Baum & Shor-Posner, 1998; Campa et al., 1999), immune

dysfunction (Rousseau et al., 2000), and glutathione activity (Lee, 2002). Low blood levels of this trace element may already be prevalent during the early symptomatic phase of HIV infection (Beach et al., 1992).

Although selenium deficiency is rare in healthy individuals, it appears commonly during HIV infection (Baum et al., 1997). The virus manufactures selenoproteins that are involved in the regulation of viral replication, possibly depleting host levels of selenium (Patrick, 1999). Selenium status of the host may therefore play an important role in modulating viral expression, with an adequate intake preventing the replication of HIV and retarding disease progression (Baum & Shor-Posner, 1998). At cellular level, selenium, also an integral part of the enzyme glutathione peroxidase, increases the use of oxygen by the cells, thus protecting cells and membranes against peroxidative damage. Oxidative stress in HIV- infected individuals may be related to failure in these defense mechanisms, as well as the chronic and progressive inflammatory reaction associated with HIV infection development (Malvy et al., 1994). It however seems as if HAART can decrease selenium deficiency (Rousseau et al., 2000).

2.7.2.3 ZINC

It is well known that zinc plays a central role in several immune processes (Kupka & Fawzi, 2002), but is commonly deficient in African countries. Zinc deficiency is associated with suppressed immunity, impaired taste and smell, damage to the epithelial lining of the intestine and respiratory tract, and impaired memory (Shankar & Prasad, 1998).

Baum et al. (1995), who studied the relationship between parameters of HIV disease progression, including CD4+ T-cell counts and micronutrient deficiencies in HIV-seropositive homosexual men, reported an increase in the prevalence of low plasma zinc levels over the eighteen month follow-up period of the study, which was also associated with a nonsignificant decrease in CD4+ T-cell counts. When plasma zinc levels were normalized, these cell counts increased significantly. Low plasma zinc values were also observed in up to 26 percent HIV-infected individuals during the asymptomatic stage, and in up to 96 percent of HIV/AIDS-related complex patients (Beach et al., 1992). Bogden and co-workers (2000) assessed the status of selected nutrients and progression of HIV-1 infection. Participants were divided into disease stages A, B or C on the basis of the presence of opportunistic infections or other conditions. A significant association between CD4+ T lymphocyte count and plasma zinc concentrations was found, with zinc being one of the predictors of CD4+ cell count.

Contrary to these results, normal mean levels of serum zinc were reported in HIV-infected subjects during asymptomatic and advanced stages of the disease in a descriptive cross-sectional study undertaken among heterosexual adults (Skurnick et al., 1996). In another cross-sectional study, decreased serum zinc levels were only prevalent in 3 percent of HIV-infected subjects not using micronutrient supplements, with or without wasting syndrome (Coodley et al., 1993).

Despite varying results from studies on zinc status in HIV/AIDS infection, it seems that low blood levels are common in HIV disease, and may correlate with the stage of the disease and immune parameters (Kupka & Fawzi, 2002). The latter authors further stated that, "based on existing evidence, it is difficult to find consensus and establish causality between zinc nutrition and adverse HIV-related outcomes, as findings have

ranged from detrimental effects of zinc intakes above the RDA, to no effect, to potential beneficial effects”.

Of particular concern is the fact that the majority of HIV-infected people live in the developing world where zinc deficiency is highly prevalent (Kupka & Fawzi, 2002). Visser et al. (2003) noted that in settings with poor resources, simple clinical features correlated with decreased blood concentrations of zinc. Of the 132 HIV-infected adults taking part in their study in Cape Town, low plasma zinc levels were found in 20 percent of the patients with early disease, and in 36 percent and 45 percent of patients respectively with stage III and IV disease. HIV infection could further increase zinc deficiencies by adversely affecting the intake, absorption and metabolism of foods containing this mineral (Kupka & Fawzi, 2002). Zinc deficiency may however be decreased by HAART (Rousseau et al., 2000).

2.7.2.4 IRON

Iron deficiency is well known in Africa (Castaldo et al., 1996), and anemia, although not completely understood (Fuchs et al., 1993), appears widely among people living with AIDS (Castaldo et al., 1996). Anemia has been associated with HIV disease progression and an increased risk of death in these individuals (Moore et al., 1998). Van Staden et al. (1998) reported that almost 61 percent of the HIV-1 seropositive patients participating in their study had a statistically significant decrease in haemoglobin levels. Low haemoglobin levels have previously been associated with increased immune activation, low transferrin (Blumberg et al., 1984; Fuchs et al., 1993), increased ferritin levels (Blumberg et al., 1984; Fuchs et al., 1993; van Staden et al., 1998), and a reduction in serum iron binding capacity in AIDS patients. Anemia in HIV disease seems

not to result from iron, folate or vitamin B12 deficiency, but rather from marrow suppression by the disease itself, or it may be one of the side effects of Zidovudine (AZT) (Blumberg et al., 1984).

While increased levels of iron intake have been associated with a significant decreased progression rate to AIDS (Tang et al., 1993; USAID, 2001), iron supplementation might increase viral replication (Visser & Labadarios, 2004).

Iron metabolism may be disturbed as HIV progresses towards more advanced stages. This is accompanied by increased body iron stores, which potentially enhance oxidative stress, impairing several already compromised immune defense mechanisms (Boelaert et al., 1996), and predisposing to certain microbial infections (Boelaert et al., 1996; de Monye et al., 1999). The accumulation of iron may be ascribed to the body's attempt to withhold iron from the plasma, but factors including cigarette smoking, blood transfusions and the use of AZT may also play a role. Iron accumulates in macrophages, microglia, endothelial cells, and myocytes, and the iron burden is especially heavy in bone marrow, white brain matter, muscle and liver (Boelaert et al., 1996). HIV seropositive adults with high macrophage iron levels demonstrated to be more commonly infected with *Candida*, *Pneumocystis carinii* and mycobacterium. Shorter survival time has also been related to high iron stores (de Monye et al., 1999). The prevention or reduction of iron loading might retard the progression of the infectious complications of HIV infection. It has been proposed by Boelaert et al. (1996) that limitation of iron intake and the use of iron chelated drugs could help to decrease the iron burden, redistribute iron to the erythroblasts, and suppress the growth of microorganisms. In Southern Africa, traditional alcoholic brews that are very high in bio-

available iron, may further lead to dietary iron overload, particularly in rural Africans (Friedman et al., 1990).

2.8 NUTRITIONAL SUPPLEMENTATION: RESEARCH PROFILE

New studies suggesting that micronutrient supplementation may help to reduce morbidity and mortality during HIV infection, are now emerging (Semba & Tang, 1999). Vast amounts of money are spent annually on vitamin and mineral supplements in industrialized countries. In developing countries where HIV prevalence is extremely high, the identification of micronutrient deficiencies, and determination whether supplementation will improve clinical outcomes should be prioritized.

Dietary counselling and intervention based on the application of conventional criteria have shown to be ineffective in preventing progressive weight loss in HIV-infected patients, thus supporting the idea of nutritional supplementation (Chlebowski et al., 1995; de Luis Román et al., 2001). Lee (2002) argued “in a perfect world, eating a variety of healthy food is all a person living with HIV/AIDS would need to do in order to meet all their nutritional needs. But we do not live in a perfect world and a prudent amount of insurance in the form of a supplement makes sense, especially if the person living with HIV/AIDS has a poor appetite or is experiencing nausea”.

Not many clinical trials of micronutrient supplementation during HIV infection have been conducted. Most of these studies were pilot interventions with single micronutrients, and were conducted in populations at different risk for micronutrient deficiencies, making it difficult to make extrapolations to other populations (Semba & Tang, 1999). Although some of these trial studies have shown beneficial effects in HIV-infected individuals (de

Luis Román et al., 2001), Visser and Labadarios (2004) recently stated that it has not been conclusively demonstrated that nutritional supplementation enhances immunity or long-term outcomes in HIV/AIDS. Various methodological limitations have been questioned in many of the reported studies.

Skurnick et al. (1996) investigated vitamin supplement use and circulating concentrations of several nutrients and glutathione in heterosexual HIV-1 infected men and women. Although participants who took vitamin supplements had consistently fewer low concentrations of antioxidants, 29 percent of these patients still had below normal blood levels of one or more antioxidants. The researchers concluded that the use of micronutrient supplements might at least partially correct the micronutrient status of some HIV-1 patients.

Although the use of nutrient supplements may be valuable as additional therapy in the treatment of HIV/AIDS (Baum et al., 1991), the application of this therapy needs to be approached discreetly (Harbige, 1996). Meydani et al. (1991) warned that “the host stores of certain nutrients might be utilized by infectious organisms, and increasing those nutrients may aggregate the infection”. Certain micronutrients act in a synergistic way, necessitating the use of a multi-vitamin supplement to standardise the supply of other micronutrients (Jariwalla, 1995). The interactions and interdependence of nutrients during digestion, absorption and metabolism should therefore be carefully considered (Harbige, 1996).

Nutrient supplementation equalling RDA levels proved to be unsuccessful in correcting abnormal micronutrient levels in HIV infected individuals. Although nutrient requirements that exceed RDA levels have accordingly been suggested to correct these

imbalances (Baum et al., 1994), further research within the context of HIV/AIDS is imperative before any recommendations can be made (Visser & Labadarios, 2004).

It has been suggested that vitamin A supplementation may have clinical benefits for HIV-infected individuals. Particularly during early HIV infection when malabsorption of nutrients and metabolic problems are minimal, vitamin A supplementation can help to normalize serum levels of this nutrient (Ward et al., 1993). There is however little evidence that vitamin A supplementation beyond the correction of deficiency is beneficial in HIV infection (Tang & Smit, 1998; Kennedy et al., 2000), as studies failed to find a significant association between viral load and supplementation (Semba et al., 1998; Humphrey et al., 1999). Furthermore, megadoses (>20 000 IU) of vitamin A have been associated with increased mortality (Tang et al., 1996). HIV-seropositive women of childbearing age receiving either a single oral dose of 300 000 IU of vitamin A or placebo, showed no differences in any lymphocyte subset or activation marker, including CD4 percentage and CD8+CD38+. No significant clinical or immunologic adverse effects of megadoses of vitamin A were provided by the study (Humphrey et al., 1999). Further research has been suggested to clarify the potential clinical application of vitamin A supplementation in HIV-1 infection (Kennedy et al., 2000).

Early vitamin A supplementation during pregnancy has previously been associated with reduced mother-to-child transmission of HIV (Ward et al., 1993). However, Fawzi et al. (2000) reported from a large, double-blind, placebo-controlled Tanzanian study on pregnant women randomized to receive placebo, vitamin A, multivitamins excluding vitamin A, or multivitamins including vitamin A, that vitamin A supplementation was not significantly associated with a mean improvement in maternal CD4+, CD8 and CD3 cell counts. HIV-infected pregnant women received a daily vitamin A supplement, and/or

multivitamin B-complex, C and E, to examine the effect of vitamin supplements on genital HIV-1 shedding and interleukin-1 , a cytokine marker of vaginal inflammation and promoter of HIV infection. Significantly more women who received vitamin A had noticeable levels of HIV-1 in cervicovaginal lavage than those women not receiving vitamin A. Multivitamin B-complex, C and E showed no effect on the risk of viral shedding. This was not true of vitamin A. The authors thus expressed concern about the use of vitamin A supplements by HIV-1 infected women (Fawzi et al., 2004a).

Significant improvements in total white blood cell count, CD4 T-lymphocyte count, and CD4/CD8 ratio have been reported with beta-carotene supplementation among HIV-1 seropositive adults (Coodley et al., 1993). Beta-carotene supplementation has also been indicated as a decrease marker of lipoperoxides (Patrick, 1999), and an increased intake was associated with an improved survival rate (Tang et al., 1996). Studies conducted among adults in the USA and in Africa however confirmed that beta-carotene supplementation had failed to show significant or sustained improvements in viral load (Semba et al., 1998), immune status (Coodley et al., 1996; Fawzi et al., 1998), and diarrhea-associated morbidity (Kelly et al., 1999). HIV-infected adults already taking multivitamin supplements in Portland, Orego, did not seem to benefit from beta-carotene applied in megadoses (Coodley et al., 1996).

A clinical trial of vitamin E (800 IU/day) and C (1 000 milligram (mg)/day) supplementation in HIV-infected adults in Toronto Canada showed a reduction in oxidative stress and a trend towards decreased viral loads. These results make large clinical trials worth the while, particularly in patients who cannot afford new combination therapies (Allard et al., 1998). Oral supplementation with vitamin E and other nutrients

in Zambia, however did not affect either mortality or diarrhea morbidity, which could be ascribed to severe fat malabsorption in the late stage of the disease (Kelly et al., 1999).

Vitamin B6 supplementation during early HIV infection when malabsorption of nutrients and metabolic problems are minimal, can help to normalize serum levels of this nutrient (Baum et al., 1991). Although low plasma levels of vitamin B6 have not been associated with HIV progression (Tang et al., 1997a), supplement intakes more than double the RDA have been associated with increased survival rates in homosexual men infected with the virus (Tang et al., 1996). In cases where HIV positive patients are treated for TB, it is important to note that medication (Isoniazide) can increase vitamin B6 requirements.

As far as vitamin B12 replacement therapy in decelerating HIV progression is concerned, Tang et al. (1997b) reasoned that the effectiveness of supplementation is still unknown and requires further research.

Zinc supplementation has shown to be beneficial for people living with HIV/AIDS (Mocchegiani et al., 1995). Kupka and Fawzi (2002) stated that zinc supplements might be essential in HIV therapy, as this trace element plays a profound role in immune functioning. In Italy, a daily zinc supplementation of 200 mg/day administered for one month, decreased infectious disease morbidity, stabilized weight, and improved CD4 cell counts in adults with AIDS receiving ART (Mocchegiani et al., 1995).

A daily zinc supplement of 45.5 mg/day given together with Zidovudine over a period of one month, delayed the time to first opportunistic infection in disease stage III individuals, and overall decreased incidence of opportunistic infections by Candida

aesophagea and *Pneumocystis carinii* in patients with Stage IV infection. Body weight stabilized or increased, and an increase in both plasma zinc concentrations and CD4+ lymphocyte counts were noted. This was not the case in the group of Stage III or IV patients that did not receive the supplement. The authors stated that, if applied for short periods and carefully monitored, zinc supplementation may be beneficial to increase resistance to opportunistic infections (Mocchegiani & Muzzioli, 2000).

Contrary to the before-mentioned findings, zinc intakes higher than 20 mg/day were associated with a statistically significant twofold increased risk for progression to AIDS (Tang *et al.*, 1993). The same authors reported from a later study that dietary zinc intakes of 14 mg/day or more were significantly associated with poorer survival in AIDS patients (Tang *et al.*, 1996). However, the level of disease advancement, rather than the higher amounts of zinc intake could possibly be the main reason for the decreased survival in these patients. Another possible explanation is the fact that the HIV retrovirus is zinc-dependent, and an increase in its availability may promote HIV replication (Kupka & Fawzi, 2002).

In the Zambian study by Kelly *et al.* (1999), patient groups with persistent diarrhea received albendazole/placebo, or micronutrient supplementation (including 45.5 mg zinc/albendazole for two weeks. Patients were followed for three months to determine whether micronutrient supplementation could improve the effect of albendazole on reducing diarrhea. Groups showed no difference in mortality, CD4+ lymphocyte counts or diarrhea remission.

The conflicting results from zinc supplementation studies show that there is no firm and consistent evidence of improved outcome in HIV-infected adults (Coovadia & Bobat,

2002). Zinc supplementation should be applied cautiously, because its recommended intake range is narrow (Woods & Gorbach, 1999), but if applied in correct dose it may improve CD4+ cell counts, increase cell mediated immunity and decrease apoptosis (Coovadia & Bobat, 2000). Siberry *et al.* (2002) however warned that in developing countries where zinc deficiency and HIV prevalence are high, the potentially different effects of zinc supplementation in HIV-infected individuals compared to the recognized advantages in uninfected people must be considered before starting population-based zinc supplementation programmes to reduce respiratory and diarrheal illnesses. More research in this field has been proposed, particularly to determine the optimal level of zinc intake in HIV-1 infected individuals (Tang *et al.*, 1996), and to determine whether supplementation can delay disease progression and reduce mortality and morbidity (Coovadia & Bobat, 2002).

Selenium supplementation may reduce the impact of oxidative stress, and assist in increasing the enzymatic defense system in HIV-infected subjects. These findings necessitate future studies to determine and evaluate the effect of this trace mineral in HIV disease progression (Delmas-Beauvieux *et al.*, 1996).

In a recent study in Dar es Salaam, Tanzania, 1 078 pregnant women with HIV infection received daily supplements of vitamin A alone (preformed vitamin A and beta-carotene), multivitamins (vitamin B-complex, C and E), multivitamins plus vitamin A, or placebo to determine the risk of clinical disease progression, CD4+ cell counts and viral load. Doses were multiples of the RDA, but within safe levels, in order to maximize the likelihood of a beneficial effect. The group who received multivitamins showed a reduction in the relative risk of death related to AIDS, significantly higher CD4+ and CD8+ cell counts, and significantly lower viral loads. Vitamin A alone showed smaller

effects and mostly did not differ significantly from those produced by placebo. The addition of vitamin A to the multivitamin reduced the benefit of some of the studied outcomes (Fawzi et al., 2004b).

According to Stack et al. (1996), a healthy diet, accompanied by high-energy, high-protein dietary supplements may help to attain sufficient nutrient intakes during the early period of viral replication. Specialized diets such as those high in medium-chain triglyceride oil, which will be beneficial to patients with fat malabsorption, may however become necessary when secondary infections set in (Craig et al., 1994). The effect of high-energy, high-protein, oral, liquid, nutrition supplementation and nutrition counselling on the weight status of HIV-infected or AIDS patients was evaluated by Stack et al. (1996). Together with counselling, weight gain and maintenance were accomplished with this treatment. The authors therefore recommended a high-protein diet, accompanied by foods that limit gastrointestinal complications, for HIV/AIDS patients. The majority of the patients in the study who developed a secondary infection, however lost weight despite the use of supplements and counselling. According to Visser and Labadarios (2004), oral, liquid nutritional supplements are useful to provide extra energy when optimal food ingestion may be inadequate, and can contribute significantly to the maintenance of body weight.

As previously discussed, fatty acids such as omega-3 fatty acids commonly found in fish oils and seeds, play a role in the body's response to inflammation, and help to reduce the impact of cytokines such as interleukin-1 and TNF that promote wasting. A daily fish oil supplement given to sixteen men with AIDS in the USA for ten weeks, resulted in weight gain, but only in patients who did not develop new AIDS-related complications. Fish oil supplementation may therefore benefit some AIDS patients, while in others it

may be unable to counteract the metabolic consequences of acute infections (Hellerstein et al., 1996).

The application of nutritional supplementation in conjunction with a dietary counselling programme in HIV infection is supported by de Luis Román et al. (2001). In their study, HIV-patients on HAART (with or without AIDS) who received oral nutritional supplementations (standard enteral formula, or enterotrophic peptide-based enteral formula enriched with omega-3 fatty acids) for three months, showed a significant and sustained increase in weight, while an increase in CD4+ cell count was noted in the group receiving the enriched formula. The increase in weight however was mainly due to fat mass, while total body water and fat-free mass remained unchanged.

Berneis et al. (2000) also assessed the effect of an oral nutritional supplement in conjunction with nutritional counselling on whole protein metabolism. Data from this study demonstrated an anabolic effect of nutritional supplements together with dietary counselling. Diminished whole body protein catabolism resulted in increased lean body mass and decreased fat mass.

The anabolic role of glutamine-antioxidant supplementation, together with nutritional counselling, was evaluated in HIV patients who experienced more than 5 percent weight loss since disease onset. The supplement containing the amino acid glutamine, vitamin C and E, beta-carotene, selenium and N-acetyl cysteine, resulted in increases in body weight, body cell mass and intracellular water, and improved gut integrity. The authors concluded that this low-cost, low-risk supplement may be chosen to initially support HIV patients with weight loss exceeding 5 percent (Shabert et al., 1999).

Answering questions such as whether the micronutrients in supplements will be as well-absorbed in patients with asymptomatic HIV infection, whether the content of these supplements needs to be higher in HIV infected patients with diarrhea and malabsorption, and whether supplements will reduce morbidity and mortality during HIV infection, should rank high on the priority list for future research (Semba & Tang, 1999).

The question whether nutritional therapy can reverse weight loss and wasting in an African context however still exists. Relatively few HIV-infected people in Africa are aware of their HIV status in the early stages of infection, when simple, affordable nutrition supplementations and counselling may be practicable. When HIV status is revealed in the later stages of the disease, supplementation and counselling may be less effective (Piwoz & Preble, 2000).

Other questions now being raised as Africa is entering the era of greater access to ART, are whether multivitamin supplementation can delay the initiation of ART and reduce mortality. Large trials and assessment of outcomes such as mortality, will present evidence to provide scientifically based recommendations regarding the use of multivitamin supplementation for patients with HIV and AIDS, and for treatment programmes in Africa (Marston & De Cock, 2004).

2.9 MANAGEMENT STRATEGIES

In this section, support options for HIV/AIDS patients will be discussed.

2.9.1 NUTRITIONAL SUPPORT

HIV-related malnutrition should be aggressively evaluated and treated. The rationale for nutritional support for HIV/AIDS patients is based on the hypothesis that nutritional status can be improved, resulting in clinical benefits for the patient, including improvement of immune function and other clinical parameters, such as antimicrobial resistance, quality of life, and physical and mental performance (Gramlich & Mascioli, 1995; Babameto & Kotler, 1997; Keithley, 1998). Specific nutritional recommendations should be based on the stage of HIV infection of the individual, and whether opportunistic infections are present or not (Babameto & Kotler, 1997).

Ideally, nutrition intervention should be started when HIV is diagnosed (Gorbach et al., 1993; Babameto & Kotler, 1997). Traditionally, nutritional assessment and intervention were neglected until the AIDS patient reached a stage of significant malnourishment. Fortunately, there has been a shift towards earlier routine assessment and counselling for patients (Chlebowski et al., 1995; Stack et al., 1996; Keithley, 1998), which may improve the outcome of the disease. Supplementation can therefore also be introduced at an early stage of HIV infection (Jariwalla, 1995).

Education focusing on the prevention of malnutrition, and the importance of a corrective diet to maintain or improve nutritional status, should be considered as the foremost approach for nutrition therapy (Jariwalla, 1995; Babameto & Kotler, 1997; Fenton & Silverman, 2004, p. 1047). More sophisticated support may however be required during the late stage of the disease (Gorbach et al., 1993). Nutrition counselling should address the nutritional implications of the disease, including the increased risk for opportunistic infections and faster disease progression when nutritional status is

substandard. Principles of good nutrition, particularly the importance of a daily vitamin/mineral supplement and the consumption of a wide variety of nutritious and nutrient-dense foods from each of the food groups, should be part of any dietary regimen (Gorbach *et al.*, 1993; Keithley, 1998). The South African Department of Health compiled a manual on nutrition for people living with TB, HIV/AIDS and other chronic debilitating conditions (DoH, SA, 2001). The messages of “eat a variety of foods, make starchy foods the basis of each meal, eat lots of fruits and vegetables, meat and dairy foods may be eaten daily, eat dried beans, peas, lentils, peanuts or soya regularly, include sugars, fats and oils, use salt sparingly, drink lots of clean, safe water and do not take alcoholic drinks”, emphasize the importance of healthy and varied food choices for these patients.

Another essential aspect that needs to be attended to during therapy is the management of common nutrition-related symptoms such as lack of appetite, nausea/vomiting, sore mouth and throat and diarrhea. To improve the efficacy of techniques that deal with these problems, it is important that it should be individualized, and developed together with the patient and/or caregivers (Keithley, 1998). The treatment of oral and esophageal diseases and the use of appetite stimulants will further help to promote oral food intake (Gramlich & Mascioli, 1995).

Food and water safety issues are critical in HIV-infected patients (Gorbach *et al.*, 1993; Keithley, 1998). HIV/AIDS patients are highly susceptible to infection by food-poisoning bacteria such as Salmonella, Campylobacter and Yersinia, and contact with these microorganisms causes a lifelong infection that cannot be cured by antibiotics (Gorbach *et al.*, 1993). In order to decrease the risk of food and water-related infections, patients should be educated on strategies for the safe handling and storage of foods (Casey,

1997b; Keithley, 1998). Food should be kept at temperatures that will prevent bacterial overgrowth, perishable foods should be refrigerated as soon as possible and frozen foods should be thawed in a microwave oven or refrigerator (Gorbach et al., 1993; Casey, 1997b). Eggs, meats, and fish should be thoroughly cooked, and unpasteurised milk and untreated water should be avoided. Cooking utensils and cutting boards should be properly cleaned (Casey, 1997b; Keithley, 1998), and separate cutting boards should be used for raw and cooked foods. Fresh fruit and vegetables should be thoroughly washed, and raw protein foods such as raw eggs and meat should not be consumed. Hands should be thoroughly washed before handling food, and cross-contamination between raw meat or poultry and salads or fresh fruits should be avoided (Gorbach et al., 1993; Cimoch, 1997).

When oral food intake alone becomes inadequate, enteral nutrition may be initiated as support therapy (Gramlich & Mascioli, 1995; Cimoch, 1997). This may be used in addition to oral or parenteral feeding, or on its own when gastrointestinal function is preserved (Cimoch, 1997).

Parenteral nutrition is the only alternative option when all attempts to feed the patient by mouth failed, and the patient continues to lose weight (Cuff, 1990). Parenteral nutrition becomes necessary in cases of refractory vomiting, bowel obstruction, and severe secretory or intractable vomiting, or when enteral feeding is contra-indicated or cannot be tolerated by the patient (Gramlich & Mascioli, 1995; Cimoch, 1997).

In a study by Ireton-Jones and Stiller (1998), AIDS patients receiving home total parenteral nutrition, demonstrated an average of 5.5 kg increase in body weight, and a 3 kg increase in lean body mass over the period of the study. The control group who only

received nutritional counselling, lost an average of 5 kg of body weight, and 3 kg of lean body mass. The changes in these parameters were however not statistically significant.

2.9.2 PHYSICAL ACTIVITY

Physical activity seems to be promising in various areas of HIV infection. Exercise is therefore increasingly being advocated as a beneficial addition to the health treatment of HIV-infected individuals (Jones et al., 2001). Physical activity may be a therapeutic method capable of improving appetite and energy levels (USAID, 2001), which will in turn enhance overall physical, emotional and psychological well-being (Lox et al., 1995; USAID, 2001), by neutralising the effects of anxiety and depression associated with HIV diagnosis (Birk, 1996; USAID, 2001). Physical activity may be useful to improve quality of life (Stringer et al., 1998; Stringer, 1999; Yarasheski & Roubenoff, 2001), and to increase strength and functional capacity of the individual living with HIV (Evans et al., 1998).

Many recent studies have been focusing on the role of aerobic and resistance training in HIV/AIDS. Aerobic exercise as part of social and everyday activities such as walking, cleaning and collection of firewood or water is considered important for the HIV-infected individual, and should be sustained as long as patients are physically able to do so (USAID, 2001). Aerobic exercise training *per se* has also indicated to be an effective non pharmacological treatment to manage HIV-related complications such as alterations in body composition and metabolism (Yarasheski & Roubenoff, 2001). In patients on HAART with lipodystrophy syndrome, body composition and blood lipid profiles may be improved by a combination of aerobic exercise and resistance training (Jones et al., 2001).

Loss of muscle mass early in HIV disease progression may result from low levels of physical activity. There is thus potential in exercise to treat losses of muscle size (Evans *et al.*, 1998). Resistance exercise in particular may be important in maintaining body mass (Birk, 1996), and increasing lean body mass (Roubenoff *et al.*, 1999), in HIV-infected patients with or without wasting (Birk, 1996).

Guidelines for exercise in HIV lack scientific support (Terry *et al.*, 1999), as studies on the effect of exercise training on immunologic markers (CD4, CD8 and CD4:CD8 ratio), and anthropometric measures have shown conflicting results. It has been suggested that HIV-seropositive individuals that participate in moderate and high intensity exercise programmes can increase their functional capacity (Stringer, 1999; Terry *et al.*, 1999), without any obvious changes in immunological indices (Birk, 1996; Stringer *et al.*, 1998; Shephard, 1998; Terry *et al.*, 1999), viral replication (Stringer *et al.*, 1998), or anthropometric measurements (Terry *et al.*, 1999).

Although a nonsignificant increase in immune function has been observed in mildly immunocompromised HIV subjects, and lymphocyte counts have shown to improve as fitness is enhanced in HIV negative persons, no increase in CD4 count can be expected in severely immuno-compromised individuals (Birk, 1996). Mustafa *et al.* (1999), who studied the association between exercise and HIV disease progression in a cohort of homosexual men, reported an increase in CD4 cell count, indicating that moderate physical activity may slow HIV disease progression.

It is suggested that patients start exercising slowly, for instance to start walking for twenty minutes three times a week, and then gradually increase the amount of exercise

to thirty minutes four times a week (Information from Your Family Doctor, 1999). The South African manual on nutrition for people living with TB, HIV/AIDS and other chronic debilitating conditions should also be followed in this regard (DoH, SA, 2001). Before beginning an exercise programme, it should be approved by a medical practitioner. Resistance exercise does not require any special exercise equipment. Objects such as food cans, books or other objects available in the house may be used with effects similar to that of specialized equipment. As with aerobic exercise, the individual should increase his strength gradually with light weights for short periods. When not feeling well, exercise should be reduced or stopped for a while (Information from Your Family Doctor, 1999).

Exercise is both a safe and effective therapy for HIV positive individuals, and can therefore be promoted with confidence in patients with early to moderately advanced HIV infection (Shephard, 1998; Stringer et al., 1998; Stringer, 1999), and it may be used as alternative or adjunct to pharmacological anabolic treatments (Roubenoff et al., 1999). Although exercise *per se* may not significantly retard AIDS progression and the subsequent onset of AIDS, it does not appear to intensify HIV (Birk, 1996). The ability to exercise may however be compromised by deteriorations in cardiorespiratory and neuromuscular function in patients with fully developed AIDS (Shephard, 1998). Severe exercise training to the level of muscle damage and/or staleness can however have negative implications for many aspects of immune function, including resistance to infections (Shephard & Shek, 1994).

2.9.3 NUTRITIONAL SUPPLEMENTATION

There are currently no RDA's for people living with HIV. Fawzi et al. (2004b) suggested that multivitamin supplementation with the doses used in their study on pregnant women may be beneficial for HIV-infected individuals before starting with ART (Fawzi et al., 2004b). With the WHO and UNAIDS (2003b) global initiative to treat 3 million people with HIV/AIDS in developing countries by 2005, multivitamins might help to delay the need for ART, saving resources and preserving therapeutic options (Fawzi et al., 2004b).

Table 2.3, based on studies reviewed by Woods and Gorbach (1999), and the trial by Fawzi et al. (2004b), was compiled to show provisional recommendations made for HIV positive adults for selected micronutrients. Current RDA's and Upper Limits for healthy adults have been incorporated to simplify comparisons.

Table 2.3: Provisional recommendations for selected nutrients for HIV positive patients (Adapted from Woods & Gorbach, 1999 and Fawzi *et al.*, 2004b. RDA's and tolerable Upper Limits adapted from Mosen, 2000 and Trumbo *et al.*, 2001

NUTRIENT	RDA FOR HEALTHY MEN	RDA FOR HEALTHY WOMEN	UPPER LIMIT	PROVISIONAL RECOMMENDATIONS FOR HIV PATIENTS/DAY	
				Woods & Gorbach, 1999	Fawzi <i>et al.</i> , 2004b
Vitamin A (µg)	900	700	3 000	1 000	
Beta-carotene (mg)	No RDA	No RDA	No upper limit	15 (diet only)	
Vitamin E (mg)	15	15	1 000	133-267	30
Vitamin C (mg)	90	75	2 000	200-500	500
Selenium (µg)	55	55	400	100-200	
Thiamin (mg)	1.2	1.1	No upper limit	2.6	20
Riboflavin (mg)	1.3	1.1	No upper limit	2.2-6.5	20
Niacin (mg)	16	14	35	35	100
Vitamin B6 (mg)	1.3	1.3	100	3-8.5	25
Folate (µg)	400	400	400-800	1 000	800
Vitamin B12 (µg)	2.4	2.4	No upper limit	5-12	50

2.9.4 PHARMACOLOGICAL THERAPIES

Various pharmacological therapies have been developed to support HIV/AIDS patients to improve their nutritional status and prevent wasting.

2.9.4.1 ART

Three categories of antiretroviral drugs, namely the nucleoside reverse transcriptase inhibitors, protease inhibitors, and non-nucleoside reverse transcriptase inhibitors form

the mainstay of HIV/AIDS therapy (Jones, 2001).

Nucleoside reverse transcriptase inhibitors work early in the viral life cycle by blocking the core enzyme reverse transcriptase that is necessary for viral replication, and they terminate DNA chain formation (Keithley, 1998; Jones, 2001).

Protease inhibitors work at a later stage in the viral life cycle, and block the activity of the viral protease. They prevent the formation of mature, infectious viruses (Keithley, 1998; Jones, 2001).

Non-nucleoside reverse transcriptase inhibitors work by blocking reverse transcriptase activity by directly binding to it (Keithley, 1998), preventing the enzyme from converting HIV RNA into DNA (Jones, 2001).

HAART usually consists of a combination of at least three antiretroviral agents (Fenton & Silverman, 2004, p. 1038). These powerful drug combinations have brought about a dramatic improvement in HIV/AIDS survival rates (Carr & Cooper, 2000; Gomez *et al.*, 2002), with major reductions in opportunistic complications and almost complete suppression of HIV-1 replication (Carr & Cooper, 2000). Many people living with HIV infection today feel healthy and live almost normal lives, instead of becoming sick and dying of this disease (Jones, 2001). The drug combination prescribed to a patient is determined by factors such as the stage of the disease and previous drugs taken by the patient (Jones, 2001).

However, since the late 1990's, some disturbing clinical and metabolic abnormalities have been recognized under the banner of lipodystrophy in individuals receiving this

medication, particularly the protease inhibitors (Hadigan et al., 2001; Mayer et al., 2001; Salomon et al., 2002). Changes in body composition may be seen in various anatomic areas in HIV infected individuals, and manifest in most patients as a mixed syndrome of lipohypertrophy and lipoatrophy (Salomon et al., 2002).

Lipodystrophy syndrome refers to body fat redistribution, which becomes evident as peripheral fat loss (lipoatrophy in the face, limbs and buttocks), and central fat accumulation (lipohypertrophy) in the abdomen (Carr et al., 1998; Lo et al., 1998), with the waist-hip-ratio (WHR) exceeding 0.85 centimeters (cm) in women (Mayer et al., 2001), increased adiposity in the breasts or subcutaneous tissue (lipomas), and over the dorsocervical area of the neck, commonly known as the “buffalo hump” (Carr et al., 1998; Lo et al., 1998). Thinning of the arms and legs may also be seen (Fenton & Silverman, 2004, p. 1046). Lean body mass however remains unchanged (Safrin & Grunfeld, 1999; 2001; Mayer et al., 2001).

Metabolic features associated with lipodystrophy and HAART include insulin resistance, glucose intolerance, type 2 diabetes (Keithley, 1998; Martinez & Gatell, 1998; Fisher, 1999; Ducobu & Payen, 2000; Dube, 2000; Salas-Salvadó & Garcia-Lorda, 2001), hypertriglyceridemia (Keithley, 1998; Carr et al., 1998; Mulligan et al., 2000; Fenton & Silverman, 2004, p. 1046), hypercholesterolemia, (decreased HDL versus increased LDL) (Carr et al., 1998; Mulligan et al., 2000; Gomez et al., 2002), and hypertension (Hadigan et al., 2001). This clustering of metabolic disturbances simulates features seen in the metabolic syndrome (Ware et al., 2002). Therefore, although new therapies contribute significantly to the prognosis of HIV patients, they increase the risk for cardiovascular complications (Ducobu & Payen, 2000; Hadigan et al., 2001; Gomez et al., 2002).

Other complications that have emerged include osteopenia, osteoporosis (Fenton & Silverman, 2004, p. 1042), drug hypersensitivity, and mitochondrial toxicities, of which lactic acidosis and pancreatitis are the most serious ones (Carr & Cooper, 2000).

Whereas nutrition advice to a patient traditionally would be to maintain energy intake, probably by means of energy-dense high-fat foods in order to prevent wasting associated with disease progression (Ware et al., 2002), the metabolic alterations being observed with new therapies need a different approach. Structured exercise, a low-fat diet, smoking cessation and weight loss for obesity, could probably help to improve the overall cardiovascular profile of patients on therapy (Salomon et al., 2002). The balance of macronutrients and micronutrients within the diet may modulate the disease process and possibly the response to these therapies. Low-fat, high-carbohydrate diets should however not be recommended until the pathophysiology of the metabolic syndrome has been completely unveiled (Ware et al., 2002). Prospective studies to facilitate suitable risk management decisions warrant attention (Miller et al., 2000).

The response of a patient to drug therapy is mainly influenced by the nutritional status before therapy is commenced, and the patient's ability to consume and tolerate an adequate food intake during therapy. Malnourished patients with decreased serum proteins may not fully benefit from certain drug therapies, because many drugs, particularly protein-bound drugs, are bound to, or dependent on serum proteins for delivery and use by their target cells (Cimoch, 1997).

2.9.4.2 OTHER PHARMACOLOGICAL THERAPIES

As discussed elsewhere, cytokines such as TNF- α and interleukin-1 may be partially responsible for anorexia and metabolic changes associated with HIV/AIDS malnutrition. Some cytokine inhibitors are being investigated for their positive effect on appetite and weight gain, but larger clinical trials are needed to demonstrate whether these agents indeed have a long term influence on these aspects (Keithley, 1998).

Appetite stimulants, including Megestrol acetate, dronabinol, and experimentally, medical marijuana, are appetite stimulants used to counteract HIV-associated anorexia. Weight gain from these agents is primarily fat (Fenton & Silverman, 2004, p. 1045).

Some option therapies to treat underlying hormonal irregularities, loss of body cell mass and wasting, include hormonal therapy, anabolic steroids, and human growth hormone (Fenton & Silverman, 2004, p. 1045). Anabolic agents can reverse weight loss and increase lean body mass in HIV-associated wasting (Salomon *et al.*, 2002). This treatment however requires adequate food intake and progressive resistance exercise to maximize increases in body cell mass. Growth hormone has shown to improve nitrogen balance and increase lean body mass (Nemechek *et al.*, 2000; Fenton & Silverman, 2004, p. 1045), and has proven to maintain body weight in AIDS patients (Nemechek *et al.*, 2000). However, side effects including elevated blood glucose levels, mood changes, skin disorders, abnormal hair growth, menstrual irregularities, changes in libido and potency, fluid retention, and abnormal liver enzymes have been reported for patients on this therapy (Fenton & Silverman, 2004, p. 1045). Growth hormone is also unaffordable by many people living with HIV/AIDS (Keithley, 1998).

2.9.5 ALTERNATIVE REMEDIES

Some people infected with HIV become frustrated with the disease and the lack of definitive medical therapies, and therefore seek help in alternative treatment or traditional medicines in their search for answers to control the disease (Fenton & Silverman, 2004, p.1054). These therapies should however be approached carefully as some products which are claimed to be beneficial, may in fact be detrimental to health (Visser & Labadarios, 2004).

Diets such as the anti-Candida diet, the macrobiotic diet and herbal mixtures that are advocated for relief of HIV-related symptoms have not been subjected to adequate formal clinical research (Visser & Labadarios, 2004). Some herbs, including St John's Wort, which have been considered as safe, are now contra-indicated when used with antiretroviral drugs (Visser & Labadarios, 2004; Fenton & Silverman, 2004, p. 1054). The herbs ginkgo biloba and ginseng, also frequently used by HIV/AIDS patients, may both increase bleeding when taken with other blood-diluting medications or supplements (Visser & Labadarios, 2004). There is also concern about silymarin, the flavonoid extract from *Silybum marianum* (milk thistle) that could reduce metabolism of coadministered medications and increase toxicity. Echinacea, cat's claw and Chinese herbs are also oftenly used. Some patients use techniques such as Reiki, massage, yoga and acupuncture (Fenton & Silverman, 2004, p. 1054).

The safety and efficacy of other alternative treatments such as arginine, carnitine, coenzyme Q10, colostrum, dehydroepiandrosterone, lipoic acid, N-acetylcysteine and whey protein have not been sufficiently evaluated (Visser & Labadarios, 2004).

Questions to consider in assessing alternative therapies include the following:

- “Is the product or treatment healthful?”
- Are there harmful drug-drug interactions with prescription or over-the-counter medications or nutrients?
- Are unproven treatments being used, while delaying effective conventional treatment(s) and possibly missing important windows of opportunity?
- Does the therapy work?
- Is the financial expense worth the benefit”?

Additionally, patients should be wary of promotion campaigns using sensationalism, testimonials, or claims that they are based on secret formulae, or literature accusing the government or physicians of neglect (Fenton & Silverman, 2004, p.1054).

With recent press releases about the benefits of treating HIV with certain single foods or food combinations, the question rises whether current recommendations should be revised and food combinations rather been prescribed (Nutrition Information Centre, University of Stellenbosch (NICUS), 2003). In this context, beetroot, onions, garlic, extra virgin olive oil and the African potato are commonly prescribed or recommended foods. There is to date however no convincing or consistent scientific evidence that any of these foods, single or in combination, can transform the course of HIV or any other disease (Visser & Labadarios, 2004).

Beetroot has received some attention as treatment for anemia in people living with HIV/AIDS. This vegetable can however not be used to treat iron deficiency anemia or HIV/AIDS. It has also been suggested that iron supplementation in HIV/AIDS patients may lead to increased viral replication (Visser & Labadarios, 2004).

The antioxidant properties of the phytochemicals present in onions and garlic are well recognized. Besides all the known benefits associated with onion and garlic ingestion, it has not been scientifically proven that these commodities will increase immunity or alleviate HIV-related symptoms successfully. Garlic supplements have also received attention for their role in reducing serum cholesterol levels associated with the use of ART. The marginal nature of the beneficial effect documented from two meta-analyses, makes this a debatable topic. Additionally, it has been documented that garlic extract supplements have been indicated to induce drug-nutrient interactions (sharply reduced blood concentrations of Saquinavir used in HIV treatment). Consequently HIV/AIDS patients should avoid these supplements if using Saquinavir as a single anti-protease (Visser & Labadarios, 2004).

Extra virgin olive oil may have some health-promoting benefits for people living with HIV/AIDS, particularly those on ART with lipodystrophy syndrome. There is however no convincing or consistent scientific evidence that this food commodity can boost the immune system or change the course of the disease. In addition, extra virgin olive oil is expensive, and can limit available finances for other healthy foods (Visser & Labadarios, 2004).

The safety of the African potato as treatment for HIV/AIDS has been seriously questioned. In one study, severe bone marrow suppression was observed after eight weeks of treatment, leading to early termination of the study. After an initial increase in total lymphocyte count and absolute CD4 cell count, these parameters decreased significantly. Until the safety and efficacy of such supplements have been resolved, HIV/AIDS patients should avoid using them (Visser & Labadarios, 2004).

It is clear that long-term intervention studies are necessary before these food claims can be made. Unless safety concerns have not been resolved, such as in the African potato, people can however consume onions, garlic, beetroot and extra virgin olive oil if preferred, and if they make them feel better (NICUS, 2003).

2.9.6 WHAT DOES THE FUTURE HOLD?

As far as future treatments are concerned, the development of new international vaccines brings hope for eradicating HIV. Some of these vaccines use harmless parts of the HIV, in the hope that the immune system will recognize the virus, and avoid attack by the intact virus. HIV is however a versatile virus that can quickly alter its genetic structure. The efficacy of these vaccines should therefore be questioned. The effect of structured medication interruptions or “drug holidays” is also evaluated to determine whether patients can safely discontinue the use of some drugs at certain times in the medication cycle without the virus being replicated. Although some success have been documented with this approach, the long-term implications still have to be determined (Jones, 2001).

HIV remains a major health threat. However, novel therapies cause some optimism regarding the expectance of HIV suppression. These new drugs have helped to transform the disease from a fatal condition to a chronic, manageable viral infection (Roberts, 1996; Jones, 2001).

2.10 SUMMARY

AIDS is caused by the human immunodeficiency virus, which is a retrovirus. This virus targets the T lymphocytes and macrophages of the immune system where new viral particles are being produced. The hallmark of the disease is the resulting dramatic decrease in immune function. HIV is predominantly a sexually transmitted disease, and is transmitted by both homosexual and heterosexual contact. Heterosexual transmission is worldwide the most common way of infection, particularly in developing countries. HIV infection develops through four main stages, namely acute HIV infection, asymptomatic HIV infection, symptomatic HIV infection, and AIDS, which is the severe form of the disease.

The pathogenesis of malnutrition in HIV/AIDS is multi-faceted, with the major contributors being decreased food intake, malabsorption, metabolic changes, depletion of antioxidant nutrients, accompanied by increased nutritional needs and increased tissue catabolism. Malnutrition may alter immune function, leading to faster disease progression, quicker onset of weight loss and wasting, and increased morbidity and mortality. The weight loss and wasting typically found in HIV/AIDS-infected individuals, is a severe nutritional manifestation of the disease, and are major causes of morbidity and mortality. Co-infection with HIV and TB worsens this phenomenon. It has been hypothesized that high levels of leptin may play a role in AIDS-associated wasting. Although wasting has become less common with the application of ART, a new problem of fat redistribution or lipodystrophy has evolved. Contrary to weight loss and wasting, is the evidence of obesity in HIV infection that has been reported in some patients. Macronutrient and micronutrient deficiencies are well-documented consequences of HIV/AIDS. Many recent studies have therefore been focussing on the use of nutritional

supplementation to improve immune function and anthropometric profiles, and to reduce disease-associated morbidity and mortality.

Although nutritional support will not cure patients, it should be part of any management programme for HIV/AIDS patients. Good nutrition will impact positively on immunity and facilitate the well-being and quality of life of patients. A corrective diet, consisting of safe food and water, accompanied by nutritional supplementation, and the treatment of symptoms such as appetite loss, vomiting, a sore mouth and throat and diarrhea, will be beneficial to patients. Physical activity is also now being advocated as part of the treatment of HIV-infected patients. This therapy should be sustained as long as the patient is physically able to do so, as it can make many positive contributions towards the general well-being of the person living with HIV. Nutritional supplementation may be beneficial for health maintenance and improved immunity of the patient living with HIV and AIDS. However, more research has been suggested in some areas of supplementation.

Although ART has changed HIV/AIDS from a fatal to a chronic disease, this therapy cannot be afforded by millions of patients in developing countries. Additionally, the unique side effects that have emerged with the use of these new drugs should be a matter of concern.

The use of alternative therapies to control HIV/AIDS has received wide attention in recent years. These treatments have however not been subjected to adequate formal clinical research, and some could in fact be detrimental to health.

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CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter the specific apparatus, techniques, test sample and procedures used for the study will be discussed. The methods for statistical analyses of the data are also included.

Within the larger study, the researcher was involved in the design and adaptation of socio-demographic and food frequency questionnaires. Furthermore, the researcher formed part of the team that collected the data on anthropometry and dietary intake, and assisted in the collection of blood samples.

3.2 STUDY DESIGN

A cross-sectional study was undertaken. Figure 3.1 shows the framework to determine the health and nutritional status of HIV positive and HIV negative women (25-44 years), in Mangaung.

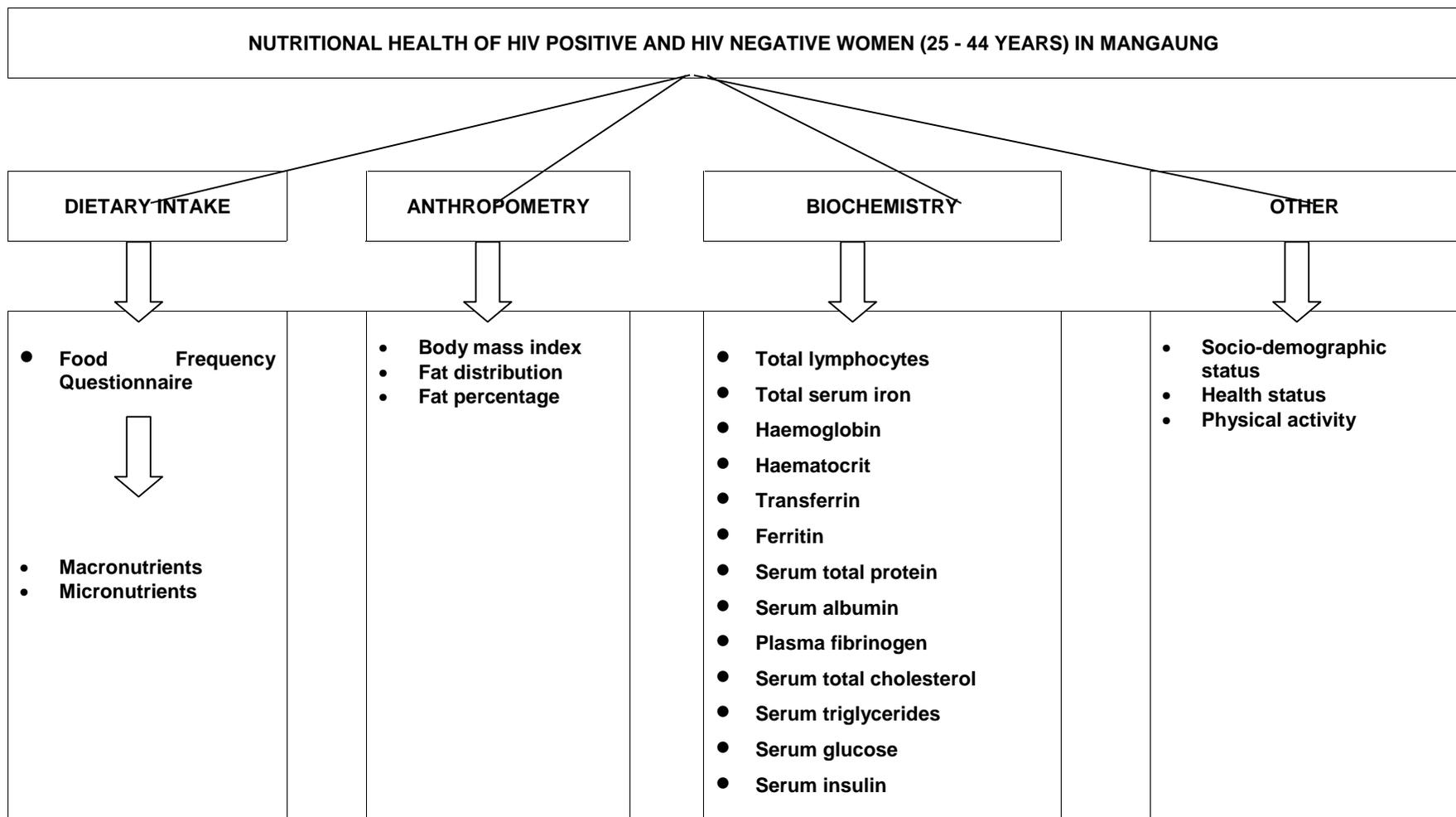


Figure 3.1: Framework to determine the health and nutritional status of HIV positive and HIV negative women (25-44 years) in Mangaung

3.3 OPERATIONAL DEFINITIONS

Variables defined to meet the objectives of this study, included socio-demographic status, anthropometry, dietary intake, levels of physical activity, health status, and biochemical parameters.

3.3.1 SOCIO-DEMOGRAPHIC STATUS

For the purpose of this study, socio-demographic status refers to the number of years residing in an urban area, smoking habits, household composition, marital status, highest level of education, employment status of the respondent or husband/partner, head of the household, type and size of dwelling, income and amount of money spent on food weekly.

3.3.2 ANTHROPOMETRY

Anthropometry includes waist-hip-ratio (WHR), body mass index (BMI), waist circumference and fat percentage.

3.3.2.1 WHR

WHR refers to the ratio of the waist circumference and the hip circumference. Cut-off points used for this study were a waist-hip circumference ratio of ≥ 0.8 in the African women, that indicated an android fat distribution (Hammond, 2000, p. 372), and a WHR of <0.8 , indicating a gynoid fat distribution.

3.3.2.2 BMI

BMI refers to weight (kilograms) / height (meters²), and was categorized as BMI <18.5 kg/m² (underweight), BMI 18.5-24.9 kg/m² (normal weight), BMI 25-29.9 kg/m² (overweight) and BMI ≥ 30 kg/m² (obese) (Laquatra, 2004, p. 565).

3.3.2.3 WAIST CIRCUMFERENCE

Waist circumference refers to the minimal abdominal circumference located midway between the lower rib margin and the iliac crest (Lee & Nieman, 1996, p. 245). Cut-off points used for this study were a waist circumference <88 cm, that indicated a normal waist circumference, and ≥88 cm, that indicated a high waist circumference (Smolin & Grosvenor, 2000, p. 213).

3.3.2.4 FAT PERCENTAGE

Fat percentage refers to the percentage of fat tissue in the body as measured by bioimpedance (Bodystat R 1500 – Bodystat, Isle of Man, Limited; Pressman & Adams, 1990, p. 52; Lee & Nieman, 1996, p. 272; Hammond, 2004, p. 428).

Fat percentages were categorized as <20 (low), 20≤25 (normal), and >25 (high) (Laquatra, 2000, p. 488).

3.3.3 DIETARY INTAKE

For the purpose of this study, dietary intake refers to the habitual types, quantities and frequency of food and drink consumed daily, weekly and monthly (Dwyer, 1998, p. 942; Hammond, 2004, p. 418), over a period of six months prior to the study.

All nutrients that have a Recommended Dietary Allowance (RDA) or Adequate Intake (AI) were categorized as <67 percent or ≥67 percent of the recommended dietary intake in order to determine the adequacy of dietary intake.

3.3.4 LEVEL OF PHYSICAL ACTIVITY

Physical activity refers to the levels of habitual physical activity, structured around household and gardening activities, activities at the workplace, transport and leisure time activities. Physical activity levels were categorized as <4 (low level of activity), 4<6 (moderate level of activity), and >6 (high level of activity).

3.3.5 HEALTH STATUS

For the purpose of this study, health status includes blood pressure, the use of chronic medication, the presence of visible/tangible jaundice, anemia, clubbing, cyanosis, glands, oedema, cardiovascular- or respiratory abnormalities, abdominal pathology, and whether respondents wanted to be informed about their HIV/AIDS test results.

3.3.6 BIOCHEMICAL PARAMETERS

Biochemical parameters were categorized as follows:

- Total lymphocytes: $0.8-3.3 \times 10^9$ /Liter (L).
- Haemoglobin: 11.5-16.5 gram per deciliter (g/dL).
- Haematocrit: 0.35-0.47 liter per liter (L/L) (Cross & Heyns, 1983);
- Total serum iron: 0.7-1.8 milligram per liter (mg/L) (Dacie & Lewis, 1991, p. 14);
- Transferrin: 2.0-3.0 gram per liter (g/L) (Dacie & Lewis, 1991, p. 14);
- Ferritin: 15-300 microgram per liter ($\mu\text{g/L}$) (Kaplan & Pesce, 1984, p. 1279);
- HIV status: positive or negative
- Serum total protein: 60-82 g/L;
- Serum albumin: 34-48 g/L (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 1970569);
- Plasma fibrinogen: 1.5-4 g/L (Dacie & Lewis, 1991, p. 13);
- Serum total cholesterol: 0.9-5.2 millimol per liter (mmol/L) (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 1489232);
- Serum triglycerides: 2 mmol/L (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 488872);
- Serum glucose: 3.05-6.38 mmol/L (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 1448668);
- Serum insulin: 2-25 micro-units per milliliter ($\mu\text{U/ml}$) (DRG Diagnostics, catalogue no. EIA-2935);

3.4 MEASURING INSTRUMENTS AND TECHNIQUES

All instruments, techniques and procedures used in the study were standardised prior to its implementation. Methods were standardised to ensure validity and reliability.

3.4.1 SOCIO-DEMOGRAPHIC STATUS

A socio-demographic questionnaire was used to determine the socio-demographic status of respondents (Appendix B). The socio-demographic questionnaire was administered by one of the team members during an individual interview with each subject.

To determine reliability of the socio-demographic questionnaire, the questionnaire was re-administered to a random sample of 10 percent of the total sample within one to three weeks of the initial survey. Where answers to questions differed with more than 10 percent between the first and second survey, the question was considered unreliable. The reliability of the socio-demographic questionnaire was very good in this study.

3.4.2 ANTHROPOMETRIC MEASUREMENTS

Anthropometry involves obtaining physical measurements of an individual, and relating these measurements to standards that reflect the health and nutritional status of the subject (Lee & Nieman, 1996, p. 224, Hammond, 2004, p. 421).

In order to ensure validity and reliability of results, all anthropometric measurements were determined in accordance with published recommendations (Lee & Nieman, 1996, pp. 225, 228-229, 244-245, 272-273; Bodystat R1500 Bodystat, Isle of Man, Limited).

Subjects did not exercise for 24 hours, consume alcohol or caffeine for 24 hours prior to measurements (Bodystat R1500 – Bodystat Isle of Man Limited). Weight, height, waist and hip circumferences, and bioimpedance were measured to determine anthropometric status of the subjects. Subjects were examined in an examination gown, and without shoes for all anthropometric measurements.

The following standardised apparatus and methods were used for the anthropometric measurements:

3.4.2.1 WEIGHT

The 770 Seca digital electronic scale (Bizerba 75860) was used to weigh the subjects. This scale can weigh up to 150 kg. All subjects were weighed to the nearest 0.1 kg. The scale was placed on a flat, hard surface. The subject had to stand in the middle of the scale's platform, without touching anything, and with the body weight distributed on both feet (Lee & Nieman, 1996, p. 228-229).

3.4.2.2 HEIGHT

Height was determined by means of a stadiometer, to the nearest 0.5 centimeters. The stadiometer consists of a light metal frame that is mounted on a stand with a right-angle headboard that can be moved up and down (Lee & Nieman, 1996, p. 225). The

stadiometer can measure up to a height of two meters.

Measurements were taken with the subject standing barefoot on a flat surface, with heels together, arms to the side, legs straight, shoulders relaxed, and the head in the Frankfort plane (Pressman & Adams, 1990, p. 46; Lee & Nieman, 1996, p. 225). Heels, buttocks, scapulae and the back of the head were against the vertical board of the stadiometer. The headboard was then lowered upon the highest point of the head with enough pressure to compress the hair. The measurement was then read with the eye level with the headboard (Lee & Nieman, 1996, p. 225-226).

3.4.2.3 WAIST AND HIP CIRCUMFERENCE

A measuring tape was used to measure the waist and hip circumferences. A non-elastic, flexible tape was used to obtain accurate values (Lee & Nieman, 1996, p. 245). Measurements were determined with the subject standing erect, abdominal muscles relaxed, arms at the side, and feet together. Waist and hip circumference measurements were determined to the nearest 0.5 cm, maintaining close contact with the skin, without compression of the underlying tissue. The waist was measured with the tape measure placed in a horizontal plane, at the minimal abdominal circumference located midway between the lower rib margin and the iliac crest. The hip was defined as the widest circumference over the great trochanters, and was measured with the tape measure in a horizontal plane around this area to the nearest 0.1 cm. The WHR was calculated by dividing the waist circumference by the hip circumference (Lee & Nieman, 1996, p. 245).

3.4.2.4 BIOIMPEDANCE

The Bodystat[®] 1500MDD was used to determine body fat percentage via bioimpedance. The Bodystat[®] works by passing a safe current through the body, and measures impedance at 50 kHz. The current is harmless and cannot be felt by the subject. The body's resistance to the current is measured by this instrument, and body fat, lean body mass, dry lean mass and total body water are predicted.

The procedures were as follows:

- The bladder of the subject was emptied;
- Subjects were dressed in a light examination gown, without shoes and stockings/socks;
- Height and weight were determined accurately, as described elsewhere;
- Elbow width was necessary for bioimpedance, and was measured with a sliding ruler to the nearest 0.1 mm. The respondent was instructed to stand and stretch out the right arm, palm up, so that the arm is horizontal to the ground. While bending at the elbow, the lower arm was brought up to the vertical position. The width between the protruding condyles of the elbow was measured with the slide ruler, and the reading was recorded;
- Subjects lay relaxed and flat on an examination bed, with the arms and legs slightly spread, but with no parts of the body touching one another;
- The self-adhesive disposable electrodes were attached to the right hand and the right foot;
- One red lead was placed behind the knuckle of the middle finger of the right hand;

- One black lead was placed on the wrist next to the ulna head of the right hand;
- The other red lead was placed behind the second toe next to the big toe of the right foot;
- The other black lead was placed on the ankle at the level of, and between the medial and lateral malleoli (the large protruding bones on the sides of the ankle) of the right foot;
- Electrodes supplied by Bodystat were used;
- The machine was switched on, and when the reading was stabilized, the impedance reading was recorded (Bodystat R1500 Bodystat, Isle of Man, Limited).

3.4.3. DIETARY INTAKE

Dietary intake was determined by means of a Quantitative Food Frequency Questionnaire (FFQ). The FFQ was adapted from the THUSA study (Potchefstroom University), and was adjusted to include local food preferences and habits of the sample (Appendix D). This method of dietary assessment was considered to be a good representation of the dietary intake of the large number of women who participated in this epidemiological study, and was used to determine the habitual intake of the following:

- Energy;
- Proteins;
- Carbohydrates;
- Fats;

- Vitamins: thiamin, riboflavin, niacin, piridoxine, folic acid, vitamin B12, vitamin C, vitamin A, vitamin D, vitamin E, vitamin K;
- Minerals: calcium, iron, iodine, magnesium, phosphorus, selenium, zinc.

A FFQ was chosen to determine dietary intake due to the fact that FFQ's are the chosen method to use for describing intake of groups rather than for individuals (Dwyer, 1998, p. 945), and are commonly used in epidemiological research on diet and disease. Furthermore, it provides an overall picture of food intake (Dwyer, 1998, p. 943), which may be more representative of the usual intake of the individual than a few days of diet records. This method is also relatively inexpensive for large sample sizes. The design can be based on large-population data, and it is a suitable method to choose for research on diet-disease relationships (Lee & Nieman, 1996, p. 107; Dwyer, 1998, p. 943).

The FFQ comprised food items habitually consumed by the participants. Both traditionally consumed, and Western foods were included. Provision was made for the addition of unlisted food items.

A special section for reporting foods hunted or collected, such as wild birds, animals, insects, fruit and berries was included in the questionnaire.

Validity and reliability of the FFQ were determined prior to the study by interviewing 30 women in Margaung not included in the sample. The FFQ was administered in a personal interview with each respondent, after which the subjects were instructed to weigh and measure their actual food intake and record it in a food diary for a period of one week. One month later the FFQ was re-administered. Data obtained from FFQ 1

and the food diary were used to determine validity. Data obtained from FFQ 1 and 2 were compared to determine reliability. Results of this prior study indicated that reliability of the FFQ was good. Large variations however, were reported between FFQ 1 and the food diary. The fact that participants were largely illiterate and found it difficult to record daily food intake correctly, even under supervision, is most likely responsible for the poor validity observed.

During the main study, the FFQ's were administered by the researcher and three other team members, after attending a training session by a dietician who participated in the South African National Food Consumption Survey conducted in 1999.

Three interpreters (one Xhosa and two Sotho speaking) assisted the interviewers. Prior to each interviewing session, the procedures for reporting dietary intake were explained to the respondent.

Participants were requested to report food items selected from the different categories listed in the FFQ, as consumed daily, weekly, monthly or seldom.

The following materials and equipment were used to determine food choices and portion sizes:

- A set of household measuring cups (250 ml, 125 ml, 62 ml and 31 ml);
- A set of household measuring spoons (15 ml, 7,5 ml, 5 ml, 2,5 ml, 1,2 ml and 0,6 ml);
- A large household spoon used for dishing up (heaped spoon, 125 ml);
- Empty labeled food containers;

- Real food (snack foods), weighed on an analytical scale to determine the weight for commonly used portion sizes;
- Food models.

The recorded food items were coded by means of the Food Composition Tables of the Medical Research Council (Langenhoven *et al.*, 1998). The quantities of food items recorded on the questionnaire were converted to gram weights using the Food Quantities Manual (Langenhoven *et al.*, 1991). The data was summarized on a coded summary sheet before it was processed. The weight of food items consumed on a daily basis was entered as such. The weight of food items not selected by the respondents on a daily basis, was calculated as follows:

- Food in grams consumed on a monthly basis \div 30 days;
- Food in grams consumed on a weekly basis \div 7 days.

Complex dishes not appearing in the Food Composition Tables, were broken down into individual ingredients and weights, and coded as such.

3.4.4 PHYSICAL ACTIVITY

A questionnaire based on the one developed by Baecke *et al.* (1982), and adapted by Kruger (1999), was used to develop a questionnaire to measure physical activity for occupation and leisure time activities (Appendix E).

The physical activity questionnaire that was used in this study, was completed during a personal interview with each respondent. Respondents were then categorized into three

activity levels, namely low, moderate and high.

The following information was included in the questionnaire:

- Identifiable details of the respondent;
- Main occupation;
- Standing activities at work;
- Standing activities at home;
- Sitting activities at work;
- Sitting activities at home;
- Duration of sitting activities at work/home;
- Duration of standing activities at work/home;
- Type and duration of transport;
- Leisure time activities and the duration there-of.

As with the other questionnaires, 10 percent of the sample were re-interviewed three weeks to a month after the initial survey to determine reliability.

For each question, the answers obtained in the main survey and the reliability study were compared by k*k tables, and where the answers to questions differed with more than 20 percent between the first and second survey, the question was considered unreliable, and ignored in further computations.

For continuous variables, the difference between the two surveys was calculated and the number of non-zero differences reported.

3.4.5 HEALTH STATUS

A standard medical questionnaire was developed to determine the general health status of the subjects (Appendix F). The questionnaire provided categories including those for blood pressure, chronic medication taken, general visible or tangible abnormalities, cardiovascular and respiratory abnormalities, abdominal pathology, and whether the subject wanted to be informed of the HIV/AIDS result. The medical examination was performed by a registered medical practitioner, using standard techniques.

3.4.6 BLOOD SAMPLES

Fasting blood samples of the subjects were collected by a qualified nursing sister. The following apparatus were used:

“Vacutainer Systems” needles, 21 G. (thickness) X 38 millimeter (mm) (length) and a tourniquet were used to collect blood samples. Preptic swabs were used to disinfect the area before blood was drawn.

10 ml Vacutainer (BD, TM; catalogue number 368430, Plymouth, UK.) blood tubes (red stopper), were used for all blood samples except for full blood samples, where 10 ml Vacutainer ethyldimethylacetic acid (EDTA) blood tubes (purple stopper) were used.

To collect blood samples, the respondent sat in a relaxed and comfortable position, either on a chair or a laboratory stool. Blood samples were collected from the cubital

fossa vein. Where the registered nurse was unable to obtain a blood sample, the medical practitioner assisted.

3.4.6.1 BIOCHEMICAL ANALYSIS

Fasting blood samples were used to determine total lymphocyte counts, haemoglobin, haematocrit, total serum iron, transferrin, ferritin, HIV status, serum total protein, serum albumin, plasma fibrinogen, serum total cholesterol, serum triglyceride, serum glucose and serum insulin concentrations.

Laboratory quality control was performed using standardised calibration and quality control specimens as supplied by the manufacturers of the respective methods.

3.4.6.2 BLOOD SAMPLE PREPARATION

The preparation of blood samples will be described in the following section.

i) PLASMA

For the preparation of essentially platelet-free plasma, 10 ml citrated blood (1 volume of 3.8 percent tri-sodium citrate [Saarchem, South Africa, catalogue no. 5822500] in a 0.1 Molar (M) sodium phosphate buffer, pH 7.4, was centrifuged twice, for 10 minutes at 2 800 x g. Citrate acts as an inhibitor of early activation of factor V and VIII.

Determinations involving fibrin network structure properties were performed on fresh plasma samples. All remaining plasma samples were stored at -72°C in Eppendorf® vials for later analyses.

ii) SERUM

5 ml of whole blood was left to clot at room temperature. These samples were centrifuged at 3 360 revolutions per minute (rpm) for 20 minutes in order for serum to separate. Samples were frozen at -72°C in Eppendorf® vials.

iii) FULL BLOOD COUNTS

The metabolic variables haemoglobin, haematocrit and total lymphocyte counts were measured by means of a full blood count. Full blood counts were performed on EDTA blood using a Coulter Microdiff 18 Cell Counter. This method counts and sizes cells by detecting and measuring changes in electrical resistance when a particle in a conductive liquid passes through a small aperture.

iv) WHITE AND RED BLOOD CELL COUNT

Counting of red and white blood cells took place sequentially. First, the system draws the white blood cell (WBC) dilution through the WBC aperture, then drains and rinses the bath. It then draws the red blood cell (RBC) dilution through the RBC aperture. The system counts both the RBC and WBC dilutions for three consecutive periods of 4 seconds each. During the RBC count, pulses that represent cells as 36 femto liter or

greater are classified as red cells. During the WBC count, pulses that represent cells as 35 femto liter (fL) or greater are classified as white blood cells. The count cycle was monitored for abnormal variation using Coulter's Aperture Integrity Monitor (AIM). The Coefficient of Variation (C.V.) for the WBC and RBC was 1.29 percent and 1.37 percent respectively.

v) HAEMOGLOBIN AND HAEMATOCRIT

The Coulter system uses the lysed white blood cell dilution to measure haemoglobin and haematocrit concentrations. The absorbance of light from a Light Diode (LD) is measured at 525 nm through the optical pathlength of the bath. A beam of light from a Liquid Energy Display (LED) passes through the sample through a 525 nm filter, and is measured by a photodiode. The signal is amplified and the voltage is measured and compared to the blank reference reading. The C.V. for haemoglobin and haematocrit was 1.96 percent and 2.01 percent respectively.

vi) TOTAL SERUM IRON

Total serum iron was determined on the Hitachi 902 using a colorimetric assay method (catalogue no. 11876996, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany). Under acidic conditions, iron is liberated from transferrin. Lipemic samples are clarified by the detergent. Ascorbate reduces the released Fe^{3+} ions to Fe^{2+} ions which then react with FerroZine to form a coloured complex. The color intensity is directly proportional to the iron concentration, and can be measured photometrically. The method was calibrated against the Calibrator for Automated Systems (catalogue no.

10759350, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany). Precinorm U (normal values) (catalogue no. 171735, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany) and Precipath U (abnormal values) (catalogue no. 171760, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany) were used for control purposes.

vii) TRANSFERRIN

Transferrin was determined on the Hitachi 902, using an immunoturbidimetric immunoassay supplied by Randox (catalogue no. TF 7197). This method is based on the reaction of a sample containing human transferrin with a buffer containing antibody specific for human transferrin (siderophilin). The absorbance (66 nm) of the resulting turbid solution is proportional to the concentration of transferrin in the sample. By constructing a standard curve from the absorbance of standards, transferrin concentration of the sample can be determined. Randox Specific Protein Control Low (catalogue no. PS1657) and Elevated (catalogue no. PS1658) were used for quality control.

viii) FERRITIN

Ferritin was determined on the Hitachi 902, using an immunoturbidimetric immunoassay supplied by Randox (catalogue no. FN 2467). This method is based on the reaction of a sample containing human ferritin and specific antiserum to form an insoluble complex which can be measured turbidimetrically at 700 nm. By constructing a standard curve from the absorbances of the standards, the concentration of ferritin can be determined.

Randox Liquid Assayed Specific Calibrator (catalogue no. IT 2691) was used for calibration of the method, and Randox Liquid Assayed Specific Protein Controls Level 1 (catalogue no. PS 2682), Level 2 (catalogue no. PS 2683) and Level 3 (catalogue no. PS 2684) were used for control purposes.

ix) HIV STATUS

HIV tests were performed on an Abbott AxSYM® System, using the Human Immunodeficiency Viruses (HIV-1/HIV-2): (Recombinant Antigens and Synthetic Peptides) reagent pack (Abbott, Germany, catalogue no. 3D41-20). The HIV 1/2 gO reagent pack is for the *in vitro* qualitative detection of antibodies to human immunodeficiency virus type one and/or type two in human serum or plasma, by Microparticle Enzyme Immunoassay.

x) SERUM TOTAL PROTEIN

Serum total protein was determined in duplicate on the Boehringer Mannheim Hitachi 902 chemistry analyser using a colorimetric method (catalogue no. 1553 836, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany). Protein forms a coloured complex with cupric ions in alkaline medium. The intensity of the developed colour is proportional to the concentration of protein in the sample. The method was calibrated against the Calibrator for Automated Systems (catalogue no. 759 350, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany). Precinorm U (normal values) (catalogue no. 171 735, Boehringer Mannheim-Roche Diagnostics, Mannheim,

Germany) and Precipath U (abnormal values) (catalogue no. 171 760, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany) were used as control serum. The C.V. for the method was 1.0 percent.

xi) SERUM ALBUMIN

Serum albumin was determined using a colorimetric endpoint method supplied by Roche Diagnostics GmbH, Mannheim, Germany (catalogue no. 1970569), on the Boehringer Mannheim/Hitachi 902 automatic chemistry analyzer. At a pH value of 4.1, albumin displays a sufficiently cationic character to be able to bind with bromcresol green (BCG), an anionic dyestuff, to form a blue-green complex. The colour intensity of the blue-green colour is directly proportional to the albumin concentrate, and can be determined photometrically. The method was calibrated against Calibrator for Automated Systems supplied by Roche Diagnostics GmbH, Mannheim, Germany (catalogue no. 759350). Precinorm U, for normal values (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 171735), and Precipath U (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 171778) for pathological range values (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 171778) were used as control samples for reliability of the measurements. The C.V. for the method was 2.05 percent.

xii) PLASMA FIBRINOGEN

The method of Clauss (1957) was used for the quantitative determination of total plasma fibrinogen concentration.

The Clauss method: Total fibrinogen concentration was determined with the method of Clauss and a Fibrintimer² (Pathteq, Marburg, Germany) using Multifibren® U (14 X 2 ml code no. OWZG 15). Kaolin Suspension (code no. OQAB) was used for the Fibrintimer². Citrated plasma was brought to coagulate with a large excess of thrombin. The coagulation time depends on the fibrinogen concentration in the sample. Control Plasma N (code no. ORKE) and Control Plasma P (code no. OUPZ) were used as standards for internal quality control. The C.V. for the method was 1.8 percent.

xiii) SERUM TOTAL CHOLESTEROL

Serum total cholesterol was determined using the CHOD-PAP method (catalogue no. 1489232) supplied by Roche Diagnostics GmbH, Mannheim, Germany. This method is based on an enzymatic colorimetric principle. This method is based on the determination of Δ^4 -cholestenone after enzymatic cleavage of the cholesterol ester by cholesterol esterase, conversion of cholesterol by cholesterol oxidase, and subsequent measurement by the Trinder reaction of the hydrogen peroxide formed. Optimization of ester cleavage (>99.5 percent) allows standardisation using primary and secondary standards and a direct comparison with the CDC and NIST reference methods. The C.V. for this method was 0.33 percent.

xiv) SERUM TRIGLYCERIDES

Fasting triglycerides were determined using the GPO-PAP method supplied by Roche Diagnostics GmbH, Mannheim, Germany (catalogue no. 148872). The method is based

on an enzymatic colorimetric principle. This method is based on the work by Wahlefeld using a lipoprotein lipase from microorganisms for the rapid and complete hydrolysis of triglycerides to glycerol followed by oxidation to dihydroxyacetone phosphate and hydrogen peroxide. The hydrogen peroxide produced then reacts with 4-aminophenazone and 4-chlorophenol under the catalytic action of peroxidase to form a red dyestuff (Trinder endpoint reaction). The C.V. for this method was 1.29 percent.

xv) SERUM GLUCOSE

Glucose was determined using an enzymatic colorimetric method, supplied by Roche Diagnostics GmbH, Mannheim, Germany (catalogue no. 1448668) on a Boehringer Mannheim Hitachi 902 automatic chemistry analyzer.

Glucose was oxidized by glucose-oxidase (GOD), in the presence of atmospheric oxygen to gluconolactone oxidiert. The resulting hydrogen peroxide was oxidized in the presence of peroxidase (POD) 4-amino-phenazone and phenol to 4-(p-benzochinonemonolmino)-phenazone. The colour intensity of the red dye is directly proportional to the glucose concentration and was determined photometrically. The method was calibrated against Calibrator for Automated Systems (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 759350). Precinorm U, for normal values (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 171735), and Precipath U (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 171778), for pathological range values, (Roche Diagnostics GmbH, Mannheim, Germany, catalogue no. 171778), were used as control samples for reliability of the measurements. The C.V. for the method was 1.41 percent.

xvi) SERUM INSULIN

The DRG insulin ELISA is a solid phase two-site enzyme immunoassay. It is based on the direct sandwich technique in which two monoclonal antibodies are directed against separate antigenic determinants on the insulin molecule. During incubation, insulin in the sample reacts with biotin-conjugated anti-insulin antibodies, and anti-insulin antibodies bound to microtitration well. A simple washing step removes unbound biotin labeled antibody. During the second incubation step, Streptavidin Peroxidase Enzyme Complex binds to the biotin-anti-insulin antibody. The bound HRP complex is detected by reaction with 3,3', 5,5'-tetramethylbenzidine. The reaction is stopped by adding acid to give a colorimetric endpoint that is read spectrophotometrically. The C.V. for the method was 6.8 percent.

3.5 POPULATION AND SAMPLING

3.5.1 TARGET POPULATION

This study was conducted in the Mangaung area of Bloemfontein. This is an area in the Free State Province of South Africa that was chosen for the original study, where a nutrition transition accompanied by an increase in the prevalence of chronic diseases of lifestyle, have most likely occurred due to urbanization and westernization. In order to be able to attribute the health status of the women to lifestyle (especially diet and physical activity), it was necessary to determine HIV status. The high prevalence of HIV infection in the sample was unexpected, but afforded the researchers the opportunity of extending the study to investigate the association between HIV status with health and nutritional status.

3.5.2 SAMPLE SIZE

A random sample of 500 post-pubertal and premenopausal African women, in the Mangaung area of Bloemfontein, from the two age groups 25-34, and 35-44 years, were selected by the Department of Biostatistics, Faculty of Health Sciences, University of the Free State. A township map obtained from the Greater Bloemfontein Municipality was used to make the selection. A sample of 500 women was estimated to be representative of the whole Mangaung area. The sample included respondents from two formal settlements, namely Pahameng and Botchabela, and two informal settlements, namely Joe Slovo and Namibia.

The residential plots in the four selected areas were counted and numbered, and a proportionate number of respondents were selected randomly from these plots. In Namibia 2995 plots were counted, 1711 in Pahameng, 1359 in Joe Slovo, and 2308 in Botchabela.

Twenty subjects were recruited by the two community health workers per week to attend the research session at the Central University of Technology, Free State, conducted over a period of twenty five weeks, commencing in March 2000, and ending in November 2000.

3.5.3 INCLUSION CRITERIA

The following inclusion criteria were applicable:

- Persons took part in the research study voluntarily;

- African female;
- Within the age group 25-44;
- Non-pregnant;
- Fasting from 22:00 the night prior to data collection;
- Persons had to be available for the full duration of the investigation session (one day).

3.5.4 PILOT STUDY

Before commencing with the main study, a pilot study was conducted. Ten African women in the age group 25-44 took part in the pilot study. During the pilot study, the questionnaires were administered to ascertain that terminology were clearly understood, and to indicate the number of subjects that could be handled with ease during one data collection session.

The FFQ was pre-tested on a sample of thirty women in Mangaung. This pilot study also served as a reliability and validity study.

For all other questionnaires, except the FFQ, 10 percent were repeated within one to three weeks of the initial survey. Where answers to questions differed with more than 10 percent between the first and second survey, the question was considered unreliable.

3.5.5 ETHICAL APPROVAL

Ethical approval for the original study was obtained from the Ethics Committee of the Faculty for Health Sciences, University of the Free State (ETOVS 02/00). The extended study was resubmitted, and approved (ETOVS 02/00). The subjects participating in the study gave written informed consent, after the purpose and procedures of the study were explained to them by the community health workers who assisted in contacting the sample. Respondents were assured that information would be handled as confidential. All subjects took part in the study voluntarily. Before the study commenced, participating subjects were informed that their HIV status was going to be determined, and they were given the option of receiving the results. Patients who tested HIV positive who chose to receive their results were contacted and seen by the medical practitioner, who informed them of their HIV status. These patients were referred for further counselling. No member of the research team other than the medical practitioner had access to the HIV results of participants.

3.6 IMPLEMENTATION OF THE STUDY

3.6.1 STUDY PROCEDURES

Prior to the study, approval of the research project was obtained from the Community leaders of the four selected areas, namely Pahameng, Botschabela, Joe Slovo and Namibia. A letter explaining the extent and purpose of the study was written to these Community leaders (Appendix G). A talk by the project leader on Radio Lesedi, a local radio station, served as a further method to inform the local community of Mangaung about the study. In addition, two community health workers who supported the

researchers, addressed community meetings in each of the four selected areas to explain the purpose and procedures of the study.

Twenty subjects from the selected areas were visited by the community health workers at their residences the week before they attended the research session. If a selected respondent was not available, the community health worker moved to the residence situated to the right of the selected residence. If not successful, the community health worker visited the residence situated to the left of the first selected residence. If this failed, a new plot was selected by the Department of Biostatistics, University of the Free State. During these contact sessions, the community health workers explained the details of the research study. Respondents took part in the study voluntarily. The subjects gave written informed consent (Appendix A), approved by the Ethics Committee of the Faculty for Health Sciences, University of the Free State, after the purpose and procedures of the study were thoroughly explained by the community health worker. Employed respondents were issued with a letter (Appendix H) which explained the purpose of the study to employers. Respondents were instructed to fast overnight, abstain from exercising for 24 hours, and avoid consuming alcohol and caffeine for 24 hours prior to the collection of data. The subjects were informed to gather at a central point for collection at 08:00 on the day of data collection, after which they were transported by mini buses to the research centre, where all investigations took place. Each respondent received a remuneration of R40,00 for taking part in the research study. The community health workers were also remunerated for their contribution.

On arrival at the research centre, each respondent was issued with a nametag with their respondent number and a list of all the stations that they had to visit. A medical

examination was done, anthropometric measurements determined, and blood samples were collected, after which respondents were given tea and sandwiches. Questionnaires were administered after tea. Three interpreters were available to assist the researchers at the stations where language problems were encountered. A research assistant coordinated the procedures to ensure that each respondent visited each of the stations.

The stations were the following:

- General examination by a medical practitioner;
- Blood sampling;
- Anthropometric measurements;
- FFQ
- Socio-demographic questionnaire;
- Physical activity questionnaire;
 - Other questionnaires not applicable to this study were administered.

After all the procedures had been completed, the respondents received their remuneration. Subjects were responsible for their own transport back to their residential areas.

3.6.2 STATISTICAL ANALYSIS

All data sets were categorized into two age groups: younger than 35 and 35 years and older. For each group continuous variables were described by means and standard

deviations or medians and percentiles as applicable. Categorical variables were described by frequencies and percentages.

3.6.2.1 SOCIO-DEMOGRAPHIC STATUS

Frequencies and percentages were used to describe categorical and numerical variables.

3.6.2.2 ANTHROPOMETRY

WHR, BMI and fat percentage were calculated and categorized according to the cut-off points discussed under sections 3.3.2.1, 3.3.2.2 and 3.3.2.4 respectively.

3.6.2.3 DIETARY INTAKE

Nutrient intake was calculated using the Food Composition Tables of the Medical Research Council (Langenhoven *et al.*, 1998), and described by medians and means. For all nutrients that have an RDA or adequate intake (AI), the percentage of women with intakes <67 percent or ≥67 percent of the RDA or AI were calculated and described by frequencies and percentages.

3.6.2.4 PHYSICAL ACTIVITY INDEX

Physical activity was calculated according to method used in the THUSA study (Kruger, 1999). The physical index was calculated as follows:

Physical activity index = 0.47 (work index) + 0.059 (commuting index) + 0.001 (stair index) + 0.47 (sport index + leisure index).

The questionnaire used in this study differed from the one used in the THUSA study in the classification of time of activity. In this study, respondents were asked to specify the amount of time spent on a specific activity in minutes, while the THUSA study used a classification of time as “never, seldom, sometimes and always”. The amount of time for each activity was defined as never when a person spent 0 percent of their time at work or at home with inactivity. Seldom was defined as less than 10 percent of the time and 10 percent to 50 percent was defined as sometimes. Fifty percent to less than 85 percent was defined as often, and more than 85 percent as always. Classification of activities at home and at work was included. As the physical activity for the THUSA study was calculated for the work place, activity at home was calculated as work activity when a person did not work. If a person was employed, then work was calculated as work activities at work plus work activities at home.

The physical index was calculated and categorized as <4 (low), 4<6 (normal), and >6 (high) (Kruger, 1999).

For each combination of age group, physical activity group, and HIV-group, the physical activity questions were compared by means of chi-square test and Fisher's exact test, and 95 percent confidence intervals (CI) were calculated for the percentage difference. Medians were compared by 95 percent non-parametric CI and the Kruskal-Wallis test.

3.6.2.5 HEALTH STATUS

Variables were described by frequencies and percentages.

3.6.2.6 BIOCHEMICAL PARAMETERS

Variables from the blood sample were categorized according to the cut-off points discussed under section 3.2.5. For each age group, the categorized variables were described by frequencies and percentages.

3.7 RELATIONSHIPS

Within each age group, HIV positive and HIV negative groups were compared for each parameter by 95 percent CI's.

3.7.1 GROUPS WITH AND WITHOUT POOR PROGNOSTIC MARKERS

Both younger and older HIV positive and HIV negative women were categorized into groups with and without poor prognostic markers in an effort to distinguish between HIV positive women in an early stage of infection and those in a more advanced stage of infection.

Women were considered to have a poorer prognosis if they had more than four of the following markers:

- Serum total protein <60 g/L;
- Total serum iron <0.7 mg/L;

- Transferrin >3.0 g/L;
- Haemoglobin <11.7 g/dL;
- Serum albumin <34 g/L;
- Total lymphocytes <0.8 x 10⁹/L;
- Marital status: not married at all;
- Level of education: non/primary school;
- Head of household: no husband;
- Smoke: smoke and snuff were bad markers;
- Urbanized: ≥ 10 years in an urban area.

In the age category 25-34 years, the majority of both HIV positive and HIV negative women had four or less of the indicators of poor prognosis (85.71 percent of HIV positive women and 96.97 percent of HIV negative women). Although there were more HIV negative women with four or less indicators, the difference was not significant, 95 percent CI [1.8; 20.6]. Only 14.29 percent of HIV positive women had more than four indicators, and only 3.03 percent of HIV negative women had more than four indicators, thus indicating that most of the HIV positive women included in this study were probably still in an early stage of HIV infection.

In the age category 35-44 years, the percentage of women with more than four indicators was 21.43 percent for HIV negative women, and 26.67 percent for HIV positive women, which was not at all significant, 95 percent CI for the difference (negative – positive) [-22 percent to 11 percent].

Due to the relatively small percentage of women with more than four markers of poor prognosis, it was not possible to compare variables such as dietary intake and anthropometry between these groups.

3.8 SUMMARY

The aim of this study was to determine the health and nutritional status of HIV positive women (age 25-44) in Margaung. A sample of 500 post-pubertal and premenopausal women was randomly selected from this area for the study.

The socio-demographic composition of the subjects was determined by means of a questionnaire, which included identifiable details of each subject, the family composition, household and economic status.

Anthropometric measurements included BMI, fat percentage and WHR (to determine fat distribution) of each respondent.

Dietary intake of respondents was determined by means of a standardised FFQ, including traditional and Western foods, after which they were analysed to determine the habitual intake of respondents.

Physical activity levels were determined by means of a physical activity questionnaire, that included questions on activities at home and work, leisure time activities and type of transport. Respondents were then categorized into three activity levels, namely low, moderate and high.

A general medical examination was performed on each subject by a medical practitioner.

Blood samples were collected by using standard procedures, to determine total lymphocytes, haemoglobin, haematocrit, total serum iron, transferrin, ferritin, HIV status, serum total protein, serum albumin, plasma fibrinogen, serum total cholesterol, serum triglycerides, serum glucose and serum insulin status of each subject.

Relationships between HIV and all the above mentioned parameters were determined.

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CHAPTER 4

SOCIO-DEMOGRAPHIC PROFILE OF HIV SEROPOSITIVE WOMEN (25-44 YEARS) LIVING IN MANGAUNG, SOUTH AFRICA

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ABSTRACT

Objective: To determine the socio-demographic profile of HIV positive women. *Design:* Cross-sectional study of a representative group of 500 pre-menopausal women (25-34 years and 35-44 years). *Methodology:* Socio-demographic data was obtained with a structured questionnaire. Frequencies and percentages were used to summarize categorical and numerical variables. *Results:* Sixty one percent of younger women and 38% of older women were HIV infected. Younger HIV positive women had lived significantly longer in an urban area ($p=0.0120$). Significantly more HIV positive younger women used nasal snuff ($p=0.0016$). Significantly more HIV negative older women were either married or traditionally married ($p=0.0101$). Younger women were more educated. Significantly fewer of the HIV positive older women ($p=0.0178$) than HIV negative older women had no formal or primary school education. Unemployment rates amongst younger and older HIV positive women were approximately 71%, and in HIV negative younger and older women, 78% and 64%, respectively. Significantly more HIV negative younger ($p=0.012$) and older women ($p=0.0018$) reported a husband-headed household. No significant differences were found in median room density between HIV positive and HIV negative women. *Conclusions:* Prevalence of HIV is high in this community. Socio-

demographic parameters that are different in HIV positive women include age, urbanization and marital status.

Key words: South Africa; HIV; African women; socio-demographic status

INTRODUCTION

Many countries around the world have encountered the devastating impact of HIV/AIDS (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2001). The world's worst HIV/AIDS epidemic is, however, located in Africa (de Waal & Whiteside, 2003), where the majority of the population have also experienced a drastic decline in quality of life (Tanser & Le Sueur, 2002), involving not only aspects such as functional status and well-being of the individual, but also income, freedom and environment (O'Keefe & Wood, 1996).

The HIV epidemic has reached critical levels in Southern Africa. This sub region is also the most urbanized on the African continent, with 40 percent of its inhabitants living in urban areas. Figures show that more pregnant women from urban than rural areas are HIV positive (UNAIDS, 2003). The highest prevalence rate by province among antenatal clinic attendees in South Africa for 2002 was reported for KwaZulu-Natal (36.5 percent), followed by Gauteng (31.6 percent), and the Free State province ranking third, with 28.8 percent (Department of Health, South Africa (DoH, SA), 2002). Many more may, however, be carrying the virus without being aware of it.

Besides individual risk factors for HIV infection, societal factors such as unemployment, economic insecurity, cultural norms, gender inequalities, geography, education, and lack

of information and services create the ideal climate for the epidemic to thrive (UNAIDS, 1996).

HIV/AIDS adversely affects the national development of any country, with the poor becoming poorer, and the rich becoming richer (UNAIDS, 2001). This disease is thus a major threat to the economic stability, food supplies, education and health care of already impoverished countries (Mukherjee *et al.*, 2003). The poor economic and social status of South African women living in sub standard conditions place them at greater risk of HIV/AIDS infection (O'Hara *et al.*, 2003). Poverty leads to poor nutrition and poor health, thus creating the perfect environment for HIV disease to flourish (Food and Agriculture Organization (FAO), 2001a). In addition, poverty goes hand in hand with poor hygiene, and where women live in poor conditions, an AIDS epidemic will most likely develop (FAO, 2001b). There is thus an urgent need for the social upliftment of African women, and the provision of better housing and living conditions (Esterhuysen & Doyle, 1993).

Social class is undoubtedly a risk factor in virtually all health outcomes (van Wyk & Basson, 1994; Darnton-Hill & Coyne, 1998). The lower the socio-economic status, the higher the rates of essentially all diseases are (Montague, 1996). HIV is also more severe in disadvantaged groups such as the African population (Esterhuysen & Doyle, 1993). Although literature has confirmed the interrelationship between socio-economic factors and susceptibility to HIV infection (van Wyk & Basson, 1994; Murrain & Barker, 1997) few investigations have been performed in this regard (Murrain & Barker, 1997).

Urbanization, particularly in the developing world, continues to compound the spread of diseases such as HIV/AIDS (Gordon, 2000). In a Zambian study, the rural HIV rate was

about half the prevalence level of the urban population (Fylkesnes *et al.*, 1997). The flow of young women from their home villages to urban areas in search of a better life, increases their likelihood of becoming HIV infected (Ulin, 1992). These women are often illiterate, with limited skills, few job opportunities and limited access to health and information services. Without these resources, and in order to survive economically, many become financially dependent on other strategies, such as exchanging sexual favours for money (Ulin, 1992).

A better understanding of the relationship between socio-demographic factors and HIV infection can have substantial implications for the design and implementation of prevention programmes (Murrain & Barker, 1997). Better publicity of existing knowledge would help force governments into recognizing the dimension of the HIV epidemic and the social, financial and cultural conditions that promote the spread of HIV (Pisani, 1997).

The aim of this study was to determine the socio-demographic profile of HIV positive and HIV negative women.

METHODOLOGY

The Department of Biostatistics, University of the Free State, randomly chose women from the Mangaung District, Bloemfontein, South Africa. A township map, obtained from the greater Bloemfontein municipality, was used to make the selection. Women were selected from two informal settlements and two formal settlements. Plots within the designated areas were counted and numbered, and a proportionate number of respondents were selected randomly from these plots. The size of the sample was

considered representative of the population of the Mangaung District. Trained community healthcare workers were responsible for the recruitment of the subjects. The healthcare workers were given detailed instructions about the recruitment of subjects as well as a detailed map of twenty of the selected plots on a weekly basis. On arrival of the plot the inhabitants were screened for eligibility.

The Ethics Committee of the Faculty of Health Sciences, University of the Free State (ETOVS number 02/00) approved the study. The community health workers explained the study's content and purpose. Each participant gave informed consent and was given R50-00 (approximately US \$5.00). The participants could indicate whether they wanted to receive their HIV test results. Those who chose to know their test results were referred to a medical practitioner for post-test counseling and if required, a confirmatory test. The research team was blinded with regard to the participant's HIV status.

A structured questionnaire with closed-ended questions was used to collect socio-demographic information during a face-to-face interview with each participant. Questions included: the number of years residing in an urban area, language, smoking habits, household composition, marital status, highest level of education, employment status of respondent and husband/partner, head of the household, type and size of dwelling and available facilities, income (number of people contributing, average household income per month), and the amount of money spent on food per week. Validation was done by repeating a random sample of 10 percent of the questionnaires within one to weeks of the initial survey. Where answers to questions differed with more than 10 percent between the first and second survey, the question was considered unreliable. Answers to questions on the income and amount of money spent on food

were unreliable, and results will therefore not be reported in this publication.

STATISTICAL ANALYSIS

Questions were coded and data processed using the SAS software programme. Frequencies and percentages were used to summarize categorical and numerical variables.

RESULTS

A total of 500 women were recruited for the study of which 488 were eligible to participate (4 women were found to be pregnant during the medical examination and 8 women were either older or younger than the required age). Of the 488 women, 273 were 25-34 years old and 215 were 35-44 years old.

Results of the socio-demographic data are presented in Table 1. The difference in socio-demographic profile between HIV negative and HIV positive younger women is given in Table 2 and for older women, in Table 3. For younger women, the HIV positive group had lived in an urban area for a significantly longer period than the HIV negative group ($p=0.0120$, Table 2). The majority of women spoke Sotho, followed by Tswana. Amongst all young women, the use of snuff was more popular than smoking cigarettes (Table 1). Significantly more of the HIV positive young women than HIV negative young women snuffed ($p=0.0016$, Table 2). A fairly large percentage of all the older women snuffed or smoked (Table 3).

Most of the women were living with a partner (Table 1). In both age groups, fewer HIV positive women than HIV negative women were married. Significantly more ($p=0.0101$) of the HIV negative older women than HIV positive older women were either married or traditionally married (Table 3).

Young women were better educated than older women (Table 1). Many older HIV negative and HIV positive women had primary school education (35.34 percent and 28.05 percent, respectively), or St 6-8 (37.59 percent and 51.22 percent, respectively). Significantly more of the older HIV negative women ($p=0.0178$) had no formal or primary school education (Table 3). Less than 2 percent of all the women indicated that they had some form of tertiary education.

Unemployment rates were high, ranging from 71.86 percent to 78.30 percent for younger HIV positive and negative women, respectively, and 64.66 percent to 71.95 percent for older HIV negative and positive women, respectively. More young HIV positive women than HIV negative women (23.95 versus 16.98 percent), but more old HIV negative than HIV positive women (27.82 versus 18.29 percent) were casual workers.

Significantly more ($p=0.012$) of the younger HIV negative than HIV positive women reported a husband-headed household (Table 2). Similarly, significantly ($p=0.0018$) more of older HIV negative than HIV positive women had a husband-headed household. Many older HIV negative (39.10 percent) and HIV positive women (37.80 percent) had a self-headed household.

Most women stayed in brick houses, with their own tap for drinking water, and a flush toilet. Household equipment including a working stove (gas, coal or electric) and primus

or paraffin stove were available in the majority of the households. About half of all the households had a working refrigerator and/or freezer. Most households had a working radio and/or television. The median room density for young HIV negative and HIV positive women was 2.5 and 3.0, respectively (Table 2). In the older group, median room density was 3.0 and 2.85 for the HIV negative and HIV positive groups, respectively (Table 3).

DISCUSSION

The key objective of this study was to determine the socio-demographic characteristics of the women, and to investigate the possibility of socio-demographic markers that contribute to the spread of HIV.

Socio-economic factors have a remarkable influence on the spread of HIV and the openness for health-promoting information regarding this disease (van Wyk & Basson, 1994). The positive relationship between lower socio-economic status and HIV progression has also been proven by earlier studies (Hogg *et al.*, 1994; Schechter *et al.*, 1994). According to the “downward drift” theory, there is the possibility that lower socio-economic status results from, rather than causes the poor clinical outcome of HIV-infected persons (Marneros *et al.*, 1990). Differences amongst the various groups of women in this study could not necessarily be attributed to HIV, but reflected population-wide changes, especially in a period of political, demographic and economic shifts experienced in South Africa.

Mangaung is a rapidly urbanizing African residential area situated near the outskirts of Bloemfontein, the capital city of the Free State Province. HIV infection has apparently

spread at an alarming rate in this township, with 61 percent from the age group 25-34 testing HIV positive, and 38 percent in the age group 35-44 years, being HIV positive. A possible bias could have been present in the fact that the sample was contacted during the day. If no one was found at home, the household on the left was selected. For this reason, it is possible that a larger percentage of unemployed persons were included in the sample than is representative of the community of Mangaung. On the other hand, however, participation was voluntary, and thus very ill persons could not have agreed to participate. These factors could have had an influence on the prevalence of HIV infection reported in this study.

Firstly, figures from the present study confirmed what literacy state about women, urbanization and HIV infection. The number of new infections in females in developing countries is growing faster than in males. Urbanization can be considered as one of the key determinants in HIV spreading. In this study, both the younger and older HIV positive women had been staying longer in an urban area than the HIV negative women. This could have contributed to the higher infection rates, which is similar to another Free State study, where 76.5 percent of the HIV positive participants came from urban areas in the Province (Dannhauser *et al.*, 1999). In Zambia, HIV prevalence rates in rural areas were found to be about half that of urban populations (Fylkesnes *et al.*, 1997).

The results from this study confirmed that younger women were more likely to be HIV positive. According to Gilbert and Walker (2002), young African women in developing countries form the vast majority of those currently living with HIV/AIDS. Fylkesnes *et al.* (1997) found a similar pattern of HIV infection in Zambian women, where women of child-bearing age had the highest sero-prevalence in both rural and urban areas.

According to earlier figures released on smoking patterns in South Africa, less than 10 percent of African women smoked (Yach et al., 1992), which is similar to the results of the young women in this study. Concerning health-promoting behaviour in the broad population, individuals with higher education and higher incomes are more likely to give up smoking than those of lower socio-economic status (Centers for Disease Control (CDC), 1992). Several HIV-related opportunistic infections are associated with cigarette smoking (Collins et al., 2001), thereby emphasizing the importance of good health practices for the person living with HIV/AIDS. Taking into account the women's socio-economic background, it is doubtful that they would adopt healthier habits when their HIV status became known. Although the use of dry nasal snuff, a popular habit amongst the women in the present study, has a lower risk for cardiovascular disease than cigarette smoking, chronic abuse leads to morphological and function changes in the nasal mucosa (Sapundzhiev & Werner, 2003).

A recent South African survey found that 72 percent of households are headed by women, and 31 percent of all household heads are HIV positive (UNAIDS, 2002). In this study, almost 40 percent of the older HIV negative and HIV positive women had a self-headed household, placing them at greater risk for financial insecurity than one headed by a husband. The majority of the women in the present study were either unmarried or living together with a partner. More of the HIV positive women than uninfected women from both age groups in the present study were unmarried, could have played a role in their HIV status. The possibility of HIV positive women having multiple sexual relationships cannot be excluded in this regard (NICDAM, 2000). Similar levels of HIV infection were found among child-bearing women in Zambia, where the odds ratio in urban areas for unmarried and married women was 1:0.81 (Fylkesnes et al., 1997).

Results from the present study showed that significantly ($p=0.0178$) more of the older HIV negative than HIV positive women had no education, or primary school education only (Table 3). Of the 167 young HIV positive women, 73 reported that they had St 9-10, and 68 had only St 6-8. Of the older HIV positive women, more than half (51.2 percent) only had St 6-8. Pertaining that low educational attainment was a common trend in all the women, we did not identify a clear association between HIV infection and schooling. In our study sample, the number of respondents with no formal schooling or a tertiary qualification was very small. Nevertheless, this was true not only in the HIV-infected women, but also in those not infected. The distribution of our results was similar to an American study (Woods *et al.*, 2002), in that most women fell between the education levels of primary school to St 9-10. In the women's health status study by Hoffman *et al.* (1997) amongst women in Khayelitsha, 7 percent of the respondents had no formal schooling, 16.5 percent were functionally illiterate with less than five years of formal education, and 54.3 percent had some secondary education. According to figures released in 1995, 23 percent of African women aged 25 years and above had no formal education, and more than 25 percent had not passed grade 5. This can contribute to the marginal position of African women in the South African economy (Gilbert & Walker, 2002). In this study, the younger group of women seemed to be more educated than the older women, indicating that levels of education are improving amongst the younger African generation in poor settlements.

Unemployment rates were high amongst all the participants in this present study. Social discrimination in employment practices against individuals with HIV infection, and the numerous disease-associated symptoms are therefore unlikely explanations for unemployment in this study. In another Free State study, urban unemployment rates of

83 percent and 80 percent were reported respectively for HIV-affected and unaffected households (Bachmann & Booysen, 2003), which was generally higher than results from our study. In a recent study performed in informal settlements in the Vaal Triangle, 94.2 percent of the respondents, and 64.9 percent of their partners did not have a job (Oldewage-Theron et al., 2003), confirming that unemployment is a common trend amongst the socially disadvantaged.

More of the HIV negative than HIV positive women from both age groups in this study stayed in tin shacks, showing that living conditions of HIV positive women are not necessarily worse than that of their HIV negative counterparts. Furthermore, no significant relationships were found between room density in the case of HIV negative and HIV positive younger women (median: 2.5 versus 3.0) or HIV negative and HIV positive older women (median: 3 versus 2.85). In the Free State study by Bachmann and Booysen (2003), a mean of 5.6 persons versus 4.6 persons were reported respectively for HIV-affected and unaffected urban households ($p=0.002$), showing that affected households were larger than unaffected ones.

In this study, most households had their own tap for drinking water and a flush toilet. However, the lack of household facilities such as a working refrigerator and/or freezer and a working stove or primus in a reasonably large percentage of households causes concern. The availability of commodities such as safe drinking water, cold/frozen storage and proper cooking facilities are of great importance, particularly in HIV-affected households. Since there is the risk of food and water-related infections, the safe handling, cooking and storage of foods should be prioritized (Keithley, 1998).

CONCLUSION

Unemployment, poor education and household conditions were the general tendency, and not only relevant to HIV positive women. Strategies for intersectoral collaboration should be intensified in order to improve the current infrastructure and socio-economic status of women. In order to improve the quality of life of those already infected with the virus, it is important to create the necessary supportive environment.

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Table 1: Socio-demographic data of HIV negative and HIV positive women

	25-34 Years				35-44 Years			
	HIV NEGATIVE		HIV POSITIVE		HIV NEGATIVE		HIV POSITIVE	
	N	% of total group						
Language:	106		167		133		82	
• Sotho	49	46.23	93	55.69	73	54.89	38	46.34
• Tswana	29	27.36	41	24.55	27	20.30	29	35.37
• Afrikaans	5	4.72	1	0.60	4	3.01	2	2.44
• Other	23	21.70	32	19.16	29	21.80	13	15.85
Do you smoke at all?	106		167		133		82	
• Yes	4	3.77	15	8.98	44	33.08	20	24.39
• No	83	78.30	100	59.88	51	38.35	40	48.78
• Snuff	19	17.92	52	31.14	38	28.57	22	26.83
Marital status of respondent	106		167		133		82	
• Unmarried	39	36.79	62	37.13	35	26.32	19	23.17
• Married	22	20.75	22	13.17	32	24.06	8	9.76
• Divorced	2	1.89	4	2.40	8	6.02	10	12.2
• Separated	2	1.89	2	1.20	9	6.77	3	3.66
• Widowed	0	0.00	3	1.80	6	4.51	8	9.76
• Living together	37	34.91	70	41.92	37	27.82	29	35.37
• Traditional marriage	4	3.77	4	2.40	6	4.51	3	3.66
• Other	0	0.00	0	0.00	0	0.00	2	2.44

Table 1: Socio-demographic data of HIV negative and HIV positive women (Continued)

	25-34 Years				35-44 Years			
	HIV NEGATIVE		HIV POSITIVE		HIV NEGATIVE		HIV POSITIVE	
	N	% of total group						
What is your highest level of education?	106		167		133		82	
• None	1	0.94	1	0.60	17	12.78	3	3.66
• Primary school	13	12.26	23	13.77	47	35.34	23	28.05
• St 6-8	32	30.19	68	40.72	50	37.59	42	51.22
• St 9-10	58	54.72	73	43.71	18	13.53	14	17.07
• Tertiary education	2	1.89	2	1.20	1	0.75	0	0.00
Employment status of respondent	106		167		133		82	
• Housewife by choice	1	0.94	0	0.00	0	0.00	0	0.00
• Unemployed	83	78.30	120	71.86	86	64.66	59	71.95
• Self employed	2	1.89	5	2.99	6	4.51	5	6.10
• Full time wage earner	2	1.89	2	1.20	4	3.01	3	3.66
• Other, specify (part-time, piece job, etc.)	18	16.98	40	23.95	37	27.82	15	18.29
Husband/partner's employment status	65		99		80		49	
• Retired by choice	0	0.00	0	0.00	1	1.25	0	0.00
• Unemployed	9	13.85	12	12.12	9	11.25	5	10.20
• Self employed	2	3.08	7	7.07	1	1.25	3	6.12
• Full time wage earner	31	47.69	65	65.66	44	55.00	24	48.98
• Other, specify (part-time, piece job, etc.)	23	35.3	15	15.15	25	31.25	17	34.69

Table 1: Socio-demographic data of HIV negative and HIV positive women (Continued)

	25-34 Years				35-44 Years			
	HIV NEGATIVE		HIV POSITIVE		HIV NEGATIVE		HIV POSITIVE	
	N	% of total group						
Who is the head of this household?	106		167		133		82	
• Self	16	15.09	25	14.97	52	39.10	31	37.80
• Husband	39	36.79	38	22.75	57	42.86	18	21.95
• Child/Children	0	0.00	0	0.00	0	0.00	0	0.00
• Parent	40	37.74	65	38.92	17	12.78	20	24.39
• Grandparent	3	2.83	9	5.39	0	0.00	0	0.00
• Friend	1	0.94	0	0.00	0	0.00	0	0
• Other, specify	7	6.60	30	17.96	7	5.26	13	15.85
Type of dwelling	106		167		133		82	
• Brick, Concrete	71	66.98	129	77.25	98	73.68	60	73.17
• Traditional mud	0	0.00	1	0.60	0	0.00	0	0.00
• Tin	23	21.70	28	16.77	32	24.06	18	21.95
• Plank wood	9	8.49	7	4.19	3	2.26	3	3.66
• Other, specify	3	2.83	2	1.20	0	0.00	1	1.22
Where do you get drinking water most of the time?	106		167		133		82	
• Own tap	100	94.34	153	91.62	126	94.74	77	93.90
• Communal tap	6	5.66	14	8.38	7	5.26	4	4.88
• Other	0	0.00	0	0.00	0	0.00	1	1.22

Table 1: Socio-demographic data of HIV negative and HIV positive women (Continued)

	25-34 Years				35-44 Years			
	HIV NEGATIVE		HIV POSITIVE		HIV NEGATIVE		HIV POSITIVE	
	N	% of total group						
What type of toilet does this household have?	106		167		133		82	
• Flush	98	92.45	154	92.22	127	95.49	79	96.34
• Bucket, pot	8	7.55	13	7.78	6	4.51	3	3.66
Does the home have a working refrigerator and/or freezer?	106		167		133		82	
• Yes	61	57.55	86	51.50	67	50.38	40	48.78
• No	45	42.45	81	48.50	66	49.62	42	51.22
Does the home have a working stove (gas, coal or electric) or hot plate?	106		167		133		82	
• Yes	81	76.42	117	70.06	90	67.67	50	60.98
• No	25	23.58	50	29.94	43	32.33	32	39.02
Does the home have a working primus or paraffin stove?	106		167			133		82
• Yes	71	66.98	116	69.46	104	78.20	63	76.83
• No	35	22.02	51	30.54	29	21.80	19	23.17
Does the home have a working microwave?	106		167		133		82	
• Yes	14	13.21	16	9.58	12	9.02	3	3.66
• No	92	86.79	151	90.42	121	90.98	79	96.34
Does the home have a working radio and/or television?	106		167		133		82	
• Yes	95	89.62	142	85.03	103	77.44	66	80.49
• No	11	10.38	25	14.97	30	22.56	16	19.51

Table 2: Significance of differences in the socio-demographic profile between HIV negative and HIV positive women (25-34 years)

SIGNIFICANCE OF DIFFERENCES IN SOCIO-DEMOGRAPHIC PROFILE BETWEEN HIV NEGATIVE AND HIV POSITIVE WOMEN (25-34 YEARS)					
	Age group 25-34 years				P value
	HIV NEGATIVE		HIV POSITIVE		
	N	% of total group	N	% of total group	
Smoke					
● Yes/Snuff	23	21.70*	67	40.12*	0.0016*
● No	83	78.30	100	59.88	
Marital status					
● Married/Traditional marriage	26	24.53	26	15.57	0.0662
● Other	80	75.47	141	84.43	
Highest level of education					
● None/ primary	14	13.21	24	14.37	0.7866
● Other	92	86.79	143	85.63	
Employment status of respondent					
● Unemployed	83	78.30	120	71.86	0.2346
● Other	23	21.70	47	28.14	
Head of household					
● Husband	39	36.79*	38	22.75*	0.0120*
● Other	67	63.21	129	77.25	
Type of dwelling					
● Brick	71	66.98	129	77.25	0.0618
● Other	35	33.02	38	22.75	
Source of drinking water					
● Own, communal	106	100.00	167	100.00	
● Other	0	0.00	0	0.00	
Type of toilet of household					
● Flush toilet	98	92.45	154	92.22	0.9428

Table 2: Significance of differences in the socio-demographic profile between HIV negative and HIV positive women (25-34 years) (Continued)

SIGNIFICANCE OF DIFFERENCES IN SOCIO-DEMOGRAPHIC PROFILE BETWEEN HIV NEGATIVE AND HIV POSITIVE WOMEN (25-34 YEARS)					
	Age group 25-34 years				P value
	HIV NEGATIVE		HIV POSITIVE		
	N	% of total group	N	% of total group	
• Other	8	7.55	13	7.78	
Working refrigerator and/or freezer in home					
• Yes	61	57.55	86	51.50	0.3284
• No	45	42.45	81	48.50	
Working stove or hot plate in home					
• Yes	81	76.42	117	70.06	0.2516
• No	25	23.58	50	29.94	
Working primus or paraffin stove in home					
• Yes	71	66.98	116	69.46	0.6673
• No	35	33.02	51	30.54	
Working microwave oven in home					
• Yes	14	13.21	16	9.58	0.3504
• No	92	86.79	151	90.42	
Working radio and/or television in home					
• Yes	95	89.62	142	85.03	0.2744
• No	11	10.38	25	14.97	
Room density	106		167		
Median	2.5		3.0		0.3074
No. of years living in urban area					
Median	8.5		14		<0.0001

*Statistically significant

Table 3: Significance of differences in the socio-demographic profile between HIV negative and HIV positive women (35-44 years)

SIGNIFICANCE OF DIFFERENCES IN SOCIO-DEMOGRAPHIC PROFILE BETWEEN HIV NEGATIVE AND HIV POSITIVE WOMEN (35-44 YEARS)					
	Age group 35-44 years				P value
	HIV NEGATIVE		HIV POSITIVE		
	N	% of total group	N	% of total group	
Smoke					
● Yes/Snuff	82	61.65	42	51.22	0.1325
● No	51	38.35	40	48.78	
Marital status					
● Married/Traditional marriage	38	28.57*	11	13.41*	0.0101*
● Other	95	71.43	71	86.59	
Highest level of education					
● None/ primary	64	48.12*	26	31.71*	0.0178*
● Other	69	51.88	56	68.29	
Employment status of respondent					
● Unemployed	86	64.66	59	71.95	0.2679
● Other	47	35.34	23	28.05	
Head of household					
● Husband	57	42.86*	18	21.95*	0.0018*
● Other	76	57.14	64	78.05	
Type of dwelling					
● Brick	98	73.68	60	73.17	0.9340
● Other	35	26.32	22	26.83	
Source of drinking water					
● Own tap, communal	133	100.00	81	98.78	0.3814
● Other	0	0.00	1	1.22	
Type of toilet of household					
● Flush toilet	127	95.49	79	96.34	1.000

Table 3: Significance of differences in the socio-demographic profile between HIV negative and HIV positive women (35-44 years) (Continued)

SIGNIFICANCE OF DIFFERENCES IN SOCIO-DEMOGRAPHIC PROFILE BETWEEN HIV NEGATIVE AND HIV POSITIVE WOMEN (35-44 YEARS)					
	Age group 35-44 years				P value
	HIV NEGATIVE		HIV POSITIVE		
	N	% of total group	N	% of total group	
● Other	6	4.51	3	3.66	
Working refrigerator and/or freezer in home					
● Yes	67	50.38	40	48.78	0.8202
● No	66	49.62	42	51.22	
Working stove or hot plate in home					
● Yes	90	67.67	50	60.98	0.3172
● No	43	32.33	32	39.02	
Working primus or paraffin stove in home					
● Yes	104	78.20	63	76.83	0.8152
● No	29	21.80	19	23.17	
Working microwave oven in home					
● Yes	12	9.02	3	3.66	0.1337
● No	121	90.98	79	96.34	
Working radio and/or television in home					
● Yes	103	77.44	66	80.49	0.5970
● No	30	22.56	16	19.51	
● Yes					
● No					
Room density	133		82		
Median	3.0		2.85		0.3296
No. of years living in urban area	133		82		
Median	10		12.5		<0.0001

*Statistically significant

CHAPTER 5

ANTHROPOMETRIC NUTRITIONAL STATUS OF HIV POSITIVE WOMEN (25-44 YEARS) IN MANGAUNG

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ABSTRACT

Objective: This study formed part of a larger study investigating the nutritional health of women in Mangaung. *Design:* Cross-sectional study. *Methodology:* A population-based random sample of 500 women was selected using township maps. The sample was divided into women between 25 and 34 years (n=273) and 35 and 44 years (n=215). Anthropometric information included body mass index (BMI), waist-hip-ratio (WHR) and fat percentage. Accepted World Health Organization (WHO) methods for determining weight, height, waist and hip circumference were used. Bodystat was used to determine bioimpedance. HIV status was determined using a micro-particle enzyme immunoassay method. Women were categorized according to BMI as underweight (BMI <18.5 kg/m²), normal weight (BMI 18.5 - <25 kg/m²), overweight (BMI 25 - <30 kg/m²) and obese (BMI ≥30 kg/m²). Fat distribution was classified as android (WHR ≥ 0.8) and gynoid (WHR < 0.8). Fat percentage between 15% and 22% was considered optimal. BMI and WHR were described by medians and percentiles and compared by non-parametric 95% confidence intervals (CI) for the median difference as well as the Mann-Whitney test. Fat percentage was described by the mean and standard deviation and compared by 95% CI's for the mean difference as well as the student t-test. *Results:*

Sixty one percent of the younger group and 38% of the older group were HIV positive. In both the younger and older groups the majority of women had a gynoid fat distribution and no association between HIV status and WHR ratio was found ($p = 0.67$ and 0.48 respectively). In the younger group, median BMI of HIV positive women (24.4kg/m^2) was significantly lower than BMI of HIV negative women (27.6kg/m^2) ($p < 0.01$). Mean fat percentage of younger women with HIV (35.34%) was also significantly lower than that of the HIV negative group (38.32%) ($p < 0.01$). In the older group BMI and fat percentage of the HIV positive and HIV negative women did not differ significantly ($p=0.89$ and $p=0.66$, respectively). *Conclusions:* In this population, the prevalence of HIV infection is higher in younger (25-34 years) than in older women (35-44 years). In the younger group, HIV status is associated with BMI and fat percentage, which are both related to mortality and morbidity. In order to differentiate between these variables in women with HIV and those with AIDS, the stage of infection would be useful.

Keywords: South Africa; HIV; African women; anthropometry

INTRODUCTION

From the start, nutrition was acknowledged as an important factor in HIV infection (Woods *et al.*, 2002) and is now generally accepted as a major determinant of immune functioning (Chandra, 1997). Nutritional factors, although not the most important etiological determinants may change immune function to facilitate disease progression, influence viral expression, and play a significant role in disease processes and related morbidity and mortality (Baum & Shor-Posner, 1998).

Any immune dysfunction as a result of HIV/AIDS leads to malnutrition, immune dysfunction, intensifies the effect of HIV, and contributes to faster progression to AIDS

(United States Agency for International Development (USAID), 2001; Department of Health, South Africa (DoH, SA), 2001). Symptoms of malnutrition include weight loss, loss of muscle tissue and subcutaneous fat, vitamin and mineral deficiencies, reduced immune competence, and an increased susceptibility to infection (Piwoz & Preble, 2000). Wasting is usually preceded by changes in appetite, repeated infections, weight fluctuations, and changes in body composition, including changes in lean body mass and cell mass (Babameto & Kotler, 1997).

While South Africans are coping with the HIV/AIDS epidemic, they are also living in a time characterised by a transition in lifestyle. The concept of the nutrition transition is described by Popkin (1994) as “a sequence of characteristic dietary and nutritional problems resulting from large shifts in overall dietary structure, related to changing economic, social, demographic and health factors”.

In addition to the transition from generally more healthy traditional diets to a Western diet, populations have become more sedentary and energy expenditure is much lower than it used to be. As a result the prevalence of chronic lifestyle diseases such as obesity, coronary heart disease, hypertension and type 2 diabetes mellitus has reached epidemic proportions (WHO, 1990).

Data on the interaction between nutritional status and HIV/AIDS is widely available in industrialized countries, but is often not available in African countries, where food availability differs greatly from that in the developed world, and where endemic malnutrition and lack of nutrition management are common (Castetbon *et al.*, 1997). In addition to malnutrition, it has become apparent that over nutrition and obesity may have a suppressing effect on the immune system (Chandra, 1997). Woods *et al.* (2002) have

stated that women are particularly at risk of inadequate dietary intake, but information about HIV-infected women and weight loss is scarce.

Therefore, the aim of this study was to determine the association of HIV status and anthropometry in women living in an urban area (Mangaung, South Africa).

METHODOLOGY

An epidemiological study was undertaken with the main objective of investigating the nutritional health of women between 25 and 44 years of age in Mangaung, the African residential community of Bloemfontein. As part of the larger study, socio-demographic status, health status as determined by a medical examination, dietary intake, levels of physical activity, body perception and attitude toward weight control, prevalence and risk of diseases of lifestyle, anthropometry and prevalence of HIV were determined. For the purpose of this publication we will report on the association between anthropometry and HIV status.

A random sample of 500 African women, from the two age groups 25-34 and 35-44 years was selected in Mangaung using township maps obtained from the Greater Bloemfontein Municipality. The sample included respondents from two built-up areas, namely Phahameng and Botchabela, and two informal settlements, namely Joe Slovo and Namibia. Respondents took part in the study voluntarily and gave written informed consent. The Ethics Committee of the Faculty for Health Sciences, University of the Free State (ETOVS no. 02/00) approved the study. The results of 4 women that were found to be pregnant during the medical examination were excluded and blood samples could not be obtained in 8 women.

BMI, WHR and fat percentage were determined. Women were categorised according to BMI as underweight (BMI <18.5 kg/m²), normal weight (BMI 18.5 - <25 kg/m²), overweight (BMI 25 - <30 kg/m²) and obese (BMI ≥30 kg/m²) (Laquatra, 2000, p. 493). Women were classified according to WHR as having an android (WHR ≥ 0.8) or gynoid (WHR < 0.8) fat distribution (Hammond, 2000, p. 327). A fat percentage between 15 and 22 was considered optimal (Nieman, 1990).

All anthropometric measurements were taken after an overnight fast, and after voiding. The same registered dietitian and qualified anthropometrist, took all the measurements throughout the study. Participants wore an examination gown, without shoes.

Weight was determined with a SECA digital electronic scale to the nearest 0.1 kilogram (kg). Height was determined by means of a stadiometer to the nearest 0.5 centimeter (cm). Waist and hip circumferences were measured with a flexible tape measure to the nearest 0.5 cm. Close contact was maintained, without compression of the underlying tissue (Lee & Nieman, 1996, p. 225-229).

Bioelectrical impedance analysis was used to determine body composition for fat. Respondents were instructed to follow the guidelines for consistent and accurate results, when written consent was obtained. The prescribed procedures for measurements were strictly adhered to (Bodystat R1 500).

All blood samples were taken by a registered nursing sister. HIV status was determined with a micro-particle enzyme immunoassay method (kits supplied by Abbott laboratories).

STATISTICAL ANALYSIS

BMI and WHR were described by medians and percentiles and compared by non-parametric 95 percent CI for the median difference as well as the Mann-Whitney test. Fat percentage was described by the mean and standard deviation and compared by 95 percent CI for the mean difference as well as the student t-test.

RESULTS

In this population, the prevalence of HIV infection was higher in younger (25-34 years) than in older women (35-44 years). Sixty one percent of younger women and 38 percent of older women were HIV infected.

BMI

In Table 1 BMI of HIV negative and HIV positive women is described. In the younger group, the median BMI of HIV negative women fell within the overweight category at 27.6 kg/m² compared to the 24.4 kg/m² of the HIV positive women, thus a median difference of 2.42 kg/m², which was statistically significant (CI for mean difference [1.1; 3.8], p <0.01). In the older group the median BMI of both HIV negative and HIV positive women fell within the overweight category and was very similar (25.0 kg/m² and 25.3 kg/m² respectively).

In all groups, the prevalence of underweight was low, ranging from 1.9 percent in the younger HIV negative women to 6.1 percent in the older HIV positive women. Although a large percentage of both HIV negative and HIV positive women had a BMI that fell

within the normal range, almost 50 percent or more of women in all groups were either overweight or obese.

WHR

The median WHR of both younger and older HIV negative and HIV positive women fell below 0.8, indicating a gynoid fat distribution. The median WHR of the younger HIV negative and HIV positive women was 0.736 and 0.731 respectively, thus a median difference of 0.004 which was not statistically significant (CI for median difference [-0.01; 0.02], $p=0.67$). In the older group the median WHR was 0.778 for HIV negative women and 0.774 for HIV positive women, also not statistically significant (CI for median difference [-0.01;0.03], $p=0.48$). In the older age group, a larger percentage of women had an android fat distribution than in the younger groups (ranging from 35.4 percent of older HIV positive women to 39.1 percent of older HIV negative women).

Fat percentage

The fat percentage of HIV negative and HIV positive women is given in Table 3. The mean fat percentage of all women, regardless of age or HIV status, fell within the obese category. The mean fat percentage of the HIV negative younger women was 38.32 percent compared to the 35.34 percent of the HIV positive women, thus a mean percentage difference of 2.98 percent, which was found to be statistically significant (CI for mean difference [1.11; 4.85], $p<0.01$). In contrast to the younger group, the mean fat percentage of HIV negative and HIV positive older women did not differ significantly (CI for mean difference [-2.70; 1.72], $p = 0.66$). Very few women had an optimal fat percentage, ranging from 2.3 percent in the older HIV negative group to 3.0 percent in the younger HIV positive group. In the younger group 92.5 percent of HIV negative women and 85 percent of HIV positive women were classified as fat and obese. In the

older group, more than 92 percent of both HIV negative and HIV positive women were either fat or obese.

DISCUSSION

South Africa is experiencing a major growing AIDS epidemic (Medical Research Council, South Africa (MRC, SA), 2000; Treatment Action Campaign (TAC), 2001), with over 1 500 people becoming infected every day. It is estimated that South Africa has more HIV-infected people than any other country, except India (National Institute Community Development and Management (NICDAM), 2000). It is difficult to estimate the actual prevalence of HIV infection in South Africa, due to the absence of nationally representative data. Prevalence of HIV in our random sample was very high at 61 percent in women between 25 and 34 years and 38 percent in women between 35 and 44 years.

In this study, median BMI of younger HIV positive women was significantly lower than that of younger HIV negative women (24.4 kg/m² and 27.6 kg/m² respectively). In contrast, the results from the Transition and Health during Urbanization of South Africans (THUSA) study (Nienaber *et al.*, 2000) showed no differences in BMI of HIV positive and HIV negative subjects (26.1 kg/m² and 27.0 kg/m² respectively). The women included in our random sample included both healthy and ill women, whereas the THUSA study only included apparently healthy subjects over a much wider age distribution.

Weight loss and wasting in AIDS patients are multi-factorial, with the major determinants being inadequate food intake, malabsorption, metabolic disturbances, uncontrolled opportunistic infection and lack of physical activity (Fenton & Silverman, 2000, p. 899).

According to Macallan (1999), weight loss and wasting in people living with HIV/AIDS develop as a result of three processes. Firstly, weight loss occurs when energy expenditure exceeds energy intake, resulting from an inadequate intake of macronutrients. Secondly, weight loss is caused by nutrient malabsorption. Thirdly, weight loss is caused by metabolic disturbances.

It seems, however, if the BMI of HIV infected individuals can vary. Kim et al. (2001), provided evidence that more than 20 percent of women in their study were obese, and 50 percent were overweight. Individuals with a baseline BMI above 25 had a much lower death risk than those with a BMI below 25, emphasizing the importance of weight maintenance in HIV infected individuals.

Contrary to wasting is the appearance of obesity in HIV infected individuals. Bell et al. (1997), found that the BMI of the participants ranged between 20 and 38 kg/m². A significant correlation was found between BMI and the extra cellular mass/body cell mass ratio, indicating that overweight patients may be more likely to be considered malnourished than patients with normal weight. Malnutrition in this case was characterised by the abnormal extra cellular/body cell mass ratio. A possible linking characteristic is hyperinsulinemia, which is characteristic of obesity, and is a profound determinant of sodium and fluid retention. More research on large numbers of obese, HIV infected individuals has, however, been suggested to determine whether these patients are indeed more malnourished than those with normal body weight (Bell et al., 1997).

Weight loss or wasting, is associated with poor health and earlier morbidity, and is therefore a major problem in HIV-infected individuals (DoH, SA, 2001). This weight loss

typically found in adult AIDS patients (Summerbell, 1994; Macallan et al., 1995; Gramlich & Mascioli, 1995; Babameto & Kotler, 1997; Casey, 1997; Fenton & Silverman, 2000, p. 899) is a severe nutritional manifestation of the disease (Babameto & Kotler, 1997).

The median WHR of both younger and older HIV negative and HIV positive women fell below 0.8, indicating a gynoid fat distribution. The median WHR of the younger HIV negative and HIV positive women was 0.736 and 0.731. In the older group the median WHR was 0.778 for HIV negative women and 0.774 for HIV positive women. These results compare well with the median WHR of 0.76 for both HIV positive and HIV negative women in the THUSA study (Nienaber et al., 2000).

The mean fat percentage of all women, regardless of age or HIV status, fell within the obese category. The mean fat percentage of the HIV negative younger women was 38.32 percent, which was significantly higher than the 35.34 percent of the HIV positive women. Results from the THUSA study showed even higher mean fat percentages of 42.9 percent for HIV negative and 43.9 percent for HIV positive women, determined using the sum of seven skinfolds (Nienaber et al., 2000).

Weight loss with depletion of body cell mass and changes in fat free mass, are common indicators of HIV/AIDS infection (Fenton & Silverman, 2000, p. 899; Piwoz & Preble, 2000). Early studies of the body composition of persons with AIDS documented weight loss typified by preferential loss of muscle mass and relative sparing of fat stores. More recent studies, however, have shown a different weight loss pattern, with individuals with a higher body fat content at the onset of wasting, losing relatively more fat, and individuals with a lower body fat content losing relatively more muscle mass (Mulligan et

al., 1997). Women also lose more body fat than lean body mass during early and advanced stages of wasting (Fenton & Silverman, 2000, p. 900), possibly due to the higher fat percentage at the onset of disease.

CONCLUSION

In conclusion, the results of the study indicate that prevalence of HIV infection is high in Mangaung, especially amongst women between 25 and 34 years. In both HIV negative and HIV positive women prevalence of obesity is very high as indicated by BMI and fat percentage. However, both of these parameters are significantly lower in the HIV positive younger women than in the HIV negative younger women.

According to Gramlich & Mascioli (1995), “records of weight changes and recognition of weight change patterns over time may supply invaluable information for diagnostic, therapeutic and nutritional intervention, and should be considered as minimal standard of care for HIV-infected patients”.

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Table 1: BMI of HIV negative and HIV positive younger (25-34 years) and older (35-44 years) women

Age group	HIV status	Median kg/m ²	BMI categories							
			Underweight <18.5 kg/m ²		Normal 18.5<25 kg/m ²		Overweight 25<30 kg/m ²		Obese ≥30 kg/m ²	
			N	%	N	%	N	%	N	%
25-34 yrs:	HIV- (n=106)	27.6*	2	1.9	38	35.8	32	30.2	34	32.1
	HIV+ (n=166)	24.4*	5	3.0	83	50.0	50	30.1	28	16.9
35-44 yrs:	HIV- (n=133)	25.0	4	3.0	62	46.6	36	27.1	31	23.3
	HIV+ (n=82)	25.3	5	6.1	33	40.2	23	28.1	21	25.6

Table 2: WHR of HIV negative and HIV positive younger (25-34 years) and older (35-44 years) women

Age group	HIV status	Median	WHR			
			<0.8		≥0.8	
			N	%	N	%
25-34 yrs:	HIV- (n = 106)	0.736	85	80.2	21	19.8
	HIV+ (n = 167)	0.731	144	86.2	23	13.8
35-44 yrs:	HIV- (n = 133)	0.778	81	60.9	52	39.1
	HIV+ (n = 82)	0.774	53	64.6	29	35.4

Table 3: Fat percentage of HIV negative and HIV positive younger (25-34 years) and older (35-44 years) women

Age group	HIV status	Mean fat % (SD)	Lean < 15 %		Optimal 15-22 %		Slightly overweight 23-26 %		Fat 27-32 %		Obese ≥ 32 %	
			N	%	N	%	N	%	N	%	N	%
25-34 yrs:	HIV- (n = 106)	38.32* (7.61)	0	0.0	3	2.8	5	4.7	14	13.2	84	79.3
	HIV+ (n = 167)	35.34* (7.65)	1	0.6	5	3.0	19	11.4	32	19.1	110	65.9
35-44 yrs:	HIV- (n = 133)	38.37 (8.06)	0	0.0	3	2.3	7	5.2	19	14.3	104	78.2
	HIV+ (n = 82)	38.86 (7.85)	0	0.0	0	0.0	6	7.3	11	13.4	65	79.3

CHAPTER 6

MACRONUTRIENT INTAKE OF HIV SEROPOSITIVE WOMEN (25-44 YEARS) LIVING IN MANGAUNG, SOUTH AFRICA

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ABSTRACT

Objective: To determine the macronutrient intake of HIV positive women. *Design:* Cross-sectional study of a representative group of 500 pre-menopausal women (25-34 years and 35-44 years). *Methodology:* Macronutrient intake was determined using a Quantitative Food Frequency Questionnaire. Median macronutrient intake of HIV seropositive and -negative women was compared to the Dietary Reference Intakes (DRI). *Results:* Sixty one percent of the younger women and 38% of older women were HIV infected. In the younger group median energy intake of HIV seronegative women was significantly lower compared to HIV seropositive women. In the older group no significant differences in energy intake were found. Median total protein, fat and carbohydrate intakes of all women exceeded the DRI. *Conclusions:* Energy intake of young HIV seropositive women was significantly higher than HIV seronegative as well as older HIV seropositive counterparts. The main focus of intervention should be to improve the quality of food intake. Information regarding the resting energy needs of HIV seropositive individuals needs further investigation.

Key words: South Africa; HIV; African women; dietary intake; macronutrients

INTRODUCTION

The HIV epidemic continues to expand in Sub-Saharan Africa, where it has been declared by the World Health Organization (WHO, 1995) as one of the major public health threats. Malnutrition is considered as one of the most significant, but puzzling consequences of HIV infection (Niyongabo *et al.*, 1999; Fenton & Silverman, 2000, p. 899). Nutrition plays an integral part within the Comprehensive HIV and AIDS Treatment Programme implemented by the South African National Government, especially in those individuals with CD4 lymphocyte counts above 200 cells/mm³ who will not receive antiretroviral therapy. The development of malnutrition during HIV/AIDS infection is complex, and broadly includes reduced dietary intake, nutrient malabsorption and metabolic alterations (Jariwalla, 1995; Gasparis & Tassiopoulos, 2001).

Good nutrition is the cornerstone for maintaining an optimum immune response (Gay & Meydani, 2001; Woods *et al.*, 2002). It is well-documented that an inadequate energy intake remains one of the primary determinants of wasting and weight loss in HIV/AIDS patients (Lakshmi pathi & Jastremski, 1989; Gramlich & Mascioli, 1995; Macallan, 1999; United States Agency for International Development (USAID), 2001). Several studies have confirmed that a large percentage of HIV patients seem likely to be deficient in macronutrients (Jariwalla, 1995; Carbonnel *et al.*, 1997; Gay & Meydani, 2001). In underdeveloped countries, protein-energy-malnutrition is the first cause of immunodeficiency (Melchior, 1997). In HIV, protein-energy-malnutrition is most often secondary to the underlying disease, and is characterised by low body weight, a small muscle mass, and a general lack of energy, protein and other nutrients (Cederholm, 1996). Women are particularly at risk of inadequate dietary

intake, but information about HIV-infected women, their dietary intake and weight loss is limited (Woods et al., 2002).

Data on the interaction between nutritional status and HIV/AIDS is well-documented (Gramlich & Mascioli, 1995) for industrialized countries, but is often unavailable in African countries, where food availability differs extremely from that in Africa, and where endemic malnutrition and poor nutritional management are common (Castetbon et al., 1997). This is of particular importance in Sub-Saharan Africa, where poor nutritional status and food insecurity essentially affect the lives of approximately 400 million people (Steyn & Walker, 2000). The results from studies performed in Western societies can therefore not be generalized to forecast the conditions in African populations (van Staden et al., 1998). A study conducted among HIV-1 seropositive patients in the Free State Province, South Africa, reported that the majority of participating subjects showed adequate energy and protein intakes (Dannhauser et al., 1999). Results of energy intakes from other studies however, vary widely, ranging from inadequate (Carbonnel et al., 1997; McCorkindale et al., 1990; Luder et al., 1995; Castetbon et al., 1997; Kim et al., 2001), to adequate (Dworkin et al., 1990), to high (Hogg et al., 1995; Izquierdo et al., 2002). The same trend was also observed for protein intakes, ranging from inadequate (Kim et al., 2001; Izquierdo et al., 2002), to intake above the recommendations (Dworkin et al., 1990; Hogg et al., 1995). Other studies reported high fat intake, associated with inadequate intake of carbohydrate (Izquierdo et al., 2002).

Further studies have been suggested to determine the possibility of a relationship between dietary intakes and nutritional status in HIV-infected patients in the African

milieu (Castetbon *et al.*, 1997). The identification and correction of nutrient deficiencies may thus play a more prominent role in developing countries where AIDS is spreading rapidly, nutritional problems occur commonly, and expensive drugs are generally unavailable (Semba & Tang, 1999).

This article is used to report only the macronutrient intake of HIV seropositive and seronegative women with a low socio-economic background living in Mangaung, Free State Province, South Africa. These findings are important for public health practice and could be used to design future nutrition intervention programmes.

METHODOLOGY

The Department of Biostatistics, University of the Free State, randomly chose women from the Mangaung District, Bloemfontein, South Africa. A township map, obtained from the greater Bloemfontein municipality, was used to make the selection. Women were selected from two informal settlements and two formal settlements. Plots within the designated areas were counted and numbered and a proportionate number of respondents were selected randomly from these plots. The size of the sample was considered representative of the population of the Mangaung District. Trained community healthcare workers were responsible for the recruitment of the subjects. The healthcare workers were given detailed instructions about the recruitment of subjects as well as a detailed map of twenty of the selected plots on a weekly basis. On arrival of the plot the inhabitants were screened for eligibility.

The Ethics Committee of the Faculty of Health Sciences, University of the Free State, approved this study (ETOVS number 02/00). The assigned community health

workers explained the content and purpose of the study to possible participants. It was required that each recruited subject gave informed consent. Subjects were given R40-00 to participate in the study. Subjects were also given the opportunity to indicate whether they would like to receive their HIV test results, or whether the outcome should be withheld from them. All subjects that chose to be given the outcome of their test results were referred to a medical practitioner, for post-test counselling and if required, a confirmatory test. The research team was unaware of the outcome of the individual HIV tests due to blinding. Energy, macronutrient, and cholesterol intakes were determined using a validated Quantitative Food Frequency Questionnaire that included Western foods and traditional foods typical of an African diet. The questionnaire was used to determine the habitual types and quantities of foods and drinks consumed by the respondents. The Food Frequency Questionnaire was administered during individual interviews by trained interviewers. Three interpreters assisted the interviewers.

The quantities of food items recorded on the questionnaire were converted to gram weights using the Food Quantities Manual (Langenhoven *et al.*, 1991), and were processed by using the Food Composition Database from the Medical Research Council (Langenhoven *et al.*, 1998). Nutrient intakes were compared to the Recommended Dietary Allowance (RDA) or Adequate Intake (AI). The percentage of respondents with intakes <67 percent of the RDA/AI was also calculated.

STATISTICAL ANALYSIS

Nutrient intake was reported using medians. Other continuous data was described using frequencies and percentages. The median nutrient intake of HIV seropositive

and HIV seronegative women was compared by means of non-parametric 95 percent confidence intervals (CI) for the median difference, and the significance thereof assessed using the Mann-Whitney test.

RESULTS

A total of 500 subjects were recruited for this study. A total of 488 recruited individuals were eligible to participate in the study. Four subjects were found to be pregnant during the medical examination and were excluded from the study. Another 8 subjects were found to be either older or younger than the required age for inclusion into the study. These subjects were excluded from the analyses. Of the 488 subjects, 273 were 25-34 years of age and 215 were 35-44 years of age. The sampling strategy was designed specifically to compare these two age categories in order to render the study results comparable to other previous studies performed within the same geographical area. The sampling strategy does not allow for a discussion of the group results as a whole.

The median total energy intake of both age groups as a whole exceeded the RDA. In both age groups the median total protein intake of the participants exceeded the RDA of 46 g/day. The ratio of median total plant protein intake to median total animal protein intake was almost 1:1 for both age groups. The median total carbohydrate intake of all the participants was more than double the RDA of 130 gram per day. In contrast to all other nutrients, both age groups did not meet the AI of 25 g/day for dietary fibre intake. Median total fat intake of both groups was higher when compared to the recommended intake of less than 30 percent of the total daily energy intake.

Sixty one percent (N=167) of the younger group of women (25-34 years) and 38 percent (N=133) of the older group of women (35-44 years) tested HIV seropositive. In the younger HIV seronegative group the median energy intake (10 447 kJ) was significantly ($p<0.049$) lower when compared to the HIV seropositive group (12 024 kJ). The dietary fibre intake in this age group was also reported to be higher in the HIV seropositive group when compared to the HIV seronegative group. In the older group the HIV seropositive individuals reported an energy intake of 10 454 kJ compared to 11 110 kJ for women without HIV. There were no other significant differences between any of the reported intakes within the different study groups.

DISCUSSION

In Sub-Saharan Africa, where HIV disease is highly prevalent, malnutrition is a frequent and serious complication of infection with the virus (Castetbon *et al.*, 2000), and is related to morbidity and mortality (Babameto & Kotler, 1997). Malnutrition is multifactorial in nature, and often presents as a result of simultaneously occurring problems related to malabsorption, metabolic alterations and inadequate food intake (Gramlich & Mascioli, 1995; Cimocho, 1997). In HIV-infected patients, a decrease in oral intake may appear even during the asymptomatic stage (McCorkindale *et al.*, 1990). Published evidence about dietary intake in HIV disease is however scant (Gramlich & Mascioli, 1995; Woods *et al.*, 2002) particularly in women (Woods *et al.*, 2002).

The relationship between HIV/AIDS and malnutrition is a classic “vicious cycle” of immune dysfunction, infectious disease and malnutrition (Piwoz & Preble, 2000).

Recent research has shown that nutritional status may affect the progression of HIV disease in adults. The double burden of raised resting energy needs and decreased nutrient absorption in people living with HIV/AIDS, places additional strain on the importance of nutrition in maintaining a healthy immune status (Lane & Provost-Craig, 2000).

In this study, the total energy, macronutrient and cholesterol intakes of older and younger groups of HIV seropositive and HIV seronegative women exceeded the recommendations for healthy adults of the same age. HIV seropositive women in the younger group consumed significantly more energy than the uninfected women within the same group. On the basis of the observed increase in resting energy expenditure (REE) with HIV infection, it is accepted that energy requirements are likely to be increased by approximately 10 percent to maintain body weight and physical activity in asymptomatic HIV-infected adults. During symptomatic HIV and subsequently during AIDS there is an even further increase in energy requirements of about 20 to 30 percent to maintain body weight (WHO, 2003). A number of studies indicate that HIV positive patients have higher energy intakes than their HIV negative counterparts (Hogg *et al.*, 1995; Izquierdo *et al.*, 2002; Williams *et al.*, 2003). A habitual energy intake greater than energy expenditure promotes obesity in healthy adults (Björntorp, 2001). Obesity favours the development of a number of health problems and co-morbidities or chronic diseases associated with a westernized lifestyle (Laquatra, 2000, p. 486).

Izquierdo and co-workers (2002) reported high energy and fat intakes accompanied by deficient intakes of carbohydrates and proteins. Other studies demonstrate that HIV seropositive patients consume significantly higher energy, protein, fat,

carbohydrate and cholesterol when compared to HIV seronegative controls (Hogg *et al.*, 1995; Williams *et al.*, 2003). Although the latter two studies were performed in men, the general trend of higher energy and macronutrient intakes of HIV seropositive patients are similar to that found in our study. It is suspected that the high total carbohydrate intake in our study can be ascribed to the staple diet of maize products. Most South African studies confirm that the intakes of total protein of adult Whites, Africans, Coloureds, and Indians either meet or exceed recommended intakes (Vorster *et al.*, 1997). Although median total protein intake exceeded the RDA in our study, existing data are inadequate to support recommendations to increase protein intake above the requirements for health (12 percent to 15 percent of total energy intake) for those living with HIV/AIDS (WHO, 2003).

When total fat intake was expressed as a percentage of total energy intakes in the present study, intakes in all the women fell within the recommended level. However, as the median total energy intake of all the women was high, the actual intake of fats exceeded the recommended level (Truswell, 1994). The adverse effects of excess fat intake on health are well-known. In addition, median cholesterol intakes exceeded the RDA in the younger HIV seropositive women. Total fat intakes in HIV patients should be maintained (WHO, 2003), unless diarrhea, associated with more advanced stages of HIV infection is present (Department of Health, South Africa (DoH, SA), 2001; WHO, 2003).

In the literature there are studies that report decreased energy intakes in HIV-infected patients (Carbonnel *et al.*, 1997; Castetbon *et al.*, 1995; McCorkindale *et al.*, 1990; Luder *et al.*, 1995; Kim *et al.*, 2001), and even in asymptomatic HIV-infected subjects and patients with early AIDS-related complex (McCorkindale *et al.*, 1990).

However, it is very difficult to compare results from this study with other similar studies. Nutrient intake is specific to a study population and depends on a variety of factors that are difficult to control for. These factors include cultural, socio-economic, environmental and geographical determinants. Study results are therefore unique to a specific population and should recommendations therefore be made pertaining to that specific population (Willett, 1998, p. 4).

Dietary fibre is believed to exert some beneficial metabolic effects (Insel *et al.*, 2001, p. 89). The reported total dietary fibre intake was marginally low in this study. In the HIV seronegative group it would especially benefit individuals to replace fat with dietary fibre. In HIV seropositive individuals, a high fibre intake may be beneficial only in the absence of diarrhea. This finding highlights the importance of addressing this issue particularly in the HIV seronegative women of our study population. However, the high energy intakes should not be discouraged in HIV positive cases (Macallan *et al.*, 1995), and every possible attempt should be made to maintain energy intake at a satisfactory level (Carbonnel *et al.*, 1997).

CONCLUSION

This study clearly shows that there are important distinctions to be made when advising individuals of different age groups as well as HIV status on food intake. It seems highly likely that HIV seronegative individuals consume enough total energy on a daily basis and should they rather be advised to derive less energy from fats rather than from carbohydrates and proteins. Recommendations would also include an increase in dietary fibre intake. Also, HIV seropositive individuals in this study reported high energy intakes. However, it would be necessary to determine the

baseline energy needs of seropositive individuals before any recommendations that could be to the detriment of the patient are made in this regard. However, a general recommendation for all age and HIV status groups would therefore seem to decrease fat intake and replace the lost energy with other food groups.

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Table 1: Energy, macronutrient and cholesterol intake of HIV positive (N = 167) and HIV negative (N = 106) women 25-34 years of age

NUTRIENT INTAKE		Median	Median difference	95% CI for median difference	p-value	RDA/AI*	<67% of RDA
Energy (kJ)	HIV+	12024	1284	2; 2552	0.049	10 093	11.98
	HIV-	10447					16.98
Total protein (g)	HIV+	84.0	7.9	-1.5; 17.2		46	2.99
	HIV-	75.5					13.21
Plant protein (g)	HIV+	35.7	2.7	-1.7; 6.8			
	HIV-	31.8					
Animal protein (g)	HIV+	42.1	4.5	-1.3; 9.8			
	HIV-	37.3					
Total CHO (g)	HIV+	350	31	-9; 70		130	0.60
	HIV-	315					0.94
Total dietary fibre (g)	HIV+	22.2	1.2	-1.5; 4.1	0.362	25*	26.95
	HIV-	20.7					32.08
Total fat (g)	HIV+	101.3	11.1	-0.5; 23.6			
	HIV-	94.2					
Saturated fat (g)	HIV+	28.0	2.4	-1.6; 6.1			
	HIV-	25.2					
PUFA (g)	HIV+	27.4	4.0	0.4; 7.6	0.03		
	HIV-	24.9					
MUFA (g)	HIV+	33.2	2.8	-1.2; 7.0			
	HIV-	29.1					
Cholesterol (mg)	HIV+	330.0	30.0	-19.9; 79.8		<300	
	HIV-	306.7					

Table 2: Energy, macronutrient and cholesterol intake of HIV positive (N = 82) and HIV negative (N = 133) women in group 35-44 years of age

NUTRIENT INTAKE		Median	Median difference	95% CI for median difference	p-value	RDA/AI*	<67% of RDA
Energy (kJ)	HIV+	10454	-524	-1782; 748		10 093	15.85
	HIV-	11110					13.53
Total protein (g)	HIV+	70.6	-6.9	-16.4; 2.6		46	6.10
	HIV-	80.3					6.02
Plant protein (g)	HIV+	31.6	-1.5	-6.1; 2.9			
	HIV-	32.9					
Animal protein (g)	HIV+	37.3	-4.8	-11.0; 1.3			
	HIV-	43.6					
Total CHO (g)	HIV+	312	-6	-45; 33		130	1.22
	HIV-	322					0.00
Total dietary fibre (g)	HIV+	21.1	-0.7	-3.6; 2.2		25*	35.37
	HIV-	20.9					31.58
Total fat (g)	HIV+	84.7	-6.3	-18.9; 6.2			
	HIV-	90.4					
Saturated fat (g)	HIV+	24.7	-2.4	-6.0; 1.4			
	HIV-	27.2					
PUFA (g)	HIV+	23.6	-1.4	-5.2; 2.6			
	HIV-	22.6					
MUFA (g)	HIV+	28.7	-1.9	-6.4; 2.3			
	HIV-	30.9					
Cholesterol (mg)	HIV+	267.1	-23.7	-74.0; 27.7		<300	
	HIV-	303.8					

CHAPTER 7

MICRONUTRIENT INTAKE OF HIV SEROPOSITIVE WOMEN (25-44 YEARS) LIVING IN MANGAUNG, SOUTH AFRICA

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ABSTRACT

Objective: To determine the micronutrient intake of HIV positive women. *Design:* Cross-sectional study of a representative group of 500 pre-menopausal women (25-34 years and 35-44 years). *Methodology:* Nutrient intake was determined using a Quantitative Food Frequency Questionnaire. Median nutrient intakes were compared to the Recommended Dietary Allowance (RDA) or Adequate Intake (AI). The percentage of women with intakes less than 67% of the RDA/AI was also calculated. Median micronutrient intake between HIV positive and HIV negative women was compared by non-parametric 95% confidence intervals (CI) for the median difference, as well as the Mann-Whitney test. *Results:* Sixty one percent of younger women and 38% of older women were HIV infected. In both HIV positive and HIV negative younger women a large percentage consumed less than 67% of the RDA/AI for calcium (49.7% and 59.4% respectively), iron (48.5% and 51.9% respectively) and selenium (49.1% and 50.0% respectively). Likewise, in the older group a large percentage of HIV positive and HIV negative women consumed inadequate amounts of calcium (48.78% and 55.64% respectively), iron (54.9% and 51.9% respectively) and selenium (62.2% and 46.6% respectively). The percentage of women with an

inadequate fat soluble vitamin intake was high in both the younger and older groups. More than half of all women took in less than 67% of the RDA for folate and more than 45% of all women took in less than 67% of the RDA for vitamin C. Younger women with HIV had significantly higher intakes of calcium ($p=0.046$), phosphorus ($p=0.04$), potassium ($p=0.04$), vitamin B12 ($p=0.01$), vitamin D ($p=0.03$) and vitamin E ($p=0.04$). Older HIV positive women had significantly lower intakes of haem iron ($p=0.03$), nonhaem iron ($p=0.04$) and selenium ($p=0.04$). *Conclusions:* Deficient micronutrient intakes are common in both HIV positive and HIV negative women. Since malnutrition is reversible, nutrition intervention focusing on a healthy well-balanced eating plan seems warranted to ensure optimal health and longevity, particularly in HIV-infected women.

Key words: South Africa; HIV; African women; dietary intake; micronutrients

INTRODUCTION

Strategies for upgrading the nutrition situation in Africa, where micronutrient deficiencies are often endemic, have posed a challenge for many years. The emergence of HIV/AIDS has further complicated this (Piwoz & Preble, 2000). South African women living in poor communities are at high risk of HIV infection due to their poor economic and social status (O'Hara *et al.*, 2003). Malnutrition is a marker of poor prognosis during HIV infection (Guenter *et al.*, 1993; Süttman *et al.*, 1995). Immune dysfunction, the hallmark of HIV infection (Baum & Shor-Posner, 1998), may influence the course of HIV progression and survival (Baum *et al.*, 1997; Semba & Tang, 1999; Bogden *et al.*, 2000). Micronutrient deficiencies may contribute to the pathogenesis of HIV infection by increasing oxidative stress, and its devastating effect on immunity (Skurnick *et al.*, 1996; Semba & Tang, 1999; Patrick, 2000). A

model of the relationship between HIV/AIDS and malnutrition shows a typical vicious cycle in which micronutrient deficiencies, nutritionally related immunosuppression, and oxidative stress lead to faster disease progression (Semba & Tang, 1999).

Several reviews and studies have confirmed that a large percentage of HIV patients apparently develop moderate to severe micronutrient deficiencies (Dworkin et al., 1990; McCorkindale et al., 1990; Chlebowski et al., 1995; Jariwalla, 1995; Macallan, 1999; Dannhauser et al., 1999; Semba & Tang, 1999; Gay & Meydani, 2001; Kim et al., 2001; Woods et al., 2002; Izquierdo et al., 2002). This has led to substantial interest in the impact of micronutrient deficiencies on HIV progression (Macallan, 1999), which may exist even in the absence of macronutrient deficiencies (Babameto & Kotler, 1997). A South African study conducted among HIV-1 seropositive patients in the Free State, indicated that despite adequate energy and protein intakes by the majority of participants, low intakes of several micronutrients were observed (Dannhauser et al., 1999).

It is widely believed that an inadequate dietary intake may contribute to the altered nutritional status in HIV disease (Gramlich & Mascioli, 1995; Casey, 1997). Nevertheless, nutrition deficits can be forestalled through early assessment and intervention (Casey, 1997), thus stressing the importance of maintaining adequate nutrient support to HIV/AIDS patients (Tang et al., 1993; Baum et al., 1994). Supportive published evidence regarding dietary intake in HIV infection is limited (Gramlich & Mascioli, 1995; Woods et al., 2002), particularly for women (Woods et al., 2002). There is still a paucity of information from developing countries regarding micronutrient status during HIV infection (Semba & Tang, 1999). With this in mind,

we determined the micronutrient intake of HIV positive women in Mangaung, in the Free State Province of South Africa.

METHODOLOGY

The Department of Biostatistics, University of the Free State, selected 500 premenopausal women from the Mangaung District, Bloemfontein, South Africa. A township map was used to make the selection. Women were selected from two informal settlements and two formal settlements. Plots within the designated areas were counted and numbered, and a proportionate number of respondents were selected randomly from these plots. The size of the sample was considered representative of the population of the Mangaung District. Subjects were recruited by trained community healthcare workers, who were given detailed instructions about the recruitment of subjects as well as a detailed map of twenty of the selected plots on a weekly basis. On arrival of the plot the inhabitants were screened for eligibility.

The Ethics Committee of the Faculty of Health Sciences, University of the Free State, approved the study (ETOVS number 02/00). The assigned community health workers explained the content and purpose of the study to possible participants. It was required that each recruited subject gave informed consent. Subjects were given R40-00 to participate in the study. Subjects were also given the opportunity to indicate whether they would like to receive their HIV test results, or whether the outcome should be withheld from them. All subjects that chose to be given the outcome of their test results were referred to a medical practitioner, for post-test counselling and if required, a confirmatory test. The research team was unaware of the outcome of the individual HIV tests due to blinding. Micronutrient intake was

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STATISTICAL ANALYSIS

Micronutrient intake was reported using medians. Other continuous data was described using frequencies and percentages. The median micronutrient intake of HIV seropositive and HIV seronegative women was compared by means of non-parametric 95 percent CI for the median difference, and the significance thereof assessed using the Mann-Whitney test.

RESULTS

A total of 500 subjects were recruited for this study. A total of 487 recruited individuals were eligible to participate in the study. Four subjects that were found to

be pregnant during the medical examination were excluded from the study. Another 8 subjects were found to be either older or younger than the required age for inclusion into the study. Of the 488 subjects, 273 were 25-34 years of age and 215 were 35-44 years of age. The sampling strategy was designed specifically to compare these two age categories in order to render the study results comparable to other previous studies performed within the same geographical area. Sixty one percent (N=167) of the younger group of women (25-34 years) and 38 percent (N=133) of the older group of women (35-44 years) tested HIV seropositive.

Tables 1 and 2 show the mineral and trace element intake of women from the two age groups. When the mineral and trace element intakes of the sample were analyzed, it became evident that both HIV positive and HIV negative women had insufficient intakes of micronutrients. Furthermore, results from both age groups of the HIV positive and HIV negative women indicated deficient intakes of more or less the same minerals and trace elements. Low median intakes of particularly calcium, total iron and selenium were reported by the total sample. In both HIV positive and HIV negative younger women a large percentage consumed less than 67 percent of the RDA/AI for calcium (49.7 percent and 59.4 percent respectively), iron (48.5 and 51.9 percent respectively) and selenium (49.1 percent and 50.0 percent respectively). In the older group the same trend was observed with a large percentage of HIV positive and HIV negative women consuming inadequate amounts of calcium (48.78 percent and 55.64 percent respectively), iron (54.9 percent and 51.9 percent respectively) and selenium (62.2 percent and 46.6 percent respectively).

Tables 3 and 4 depict the fat soluble and water soluble vitamin intake of the young and older HIV positive and HIV negative women respectively. Results show that the median intake of vitamin A was only sufficient in the older group of HIV negative women, while median vitamin D and E intakes were only adequate in the young group of HIV positive women. Concerning the B vitamins, median intakes of all the groups of women were generally slightly higher, to even double the RDA or AI. Median intakes of vitamin C by the total sample were much lower than the RDA of 75 milligram (mg)/day, with the older HIV positive and HIV negative women showing the lowest median intakes (47.54 and 43.96 mg/day respectively). The percentage of women with an inadequate fat soluble vitamin intake was high in both the younger and older HIV-infected and uninfected women. More than half of all women consumed less than 67 percent of the RDA for folate and more than 46 percent of all women consumed less than 67 percent of the RDA for vitamin C. Approximately 30 percent of the older HIV positive women consumed less than the RDA for vitamin B6.

Younger women with HIV had significantly higher intakes of calcium ($p=0.046$), phosphorus ($p=0.04$), potassium ($p=0.04$), vitamin B12 ($p=0.01$), vitamin D ($p=0.03$) and vitamin E ($p=0.04$). Older HIV positive women had significantly lower intakes of haem iron ($p=0.03$), nonhaem iron ($p=0.04$) and selenium ($p=0.04$).

DISCUSSION

Micronutrients play key roles in mediating the functions of the immune system, and deficiencies of these nutrients are associated with impaired immunity (Chandra, 1997; Woods & Gorbach, 1999). In this cross-sectional study, we identified deficient dietary intakes of various minerals, trace elements and vitamins. Although no big

differences in nutrient intake between HIV positive and HIV negative women were observed, it is noteworthy that requirements of HIV positive women are higher than those of their HIV negative counterparts (Woods & Gorbach, 1999).

Literature state that a large percentage of HIV-infected individuals fail to consume the RDA for at least one (Dworkin et al., 1990), or some micronutrients (Baum et al., 1994; Luder et al., 1995). In the Baltimore-Washington cohort of the Multicenter AIDS cohort study, numerous subjects consumed less than the RDA for iron, zinc, vitamin E, vitamin C, vitamin A, niacin, folate, vitamin B12 and B6, riboflavin and thiamin (Semba & Tang, 1999). An earlier study by Dworkin et al. (1990) revealed that although vitamin/mineral supplement consumption were taken into account in their study, 88 percent of the participants had deficient intakes of at least one nutrient, including vitamin A, C, E, B6, B12, pantothenic acid, folic acid, biotin, iron, zinc, copper, selenium, manganese and calcium. Chlebowski et al. (1995) also reported vitamin B6, zinc and folic acid intakes below the required amounts by HIV-infected patients.

When the micronutrient intakes of women in the present study were analyzed, some outstanding features became evident. About half of the total sample consumed inadequate amounts of calcium, iron and selenium (Tables 1 and 2). At least 23 percent of all the women had low intakes of vitamin A, D and E (Tables 3 and 4), while a more serious tendency of low intakes were revealed for vitamin C and folate. Of these micronutrients, selenium, iron, vitamin A, E, C (Baum et al., 1995; Harbige, 1996; Chandra, 1997) and D (Baum et al., 1995; Harbige, 1996) are vital for immune function. A deficiency of even one single nutrient, even in the mild form, can change immune function (Chandra, 1997). Additionally, selenium, iron, vitamin A, E and C

serve as indispensable antioxidants that scavenge toxic free radicals. Consequently, these nutrient imbalances may contribute to increased oxidative stress and abnormalities in immunologic or neurophysiologic functions (Jariwalla, 1995) in the HIV positive women in our study. On the contrary, micronutrient excess can also adversely affect immune function, either directly, or by competitively inhibiting the absorption or function of other necessary nutrients (Boelaert et al., 1996; Tang et al., 1996; Kupka and Fawzi, 2002).

It would perhaps be feasible to draw comparisons between the intakes of the micronutrients under question in the present study, and those from Dannhauser et al. (1999), in which the environment was similar to ours. Although lower micronutrient intakes were reported in general for the latter study, the same trend of inadequate median intakes was found for vitamin A, C, calcium and iron by the group of patients with CD4 cell counts between 200 and 499/mm³. The fact that the latter study investigated dietary intake in rural and urban male and female patients, and that a different method of dietary assessment was used, complicates comparisons between the present study and the study by Dannhauser and coworkers (1999). A further fact that is also worth mentioning is that in the present study only the HIV status of the participants, and not their CD4 cell counts were determined, while some studies assessed dietary intakes of patients in various stages of disease progression.

Notwithstanding the fact that in the present study, young HIV positive women consumed significantly more calcium than uninfected young women, calcium intakes were regarded low in all the women. Cultural habits and taboos regarding milk consumption, as well as the high cost of dairy products (Vorster et al., 1997) could lead to a calcium depleted diet. Furthermore, non-dairy coffee creamers that are

convenient to use in households without refrigerators, could have contributed to the low calcium intakes in our study. With urbanization and its accompanying changes in diet and physical activity, older African women may also increasingly be at risk for osteoporosis (Aloia et al., 1995), accentuating the importance of a calcium-rich diet.

Iron deficiency is common in Africa, and anemia appears widely among people living with AIDS (Castaldo et al., 1996). Anemia has been associated with HIV disease progression and an increased risk of death in infected individuals (Moore et al., 1998), while increased levels of iron intake have been associated with a significant decreased progression rate to AIDS (Tang et al., 1993; United States Agency for International Development (USAID), 2001). On the other hand, disturbed iron metabolism, accompanied by increased body iron stores, may develop as HIV progresses towards more advanced stages. This may potentially enhance oxidative stress, impair several already compromised immune defense mechanisms (Boelaert et al., 1996), and predispose to certain microbial infections (Boelaert et al., 1996; de Monye et al., 1999) such as *Candida*, *Pneumocystis carinii* and *Mycobacterium*. Shorter HIV/AIDS survival time has also been related to high iron stores (de Monye et al., 1999). Limitation of iron intake could amongst others, help to decrease the iron burden, and suppress the growth of micro-organisms (Boelaert et al., 1996). It is also important to mention that in Southern Africa, traditional alcoholic brews that are very high in bio-available iron, may further lead to dietary iron overload, particularly in those who frequently consume these beverages (Friedman et al., 1990).

Selenium deficiency has been described as rare in healthy individuals, but deficiencies were found to be highly prevalent during HIV infection (Baum et al., 1997). An adequate dietary intake of selenium probably prevents the replication of

HIV and retards disease progression (Baum & Shor-Posner, 1998). In the present study, the median selenium intake of all the women was considerably lower than the RDA of 55 microgram (g), with about half of the total sample consuming less than 67 percent of the RDA. In addition, HIV positive younger women showed a significantly lower intake of selenium than the uninfected younger women. This causes concern, as a deficiency of this element is associated with profound nutritional implications for individuals with HIV/AIDS (Lee, 2002), and has shown to be predictive of HIV-related prognosis (Lee, 2002; Constans et al., 1995; Patrick, 1999), such as increased mortality (Baum et al., 1997; Campa et al., 1997; Baum & Shor-Posner, 1998), immune dysfunction (Bologna et al., 1994) and glutathione activity (Lee, 2002). The inadequate intakes of selenium could be related to a core diet of maize products, a poor source of this nutrient.

Zinc deficiency is widespread in African countries (Kupka & Fawzi, 2002) where a cereal-based diet is followed (Insel et al., 2001, p. 457). Although there is powerful evidence that zinc intakes are inadequate in HIV positive persons (McCorkindale et al., 1990; Chlebowski et al., 1995; Dannhauser et al., 1999; Kim et al., 2001; Izquierdo et al., 2002), only a small percentage of all the women in the present study failed to meet the RDA for zinc. In the study by Dannhauser et al. (1999), about half of the HIV positive subjects consumed diets containing less than 67 percent of the RDA for zinc, which was related to the subjects' high intake of maize meal, a poor source of this nutrient. Whereas zinc deficiency is associated with impaired immune function, impaired taste and smell, damage to the epithelial lining of the intestine and respiratory tract, and impaired memory (Shankar & Prasad, 1998), zinc intakes of 14 mg/day or more, were significantly associated with a decreased survival rate in AIDS

patients (Tang et al., 1996). The HIV retrovirus is probably zinc-dependent, and an increase in its availability may promote HIV replication (Kupka and Fawzi, 2002).

A prominent feature in the present study was the large number of all the women with low intakes of vitamin C. Low intakes were also reported for urban African women (Vorster et al., 1997), HIV positive women (Woods et al., 2002), and HIV seropositive male and female patients (Dannhauser et al., 1999). An increased intake of vitamin C has been found to be marginally significant in reducing the rate of progression to AIDS (Tang et al., 1993), and provisional recommendations of 200-500 mg/day vitamin C have been made for HIV positive patients (Woods & Gorbach, 1999).

There is published evidence of deficient folate intakes of HIV-infected persons (Kim et al., 2001; Woods et al., 2002). Folate also stood out as being deficient in the diets of a large percentage of all the women in the present study. The insufficient consumption of folate seems to be a problem amongst others, in urban and rural Africans in South Africa (Vorster et al., 1997). Although folate deficiencies have been associated with impaired immune function (Jariwalla, 1995), the role of this nutrient in HIV/AIDS infection is not yet clear (Piwoz & Preble, 2000), with studies showing no relationship between folate deficiency and HIV-related outcomes (Tang et al., 1997).

The relatively small percentage of all the women in the present study with inadequate intakes of thiamin, riboflavin, niacin and vitamin B12 is commendable, and fairly consistent with those of other HIV studies (Kim et al., 2001; Woods et al., 2002). Maize products are a good source of thiamin, and maize meal has been enriched with niacin in South Africa for many years (Walker et al., 1983), which could possibly explain the adequate intakes in the present study. Notwithstanding these adequate

intakes, HIV positive patients are advised to increase their intakes of thiamin (2-6 mg/day), riboflavin (2.2-6.5 mg/day), niacin (35 mg/day), and vitamin B12 (5-12 g/day) (Woods & Gorbach, 1999). About 30 percent of the older HIV positive women however had low intakes of vitamin B6, which agreed with other studies (Kim *et al.*, 2001). A deficiency of this vitamin has shown to be a common accompaniment to HIV infection (Baum *et al.*, 1994; Babameto & Kotler, 1997), despite adequate intakes, particularly during the early stages of HIV-1 infection (Baum *et al.*, 1991). Consequently, HIV-infected individuals should increase their intakes of vitamin B6 to 3.0-8.5 mg/day (Woods & Gorbach, 1999). Tang *et al.* (1993) however reported that although average vitamin B6 intakes showed a decrease in HIV progression rate, very high and very low intakes did not have the same positive effect.

Fat-soluble vitamin intakes in the current study ranged from low to adequate in the total sample. Dietary intake of vitamin A was low in the younger and older HIV positive groups of women. A fairly large percentage of the total group of respondents demonstrated low intakes of vitamins A, D and E. All these vitamins have pivoting roles in immune function (Baum *et al.*, 1995; Harbige, 1996), while vitamin A and E are also strong antioxidants. HIV positive patients should be advised to increase their intakes of vitamin A to 5 000 International Units/day, and vitamin E to 133-267 mg/day (Woods & Gorbach, 1999), in order to achieve normal plasma nutrient values (Baum *et al.*, 1994).

CONCLUSION

This study provides valuable data on the extent of micronutrient malnutrition in both HIV negative and HIV positive African women in Mangaung. The results underline

the urgency for nutritional intervention to approach this aspect of HIV-infection in an innovative way, suitable for the African setting. Since malnutrition is reversible, and needs aggressive treatment, the first and foremost goals of nutrition therapy should be focusing on the prevention of micronutrient deficiencies, and the importance of a well-balanced diet to improve nutritional status. As micronutrient needs of people living with HIV/AIDS are typically higher than for the general population, micronutrient supplementation seems to be an affordable and relatively easy way to help improve the nutritional status in this milieu, and would be warranted in addition to a healthy well-balanced eating plan to ensure optimal health and longevity.

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Table 1: Mineral and trace element intake of HIV positive (N = 167) and HIV negative (N = 106) women 25-34 years of age

Nutrient		Median	Median difference	95% CI for median difference	p-value	RDA/AI*	<67% of RDA
Calcium (mg)	HIV+	679.42	97.37	1.28; 188.04	0.046	1000*	49.70
	HIV-	533.87					59.43
Chromium (µg)	HIV+	43.60	5.01	-0.94; 11.08		25*	8.98
	HIV-	35.95					14.15
Copper (mg)	HIV+	1.50	0.15	-0.04; 0.34		0.9	4.19
	HIV-	1.35					6.60
Iron Haem (mg)	HIV+	0.36	-0.006	-0.09; 0.07			
	HIV-	0.38					
Iron non-haem (mg)	HIV+	3.69	0.28	-0.21; 0.78			
	HIV-	3.19					
Total iron (mg)	HIV+	12.32	1.04	-0.62; 2.62		18	48.50
	HIV-	11.84					51.89
Iodine (µg)	HIV+	40.49	2.50	-3.19; 8.63		150	93.41
	HIV-	39.67					96.23
Potassium (mg)	HIV+	3024.8	342.30	18.66; 677.01	0.04	2000	
	HIV-	2594.0					
Magnesium (mg)	HIV+	388.95	38.09	-5.19; 80.38		320	9.58
	HIV-	342.31					16.98
Manganese (µg)	HIV+	3083.4	252.26	-165.97; 635.6		1800	4.19
	HIV-	2776.1					10.38
Sodium (mg)	HIV+	2708.4	325.47	-18.11; 677.04		3000	
	HIV-	2555.9					
Phosphorus (mg)	HIV+	1397.0	162.55	2.34; 320.24	0.04	700	1.80
	HIV-	1206.2					5.66
Selenium (µg)	HIV+	37.04	2.59	-3.14; 8.54		55	49.10
	HIV-	36.92					50.00
Zinc (mg)	HIV+	10.79	0.81	-0.43; 2.01		8	7.78
	HIV-	9.89					16.98

Table 2: Mineral and trace element intake of HIV positive (N = 82) and HIV negative (N = 133) women in group 35-44 years of age

Nutrient		Median	Median difference	95% CI for median difference	p-value	RDA/AI*	<67% of RDA
Calcium (mg)	HIV+	681.27	42.56	-66.17; 159.35		1000*	48.78
	HIV-	614.16					55.64
Chromium (µg)	HIV+	34.74	-7.53	-15.04; 0.06		25*	10.98
	HIV-	45.58					12.03
Copper (mg)	HIV+	1.35	-0.10	-0.28; 0.09		0.9	10.98
	HIV-	1.39					7.52
Iron Haem (mg)	HIV+	0.24	-0.07	-0.15; -0.01	0.03		
	HIV-	0.35					
Iron non-haem (mg)	HIV+	3.13	-0.57	-1.11; -0.02	0.04		
	HIV-	3.70					
Total iron (mg)	HIV+	10.59	-0.74	-2.30; 0.91		18	54.88
	HIV-	11.70					51.88
Iodine (µg)	HIV+	35.12	-2.17	-8.40; 3.93		150	96.34
	HIV-	38.26					96.99
Potassium (mg)	HIV+	2689.5	-4.60	-322.32; 318.2		2000	
	HIV-	2783.0					
Magnesium (mg)	HIV+	391.20	3.54	-41.93; 46.76		320	12.20
	HIV-	363.77					15.04
Manganese (µg)	HIV+	2803.7	-85.53	-513.71; 317.7		1800	10.98
	HIV-	2818.0					6.02
Sodium (mg)	HIV+	2282.6	-18.22	-362.37; 325.9		3000	
	HIV-	2332.2					
Phosphorus (mg)	HIV+	1273.8	-18.33	-158.12; 149.7		700	2.44
	HIV-	1296.7					1.50
Selenium (µg)	HIV+	30.42	-6.81	-12.94; -0.46	0.04	55	62.20
	HIV-	38.42					46.62
Zinc (mg)	HIV+	9.15	-0.63	-1.90; 0.56		8	10.98
	HIV-	10.05					12.03

Table 3: Vitamin intake of HIV positive (N = 167) and HIV negative (N = 106) women 25-34 years of age

Nutrient		Median	Median difference	95% CI for median difference	p-value	RDA/AI*	<67% of RDA
Vitamin A Re (µg)	HIV+	687.30	19.8	-104.2; 144.2		700	31.14
	HIV-	674.50					29.25
Vitamin D (µg)	HIV+	5.36	0.90	0.12; 1.75	0.03	5*	27.54
	HIV-	4.50					33.96
Vitamin E (mg)	HIV+	16.45	2.21	0.04; 4.38	0.04	15	25.15
	HIV-	14.11					32.08
Vitamin K (µg)	HIV+	126.31	11.31	-10.94; 34.30		90*	20.36
	HIV-	108.02					22.64
Thiamin (mg)	HIV+	1.72	0.19	-0.02; 0.39		1.1	7.78
	HIV-	1.46					12.26
Riboflavin (mg)	HIV+	2.09	0.14	-0.15; 0.43		1.1	4.19
	HIV-	2.00					6.60
Niacin (mg)	HIV+	21.78	2.40	-0.20; 4.94		14	5.99
	HIV-	18.97					13.21
Vitamin B6 (mg)	HIV+	1.55	0.15	-0.04; 0.35		1.3	16.17
	HIV-	1.47					25.47
Folate (µg)	HIV+	252.72	30.04	-1.44; 60.96		400	53.29
	HIV-	233.82					62.26
Vitamin B12 (µg)	HIV+	5.38	1.09	0.26; 1.95	0.01	2.4	5.99
	HIV-	4.18					10.38
Vitamin C (mg)	HIV+	54.10	5.99	-4.08; 15.37		75	46.11
	HIV-	53.64					49.06
Pantothenic acid (mg)	HIV+	5.90	0.61	-0.08; 1.30		5*	11.38
	HIV-	5.34					22.64
Biotin (µg)	HIV+	36.42	3.33	-1.62; 8.41		30*	16.77
	HIV-	31.31					18.87

Table 4: Vitamin intake of HIV positive (N = 82) and HIV negative (N = 133) women in group 35-44 years of age

Nutrient		Median	Median difference	95% CI for median difference	p-value	RDA/AI*	<67% of RDA
Vitamin A Re (µg)	HIV+	593.57	-67.13	-200.32; 68.98		700	29.27
	HIV-	822.90					23.31
Vitamin D (µg)	HIV+	4.74	-0.02	-0.89; 0.92		5*	34.15
	HIV-	4.40					39.10
Vitamin E (mg)	HIV+	13.01	-1.82	-4.11; 0.42		15	39.02
	HIV-	14.13					23.31
Vitamin K (µg)	HIV+	118.16	-20.88	-49.68; 8.29		90*	21.95
	HIV-	134.00					14.29
Thiamin (mg)	HIV+	1.45	-0.07	-0.26; 0.11		1.1	9.76
	HIV-	1.50					9.77
Riboflavin (mg)	HIV+	1.73	0.02	-0.30; 0.32		1.1	7.32
	HIV-	1.78					6.02
Niacin (mg)	HIV+	17.63	-1.31	-3.65; 1.12		14	12.20
	HIV-	19.06					11.28
Vitamin B6 (mg)	HIV+	1.22	-0.11	-0.29; 0.08		1.3	30.49
	HIV-	1.22					21.80
Folate (µg)	HIV+	220.63	-29.73	-64.22; 3.61		400	70.73
	HIV-	250.70					57.14
Vitamin B12 (µg)	HIV+	4.62	-0.04	-0.87; 0.78		2.4	9.76
	HIV-	4.59					5.26
Vitamin C (mg)	HIV+	47.54	-0.98	-10.67; 8.09		75	51.22
	HIV-	43.96					54.89
Pantothenic acid (mg)	HIV+	5.08	-0.61	-1.41; 0.12		5*	18.29
	HIV-	5.67					15.79
Biotin (µg)	HIV+	32.94	-0.75	-5.75; 4.05		30*	18.29
	HIV-	34.14					15.79

CHAPTER 8

THE RELATIONSHIP BETWEEN BODY MASS INDEX, ENERGY INTAKE AND LEVEL OF PHYSICAL ACTIVITY OF HIV POSITIVE WOMEN (25-44 YEARS) IN MANGAUNG

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ABSTRACT

Objective: To determine the relationship between body mass index (BMI), energy intake and levels of physical activity of HIV negative and HIV positive women. *Design:* Cross sectional study. *Methodology:* A random sample of 500 pre-menopausal women within the two age group categories of 25-34 and 35-44 years was selected. Data on physical activity was obtained using an adapted Baecke questionnaire and categorized into low, medium, and high levels of physical activity. Weight and height were used to calculate BMI. Dietary intake was determined by means of a standardized food frequency questionnaire. *Results:* Sixty-one percent of younger women and 38% of older women were HIV infected. The vast majority of women (91%) had low levels of physical activity, while only 9% of the sample had physical activity levels that fell within the normal to high category. More than 50% of respondents were either overweight or obese (BMI above 25 kg/m²). BMI of HIV positive younger women was, however, significantly lower than that of HIV negative women. Median energy intakes were high (more than 10 000 kJ) for both HIV

positive and HIV negative women. *Conclusions:* Reverting to a more traditional lifestyle, including diet and physical activity, could assist in addressing unfavorable BMI parameters of these African women and improve health status and quality of life of HIV infected women.

Key words: South Africa; HIV; BMI; energy intake; physical activity

INTRODUCTION

The major changes in diet and activity patterns encouraged by the technological revolution of the late 20th century have had a significant impact on body weight regulatory mechanisms. A decline in infectious diseases and an increase in the prevalence of chronic diseases of lifestyle have now become a global epidemic (Musaiger, 1992; Trowell, 1995). Obesity, hypertension, Type 2 diabetes mellitus and certain types of cancer are associated with a sedentary lifestyle and a high level of energy intake (Kumanyika et al., 1993; Seidell, 1999).

Urbanization is one of the major factors contributing to changes in lifestyle (Levitt et al., 1993). It usually includes major changes in diet and lower levels of physical activity compared with those of people in their traditional surroundings (Franz, 2000, p. 742). The patterns of change in structure of diet, physical activity and obesity are greater in developing countries (Popkin, 1994), and in South Africa morbidity and mortality from chronic diseases are more prevalent among African than Caucasian women (Walker, 1995).

Hays and Clark (1999) have reported that socio-demographic and health characteristics such as low socio-economic status, older age, race and presence of

chronic disease, tend to be associated with lower levels of activity. Various epidemiological studies have shown that a decrease in coronary heart disease, hypertension, obesity, stroke, colorectal cancer and osteoporosis is associated with increased physical activity (Paffenberger *et al.*, 1993; Kohl & McKenzie, 1994) and a healthy lifestyle (Hays & Clark, 1999).

Physical activity seems to be promising in various areas of HIV infection. Exercise is therefore increasingly being advocated as a beneficial addition to the health treatment of HIV-infected individuals (Jones *et al.*, 2001). Physical activity may be a therapeutic method capable of improving appetite and energy levels (United States Agency for International Development (USAID), 2001), which will in turn enhance overall physical, emotional and psychological well-being (Lox *et al.*, 1995; USAID, 2001), by neutralising the effects of anxiety and depression associated with HIV diagnosis (Birk, 1996; USAID, 2001). Physical activity may be useful to improve quality of life (Stringer *et al.*, 1998; Stringer, 1999; Yarasheski & Roubenoff, 2001), and to increase strength and functional capacity of the individual living with HIV (Evans *et al.*, 1998).

METHODOLOGY

A proportionally random sample of 500 African pre-menopausal women (25-44 years) was selected using township maps of Mangaung, the African residential area of Bloemfontein. The sample included respondents from two built-up areas, namely Pahameng (total of 1359 residences) and Botschabela (2308) and two informal settlements, namely Joe Slovo (1359) and Namibia (2995). Inclusion criteria were voluntarily participation, African female, age group 25 – 44 and non pregnant.

Approval for the study was obtained from the Ethics Committee of the University of the Free State. Prior to the study, the approval of the community leaders of the four selected areas was obtained and written informed consent was signed by all participants.

A questionnaire based on the one developed by Baecke et al. (1982) and adapted by Kruger (1999), was used to develop a questionnaire measuring physical activity for occupation and leisure time in this sample. The questionnaire was completed in an interview situation. Three trained interpreters (Sotho and Xhosa) assisted. According to the answers obtained in the questionnaire, respondents were categorized into three activity levels, namely low, moderate or high. Ten percent of the sample was re-interviewed two weeks after the initial survey to determine reliability of answers obtained in the first interview. Anthropometric status and dietary intake were also determined, using standard methods reported elsewhere (Walsh et al., 2004; Hattingh et al., 2004).

HIV status was determined using a micro-particle enzyme Immunoassay.

STATISTICAL ANALYSIS

The data for all data sets were categorized into two age groups: 25-34 years, and 35-44 years. For each group, continuous variables were described by means and standard deviations, or medians and percentiles as applicable. Categorical variables were described by frequencies and percentages.

The questionnaire adapted for this study differed from the one used by Kruger (1999) in the Transition, Health and Urbanisation in South Africa (THUSA) study in the classification of time of the activity. In this study respondents were asked to specify the amount of time spent on an activity in minutes, while the THUSA study had a classification of time as “never, seldom, sometimes and always”. The amount of time for each activity was defined as never when a person spent 0 percent of their time at work or at home on that activity. Seldom was defined as less than 10 percent of the time and 10 percent to 50 percent was defined as sometimes. Fifty percent to less than 85 percent was defined as often and more than 85 percent as always. Questions related to activities at home and at work were included in the questionnaire. Work activity at home was considered as “work” when a person did not work out of the home. If a person worked out of the home, “work” was calculated as work activities at work plus work activities at home.

The physical activity index (PAI) was calculated and categorized as follows (Kruger, 1999):

$$\text{PAI} = 0.47 (\text{work index}) + 0.059 (\text{commuting index}) + 0.001 (\text{stair index}) + 0.47 (\text{sport index} + \text{leisure index}).$$

Due to the small numbers of respondents with normal and high levels of physical activity, these two categories were combined to make statistical analysis of data possible. If the PAI was lower than four, women were categorized as inactive while a PAI of four or higher was categorized as normal to high.

For each combination of age group, physical activity group and HIV-group, the physical activity questions were compared by means of chi-square test and Fisher’s exact test and 95 percent confidence intervals (CI) were calculated for the

percentage difference. Medians were compared by 95 percent non-parametric CI's and the Kruskal-Wallis test.

For each question, the answers obtained in the main survey and the reliability survey were compared by k*k tables and where the percentages who gave conflicting answers were more than 20 percent, the variables were considered as unreliable and ignored in further computations. For continuous variables, the difference between the two surveys was calculated and the number of non-zero differences reported. Respondents could not accurately recall the time spent on the activities they performed which influenced the reliability of some of the questions answered in minutes and therefore they were omitted.

RESULTS

The results of four subjects that were found to be pregnant during the medical examination were excluded and blood samples could not be obtained in eight subjects. Sixty-one percent of younger women and 38 percent of older women were HIV infected.

Women were divided into eight groups, according to age, level of physical activity and HIV status. Groups 1 – 4 represent women with low levels of physical activity, while groups 5 – 8 represent women with normal to high levels of physical activity. In the groups with low levels of physical activity and normal to high levels of physical activity, women were categorized according to age (25 – 34 years, and 35 – 44 years) as well as HIV status.

Two hundred and thirty nine women were HIV negative. Of these, 106 (88 +18) were between 25 and 34 years old and 133 (128 + 5) were between 35 and 44 years old. The majority of HIV negative women were physically inactive with only 23 women (10 percent) falling in the normal to high physical activity category. Of the younger, physically inactive women without HIV (n=88), 62.5 percent had a BMI > 25 kg/m² indicating that they were overweight or obese. Of the younger physically active women (n=18) without HIV, 61 percent also had a BMI > 25 kg/m². In the older HIV negative group that were inactive (n=128), 50.0 percent had a BMI > 25 kg/m², while three (60 percent) of the physically active older women without HIV had a BMI > 25 kg/m².

Two hundred and forty nine women were HIV positive. Of these, 167 (152 + 15) were between 25 and 34 years old and 82 (76 + 6) were between 35 and 44 years old. As in the HIV negative group, the majority of HIV positive women were physically inactive with only 21 women (8 percent) falling in the normal to high physical activity category. Of the younger physically inactive women with HIV (n=151, one women's BMI was not recorded), 49.0 percent had a BMI > 25 kg/m² indicating that they were overweight or obese. Fewer HIV positive younger women that were physically active (n=15) were overweight, with only 26.7 percent having a BMI > 25 kg/m². In the older HIV positive group that were inactive (n=76), 56.6 percent, had a BMI > 25 kg/m², while only one physically active older women with HIV had a BMI > 25 kg/m².

The median BMI of the younger HIV negative women in group 1 (low physical activity) was 27.18 kg/m², thus falling within the overweight BMI category. In contrast, the BMI of the same group with HIV (group 2) was 24.87 kg/m², thus falling

within the normal weight BMI category. This difference was significant (95 percent CI for the median difference: [0.91; 3.78]), indicating that the presence of HIV infection has a significant effect on BMI. Although no significant associations could be found between the BMI of the other groups (possibly due to the small number of respondents in the physically active groups 5-8), close to significant differences were found between groups 2 and 6 (CI [-0.55; 3.86]), and groups 5 and 6 (CI [-0.14; 7.19]).

The median energy intake of HIV negative and HIV positive physically inactive and physically active women showed that, in all 8 groups, the median intake was higher than the RDA for this age group of 9 196 kJ, ranging from 10 090 kJ in group 4, to 14 519 kJ in group 8. The energy intake of the women in group 4 (35-44 years, HIV + low physical activity) was significantly lower than that of the women in group 8 (35-44 years, HIV + normal to high physical activity) (CI for the median difference [-7857; -457]). Since the women in these groups were both older and HIV positive, the only difference was their level of physical activity. Thus the more physically active women had a higher energy intake than the physically inactive women. No significant associations could be found between the energy intake of the other groups (possibly due to the small number of respondents in the physically active groups 4-8).

DISCUSSION

In this study of a community undergoing rapid epidemiological and demographic transition, prevalence of HIV was very high. In addition, high rates of physical inactivity and obesity were identified. The effect of the nutrition transition is also reflected in the diet with a high energy intake.

The study population in Mangaung is considered to be an example of a typical developing community in transition from a traditional to an urban lifestyle. It is estimated that by 2010 more than 75 percent of South Africa's population will be urbanized which will mainly affect the African population (Bourne et al., 1993; Mollentze et al., 1995; Lambert et al., 2001a).

Compared to women with normal to high levels of physical activity, low levels of physical activity in this sample were ascribed to lower participation in sporting activities, not climbing stairs, television watching and walking and cycling less often. According to Hays and Clark (1999), there is a vast shift in the structure of employment, with a movement towards more capital-intensive and knowledge-based employment that relies far less on physical activity. The rapid decline in physical activity at work is significantly associated with increased adult BMI and obesity. The shift in activity is also due to the increased use of transport to get to work or school and more passive leisure time activities such as watching television at home.

Although not underweight, most HIV positive women in this sample had a lower BMI compared to their HIV negative counterparts. Loss of muscle mass early in HIV disease progression may result from low levels of physical activity. There is thus potential in exercise to treat losses of muscle size (Evans et al., 1998). Resistance exercise in particular may be important in maintaining body mass (Birk, 1996), and increasing lean body mass (Roubenoff et al., 1999), in HIV-infected patients with or without wasting. Although exercise *per se* may not significantly retard AIDS progression and the subsequent onset of AIDS, it does not appear to intensify HIV (Birk, 1996). The ability to exercise may however be compromised by deteriorations

in cardio respiratory and neuromuscular function of patients with fully-developed AIDS (Shephard, 1998).

Aerobic exercise as part of social and everyday activities such as walking, cleaning and collection of firewood or water is considered important for the HIV-infected individual, and should be sustained as long as patients are physically able to do so (USAID, 2001). Aerobic exercise training *per se* has also indicated to be an effective non-pharmacological treatment to manage HIV-related complications such as alterations in body composition and metabolism (Yarasheski & Roubenoff, 2001).

CONCLUSION

Prevalence of HIV infection in this sample was very high, especially in the younger age group (25-34 years). Although the prevalence of overweight and obesity was an outstanding feature of the sample, BMI of HIV positive younger women was significantly lower than that of HIV negative women. In all groups, mean energy intake was high.

As both lack of physical activity and obesity are now recognized as risk factors for several chronic diseases, it is obvious that activity and dietary recommendations should complement one another (United States Department of Health and Human Services, 1996; Colditz *et al.*, 1998; Macera & Pratt, 2000). The focus should fall on changes in the food supply in the local area and a supportive environmental physical activity programme (Egger & Swinburn, 1997).

Guidelines for exercise in HIV lack scientific support (Terry *et al.*, 1999), as studies on the effect of exercise training on immunologic markers (CD4, CD8 and CD4:CD8 ratio), and anthropometric measures have shown conflicting results. It has been suggested that HIV seropositive individuals that participate in moderate and high intensity exercise programmes can increase their functional capacity (Stringer, 1999; Terry *et al.*, 1999), without any obvious changes in immunological indices (Birk, 1996; Stringer *et al.*, 1998; Shephard, 1998; Terry *et al.*, 1999), viral replication (Stringer *et al.*, 1998), or anthropometric measurements (Terry *et al.*, 1999). In addition, physical activity can increase quality of life in HIV positive individuals.

Lifestyle modification on a population level requires a comprehensive, community-based, integrated, multidisciplinary and multi-sectorial strategy. The success of a community-based lifestyle intervention programme is dependent on its acceptability, individualization, sensitivity, and sustainability and the degree to which the community adopts it (Levitt *et al.*, 1999; McCarthy *et al.*, 2002; Lambert, 2001b).

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Table 1: BMI and energy intake (kJ) of HIV negative and HIV positive physically inactive and physically active women

	Median intake	Median BMI (kg/m ²)	BMI categories (kg/m ²)					
			<18.5 Underweight		18.5<25 Normal weight		≥25 Overweight & obese	
			N	%	N	%	N	%
Group 1: 25-34 years; HIV-; Low PA (n = 88)	10 349	27.18*	2	2.27	31	35.23	55	62.50
Group 2: 25-34 years; HIV+; Low PA (n = 151)	12 072 (n=152)	24.87*	5	3.31	72	47.68	74	49.01
Group 3: 35-44 years; HIV-; Low PA (n = 128)	10 847	24.98	4	3.13	60	46.88	64	50.0
Group 4: 35-44 years; HIV+; Low PA (n = 76)	10 090*	25.58	5	6.58	28	36.84	43	56.58
Group 5: 25-34 years; HIV-; Normal to High PA (n=18)	10 927	27.81	0	0.00	7	38.89	11	61.11
Group 6: 25-34 years; HIV+; Normal to High PA (n = 15)	11 074	22.12	0	0.00	11	73.33	4	26.67
Group 7: 35-44 years; HIV-; Normal to High PA (n = 5)	11 771	27.02	0	0.00	2	40.00	3	60.00
Group 8: 35-44 years; HIV+; Normal to High PA (n = 6)	14 519*	22.41	0	0.00	5	83.33	1	16.67

PA: physical activity

*Statistically significant

CHAPTER 9

IRON STATUS OF HIV POSITIVE WOMEN (25-44 YEARS) IN MANGAUNG, SOUTH AFRICA

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ABSTRACT

Objective: This study formed part of a larger epidemiological study investigating the nutritional health of women and reports the iron status in relation to HIV infection.

Design: Cross-sectional study. *Methodology:* A population-based random sample of 500 women was selected using township maps. The sample was divided into women 25 to 34 (n=273) and 35 to 44 years (n=215). Groups were described and compared by non-parametric methods. HIV groups were also compared by 95% Confidence Intervals (CI) for the difference in the percentage of women with parameters above or below the normal range. *Results:* Sixty one percent of the younger group and 38% of the older group were HIV positive. The percentage with serum ferritin levels below 20 microgram per liter (g/L) was higher in HIV negative women, ranging from 0.0% in older HIV positive women to 10.4% in younger HIV negative women. This acute phase protein was possibly reactively elevated, especially in HIV positive women, and thus not a true reflection of iron stores. Many HIV negative and HIV positive women had low serum iron levels. A large percentage of women had elevated transferrin values ranging from 23.91% of older HIV positive women to 44.83% of older HIV negative women, possibly due to the fact that transferrin tends to increase

as an adaptive mechanism to enhance iron absorption. Significantly more HIV positive women had haematocrit values below 0.35 liter per liter (L/L) when compared to HIV negative women (13.3% and 4.72% respectively in the younger group; 95% CI [-14.0; -2.5], and 12.2% and 2.29% respectively in the older group, 95% CI [-17.2; -4.1]). *Conclusions:* Parameters of iron status indicate that iron deficiency is common in all groups and that anemia of chronic disease seems to occur in some HIV positive women.

Key words: South Africa; HIV; African women; iron status

INTRODUCTION

Since the beginning, nutrition has been acknowledged as an important factor in the course of HIV infection (Woods *et al.*, 2002). Nutrition is generally accepted as a major determinant of immune functioning (Chandra, 1997). Nutritional factors, although not the most important etiological determinants, may change immune function to facilitate disease progression, influence viral expression, and play a significant role in disease processes and related morbidity and mortality (Baum & Shor-Posner, 1998).

Iron deficiency in the African population is well documented, and anemia, although not completely understood (Fuchs *et al.*, 1993), appears widely among people living with AIDS (Castaldo *et al.*, 1996; Sullivan *et al.*, 1998; Salome & Grotto, 2002).

Anemia has been associated with HIV disease progression and an increased risk of death (Moore *et al.*, 1998; Sullivan *et al.*, 1998). Anemia can be caused by various mechanisms including infection, neoplasms, dietary deficiencies, blood loss and

medication (Sullivan *et al.*, 1998; Moyle, 2002). Iron deficiency and anemia may contribute to reduced energy levels, lower aerobic capacity, decreased endurance and fatigue (Semba, 2003). A possible sign of early iron deficiency is reduced immunocompetence, which may lead to an increased propensity for infection (Stopler, 2004, p. 842). Although some researchers (Moyle, 2002) have reported that anemia is a prognostic marker of future disease progression or death, independent of CD4 and viral load, others (Clark & Semba, 2001) report no relationship between indicators of iron status and HIV disease severity in HIV-infected pregnant African women.

Olsen *et al.* (2004) recommend that the role of iron in HIV infection be clarified, since iron is commonly administered to anemic patients and pregnant women, even in areas with a high HIV prevalence.

METHODOLOGY

An epidemiological study was undertaken with the main objective of investigating the nutritional health of women between 25 and 44 years of age in Mangaung, the African residential community of Bloemfontein. As part of the larger study, socio-demographic status, health status as determined by a medical examination, dietary intake, levels of physical activity, body perception and attitude toward weight control, prevalence and risk of diseases of lifestyle, anthropometry, micronutrient status and prevalence of HIV were determined. For the purpose of this publication we will report on the iron status of HIV positive and HIV negative women.

A random sample of 500 African women, from the two age groups 25-34 and 35-44 years was selected in Mangaung using township maps. The sample included respondents from two built-up areas, namely Phahameng and Botchabela, and two informal settlements, namely Joe Slovo and Namibia. The women took part in the study voluntarily, but were given an amount of R40.00 for participating. Written informed consent was obtained, approved by the Ethics committee of the Faculty of Health Sciences, University of the Free State (ETOVS no. 02/00). The results of 4 women that were found to be pregnant during the medical examination, and another 8 who did not meet the age requirements, were excluded. Women who wanted to be informed of the results of their HIV status (less than 30 percent of the total sample) were confidentially seen by a medical practitioner who referred HIV positive patients for counselling. All HIV positive women were antiretroviral (ART) naive.

A registered nurse collected the blood samples according to standard practice. HIV tests were performed on an Abbott AxSYM® System, using the Human Immunodeficiency Viruses (HIV-1 / HIV-2). Total serum ferritin was determined on the Hitachi 902, using an immunoturbidimetric immunoassay supplied by Randox (catalogue no. FN 2467). Serum total iron was determined on the Hitachi 902 using a colorimetric assay method (catalogue no. 11876996, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany). Serum total transferrin was determined on the Hitachi 902, using an immunoturbidimetric immunoassay supplied by Randox (catalogue no. TF 7197). The metabolic variables haematocrit and haemoglobin were measured by means of a full blood count. Full blood counts were performed on EDTA (ethyldimethylacetic acid) blood using a Coulter Microdiff 18 Cell Counter. Determination of red blood cell count was necessary to calculate mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean

corpuscular haemoglobin concentration (MCHC). Counting of red and white blood cells took place sequentially.

STATISTICAL ANALYSIS

Groups were described and compared by non-parametric methods. HIV groups were also compared by 95 percent CI's for the difference in the percentage of women with parameters below or above the normal range.

RESULTS

In this population, the prevalence of HIV infection was higher in younger (25-34 years) than in older women (35-44 years). Sixty one percent of younger women and 38 percent of older women were HIV infected.

The median values for iron status parameters of HIV negative and HIV positive women for both age groups are given in Table 1. For all parameters the median values fell within the normal reference ranges. Within these ranges, however, the younger HIV positive women had significantly lower haemoglobin ($p=0.0002$) and haematocrit ($p=0.0003$) median values. For the older HIV positive women, significantly lower and higher median values were respectively recorded for transferrin ($p=0.04$) and serum ferritin ($p=0.02$).

The iron status parameters for younger women are given in Table 2, and the parameters for older women, in Table 3. Few women had low serum ferritin levels, ranging from 0.00 percent for older HIV positive women to 10.39 percent for younger

HIV negative women. Although there were more HIV negative women with low serum ferritin levels, the difference was not significant, but a trend was indicated with a 95 percent Wilson CI [-3.1; 14.4] for the younger, and [-2.2; 15.4] for the older groups.

A large percentage of all women had serum iron levels below 0.7 milligram per liter (mg/L) (Tables 2 and 3). In the younger group there was no significant difference between the percentage of HIV positive and HIV negative women with low serum iron (95 percent CI [-16.6; 4.8]), but in the older group significantly more HIV negative women had low serum iron levels (95 percent CI [1.3; 29.2]).

As seen in Tables 2 and 3, very few women had low transferrin levels. Although more HIV positive women had low transferrin levels, the difference was not significant in both groups. More than 20 percent of all women however, had transferrin levels above 3.0 gram per liter (g/L). Significantly fewer older HIV positive women had elevated transferrin than HIV negative women (95 percent CI [2.4; 37.1]).

The percentage of women with transferrin saturation (Tables 2 and 3) below 20 percent ranged from 30.43 percent in the older HIV positive women to 36.21 percent in the older HIV negative women. In both groups, the percentage of women with transferrin saturation below 20 percent was not significantly different in the HIV positive and -negative groups. Similarly there was no significant difference in the percentage of HIV positive and HIV negative women with transferrin saturation above 50 percent.

The percentage of women with low haemoglobin levels (Tables 2 and 3) ranged from 4.58 percent in the older HIV negative women to 9.64 percent in the younger HIV

positive women. Although the percentage of women with low haemoglobin was higher in the HIV positive groups and the CI indicated a trend, the difference was not statistically significant with 95 percent CI [-11; 2.0] for the younger group, and 95 percent CI [-12.4; 2.7] for the older group).

Similarly, the percentage of women with low haematocrit levels (Tables 2 and 3) ranged from 2.29 percent in the older HIV negative-women to 13.25 percent in the younger HIV positive women. In both younger and older women, the percentage of women with low haematocrit was significantly higher in the HIV positive groups with 95 percent CI [-14.0; -2.5] for the younger group and 95 percent CI [-17.2; -4.1] for the older group.

No significant differences between MCV and MCH of HIV positive and HIV negative women could be found in both the younger and older groups (Tables 2 and 3). The percentage of women with low MCHC ranged from 1.22 percent in the older HIV positive women to 8.49 percent in the younger HIV negative women (Tables 2 and 3). In both groups, the percentage of women with low MCHC was close to significantly lower in the HIV positive groups, with 95 percent CI [0.00; 12.6] for the younger group, and 95 percent CI [0.0; 12.3] for the older group.

DISCUSSION

Prevalence of HIV in our random sample was very high. In developing countries, the disturbing trend of new infections in females growing faster than in males, is being witnessed (Piwoz & Preble, 2000), with women of childbearing age the fastest subgroup of the HIV infected population (Fenton & Silverman, 2004, p. 890).

Nutritional deficiencies may develop during any stage in the HIV infected individual. Many subclinical deficiencies are however not noticed until they have progressed to levels of expressive body depletion, because the early signs and symptoms of nutritional deficiencies, such as fatigue, irritability and dry skin, are often non specific (Cimoch, 1997).

Serum ferritin levels are in equilibrium with body iron stores and measurement of serum ferritin may best reveal early negative iron balance (Stopler, 2004, p. 840), while high serum ferritin indicates significant iron overload (Zilva et al., 1988). Serum ferritin is the most sensitive parameter of negative iron balance, because it decreases only in the presence of true iron deficiency, as with transferrin saturation. Serum ferritin levels, however, rise in chronic disease unrelated to iron metabolism, such as inflammatory disease (Stopler, 2004, p. 856) that may explain the higher median serum ferritin levels of the HIV positive women in this study. It is possible that this acute phase protein was reactively elevated, especially in HIV positive women, and thus not a true reflection of iron stores. Although fewer HIV positive women had decreased serum ferritin levels than HIV negative women, the difference was not statistically significant, but the 95 percent CI in both younger and older women seemed to indicate a trend.

Serum iron levels decrease once body iron stores (as indicated by serum ferritin) are depleted and increase with iron overload. On it's own, serum iron is not a valuable parameter of iron status as it is affected by many pathological factors other than the amount of iron in the body, such as chronic infections (Zilva et al., 1988). A large

percentage of both HIV negative and HIV positive women in this study had serum iron levels below 0.7mg/L.

Plasma transferrin is less labile than serum iron. It rises in uncomplicated iron deficiency and falls in iron overload. It can, however, fall in chronic illnesses associated with low plasma iron concentrations, but remains unchanged in acute illness (Zilva *et al.*, 1988). As expected, very few women had low transferrin values, while a large percentage had elevated transferrin levels, possibly because transferrin tends to increase as an adaptive mechanism to enhance iron absorption. Significantly fewer older HIV positive women had the expected high serum transferrin levels when compared to HIV negative women, possibly due to the chronic illness of HIV infection. Transferrin saturation falls only in the presence of true iron deficiency (Stopler, 2004, p. 846), indicating that more than 30 percent of all women were iron deficient.

The clinical impression of anemia should be confirmed by haemoglobin estimation (Zilva *et al.*, 1988). Haemoglobin levels are affected by chronic infection and other factors that can produce a condition that mimics iron deficiency anemia when, in fact, iron is adequate (Stopler, 2004, p. 843). By itself haemoglobin is unsuitable as a diagnostic tool in cases of suspected iron deficiency anemia, because it is affected only late in the disease, it cannot distinguish iron deficiency from other anemias, and haemoglobin values in normal individuals vary widely (Stopler, 2004, p. 843). Although more HIV positive women in this study had low haemoglobin levels when compared to HIV negative women, the difference was only close to significant. The stage of infection of women in this study was unknown, but in patients with AIDS, low haemoglobin levels have been associated with increased immune activation, low

transferrin (Blumberg et al., 1984; Fuchs et al., 1993) and increased ferritin levels (Blumberg et al., 1984; Fuchs et al., 1993; van Staden et al., 1998).

As haemoglobin levels start to decline, fewer red blood cells are also produced causing the packed cell volume, or haematocrit, to decline as well. Significantly more younger and older HIV positive women had haematocrit values below 0.35 L/L when compared to HIV negative women.

MCV below 81 femto liter (fL) indicates that the erythrocytes are microcytic and thus small, while a low MCH indicates that the erythrocytes are hypochromic, or pale. A microcytic, hypochromic anemia occurs when body stores are depleted and the iron deficiency is severe, but both the MCV and MCH remain normal in early iron deficiency. In contrast to iron deficiency anemia, the anemia of chronic disease is usually, but not always characterized by a normocytic, normochromic blood picture, which could explain the relatively low percentage of especially HIV positive women with decreased MCV and MCH. Serum iron levels and transferrin saturation are low, while iron stores are normal (Heyns & Badenhorst, 1986, p.46), as seen in a large percentage of patients included in this study.

Increased levels of iron intake have been associated with a significant decreased progression rate to AIDS (Tang et al., 1993; United States Agency for International Development (USAID), 2001). Although iron supplementation may prevent or treat iron deficiency (Semba, 2003; Olsen et al., 2004), it may also activate HIV expression and possibly worsen immunosuppression (Moyle, 2002), thus increasing the rate of progression of HIV infection (Olsen et al., 2004) and should be administered with caution (Semba, 2003). Iron supplementation of 60 milligram (mg)

twice per week over four months had no effect on viral load of anemic, pregnant HIV positive women (Olsen *et al.*, 2004). In developing countries, where there is a high prevalence of both HIV infection and iron deficiency, Clark and Semba (2001) recommend that the current practice of iron supplementation be continued. In the anemia of chronic disease, iron supplementation is, however, often not effective, and treatment of the underlying pathology will usually result in improvement in the anemia (Heyns & Badenhorst, 1986, p. 47).

CONCLUSION

In conclusion, the results of the study indicate that prevalence of HIV infection is high in Mangaung, especially amongst women between 25 and 34 years.

Parameters of iron status indicate that iron deficiency is common in all groups. Anemia of chronic disease seems evident in a large percentage of patients, especially in HIV positive women.

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Table 1: Median values for iron status parameters of HIV negative and HIV positive women for both age groups

Parameter	Normal range	25-34 years				35-44 years			
		HIV -		HIV +		HIV -		HIV +	
		n	Median	n	Median	n	Median	n	Median
Serum ferritin (g/L)	20 – 200	77	63.85	95	74.06	62	57.41*	46	80.02*
Serum iron (mg/L)	0.7 – 1.8	93	0.85	116	0.89	62	0.88	53	0.87
Transferrin (g/L)	2.0 – 3.0	68	2.95	85	2.8	58	3.0*	46	2.8*
Transferrin saturation (%)	20 – 50	68	25.44	85	26.01	58	24.06	46	23.81
Haemoglobin (g/dL)	11.7 – 16.0	106	14.05*	166	13.55*	131	13.7	82	13.5
Haematocrit (L/L)	0.35 – 0.47	106	40.95*	166	39.15*	131	39.5	82	39.75
MCV (fL)	81 – 99	106	89.65	166	89.95	131	91.50	82	91.5
MCH (pg)	27 – 34	106	30.50	166	30.85	131	31.3	82	31.15
MCHC (g/dL)	32 – 36	106	33.90	166	34.05	131	34.2	82	34.1

***Statistically significant**

Table 2: Iron status parameter percentages for HIV positive and HIV negative women in the 25-34 year age group

Parameter	HIV-		HIV+		95% CI
	N	%	n	%	
Serum ferritin (g/L):	(n=77)		(n=95)		
<20	8	10.39	5	5.26	-3.1;14.4
20-200	67	87.01	87	91.58	
>200	2	2.60	3	3.16	
Serum iron (mg/L):	(n=93)		(n=116)		
<0.7	28	30.11	42	36.21	-16.6;4.8
0.7-1.8	59	63.44	68	58.62	
>1.8	6	6.45	6	5.17	
Transferrin (g/L):	(n=68)		(n=85)		
<2.0	1	1.47	4	4.71	-8.7;2.3
20.0-3.0	45	66.18	55	64.71	
>3.0	22	32.35	26	30.59	-12.6;16.5
Transferrin saturation (%):	(n=93)		(n=116)		
<20	22	32.35	26	30.59	-10.4;14.2
20-50	41	60.29	51	60.0	
>50	5	7.35	8	9.41	
Haemoglobin (g/dL):	(n=106)		(n=166)		
<11.7	5	4.72	16	9.64	-11.0;2.0
11.7-16.0	95	89.62	148	89.16	
>16.0	6	5.66	2	1.20	
Haematocrit (L/L):	(n=106)		(n=166)		
<0.35	5	4.72	22	13.25	-14.0;-2.5*
0.35-0.47	95	89.62	144	86.75	
>0.47	6	5.66	0	0.00	
MCV (fL):	(n=106)		(n=166)		
<81	10	9.43	14	8.43	-5.7;8.8
81-99	92	86.79	144	86.75	
>99	4	3.77	8	4.82	
MCH (pg):	(n=106)		(n=166)		
<27	10	9.43	12	7.23	-4.3;9.9
27-34	91	85.85	147	88.55	
>34	5	4.72	7	4.22	

Table 2: Iron status parameter percentages for HIV positive and HIV negative women in the 25-34 year age group (Continued)

Parameter	HIV-		HIV+		
MCHC (g/dL):	(n=106)		(n=166)		
<32	9	8.49	5	3.01	0.0;12.6
32-36	91	85.85	158	95.18	
>36	6	5.66	3	1.81	

***Statistically significant**

Table 3: Iron status parameter percentages for HIV positive and HIV negative women in the 35-44 year age group

Parameter	HIV-		HIV+		95% CI
	N	%	n	%	
Serum ferritin (g/L)	(n=62)		(n=46)		
<20	4	6.45	0	0.00	-2.2;15.4
20-200	51	82.26	44	95.65	
>200	7	11.29	2	4.35	
Serum iron (mg/L)	(n=62)		(n=53)		
<0.7	25	40.32	13	24.53	1.3;29.2*
0.7-1.8	28	45.16	39	73.58	
>1.8	9	14.52	1	1.89	
Transferrin (g/L)	(n=58)		(n=46)		
<2.0	0	0.00	2	4.35	-12.4;1.0
20.0-3.0	32	55.17	33	71.74	
>3.0	26	44.83	11	23.91	2.4;37.1*
Transferrin saturation (%)	(n=62)		(n=53)		
<20	21	36.21	14	30.43	-9.6;20.4
20-50	30	51.72	30	65.22	
>50	7	12.07	2	4.35	
Haemoglobin (g/dL)	(n=131)		(n=82)		
<11.7	6	4.58	7	8.54	-12.4;2.7
11.7-16.0	121	92.37	72	87.80	
>16.0	4	3.05	3	3.66	
Haematocrit (L/L)	(n=131)		(n=82)		
<0.35	3	2.29	10	12.20	-17.2;-4.1*
0.35-0.47	123	93.89	69	84.15	
>0.47	5	3.82	3	3.66	
MCV (fL)	(n=131)		(n=82)		
<81	8	6.11	2	2.44	-3.1;9.4
81-99	112	85.50	75	91.46	
>99	11	8.40	5	6.10	
MCH (pg)	(n=131)		(n=82)		
<27	10	7.63	2	2.44	-1.7;11.3
27-34	108	82.44	75	91.46	
>34	13	9.92	5	6.10	

Table 3: Iron status parameter percentages for HIV positive and HIV negative women in the 35-44 year age group (Continued)

Parameter	HIV-		HIV+		
MCHC (g/dL)	(n=131)		(n=82)		
<32	10	7.63	1	1.22	0.0;12.3
32-36	108	82.44	76	92.68	
>36	13	9.92	5	6.10	

***Statistically significant**

CHAPTER 10

METABOLIC PROFILE OF HIV POSITIVE WOMEN (25-44 YEARS) LIVING IN MANGAUNG, SOUTH AFRICA

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ABSTRACT

Objective: To determine the biochemical nutritional status of HIV positive women living in Mangaung, South Africa. *Design:* Cross-sectional study of a representative group of 500 pre-menopausal African women falling within the two age group categories of 25-34 and 35-44 years. *Methodology:* Biochemical analyses were performed for fasting total lymphocytes, total serum protein, serum albumin, plasma fibrinogen, serum insulin, serum glucose, serum triglycerides and total serum cholesterol using standard methodology and appropriate controls. Obtained concentrations were compared to standard references, and values of HIV seropositive and HIV seronegative women were compared. *Results:* Sixty one percent of the younger women and 38% of older women were infected with HIV. Compared to HIV seronegative women, young and older HIV seropositive women had significantly lower median blood values for total lymphocytes ($p=0.0001$ and $p=0.02$ respectively) and serum albumin ($p=0.0001$ in both young and older HIV seropositive women), but significantly higher median blood levels of total serum protein ($p=0.0001$ in both young and older HIV seropositive women). Plasma fibrinogen and serum insulin concentrations were significantly reduced in HIV seropositive young women ($p=0.002$). Older HIV seropositive women had significantly lower total serum cholesterol values ($p=0.01$) than HIV seronegative older women. No

significant differences were found for serum glucose or serum triglycerides between HIV seropositive and HIV seronegative women within the two age groups. *Conclusions:* HIV seropositive women not receiving antiretroviral therapy have underlying metabolic abnormalities that may adversely affect their nutritional status and the course of HIV infection. Early testing for HIV, accompanied by nutrition intervention, continuous evaluation of metabolic parameters for each HIV infected individual, should be promoted. Extensive management strategies to actively treat and counsel patients with malnutrition must be implemented for maximum retention of lean body mass, infection resistance, and ongoing quality and productivity of life.

Keywords: South Africa; HIV; African women; metabolic changes

INTRODUCTION

Malnutrition remains one of the most significant, but intriguing consequences of HIV infection (Fenton & Silverman, 2000, p. 899). Although malnutrition has been recognised as a significant prognostic factor in advanced disease stages (Süttmann *et al.*, 1995), it can also occur at the onset of the chronic infection process (Ott *et al.*, 1995). Two broad categories of HIV-related malnutrition, including a decrease in oral intake and malabsorption, and metabolic abnormalities, can be distinguished (Gramlich & Mascioli, 1995).

Infection with HIV is associated with changes in the metabolic competence of in vivo macronutrient distribution (Ware *et al.*, 2002). Abnormalities in protein, glucose and lipid metabolism have been reported in HIV patients since the beginning of the AIDS epidemic (reviewed by Salas-Salvadó & Garcia-Lorda, 2001), and are associated with profound changes in body composition, particularly wasting (Kotler & Heymsfield, 1998;

Sheehan & Macallan, 2000). Metabolic changes have earlier been attributed amongst others, to the effect of the HIV virus *per se*, opportunistic infections, and changes in endocrine, liver, kidney, pancreatic and adrenal function (Hellerstein *et al.*, 1993).

Nonetheless, the complexity of these metabolic changes still leaves researchers with many questions. Further studies have been suggested to clear these uncertainties (Melchior, 1997; Salas-Salvadó & Garcia-Lorda, 2001). While recent research has been aimed at the complex metabolic changes in patients receiving antiretroviral therapy (Hadigan *et al.*, 1999; Hadigan *et al.*, 2001; Limone *et al.*, 2003), these medications are financially out of reach of millions of HIV/AIDS sufferers in developing countries (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2001).

With this study, we intended to determine the biochemical nutritional status of HIV-infected patients not receiving antiretroviral therapy.

METHODOLOGY

The Department of Biostatistics, University of the Free State, randomly chose women from the Mangaung District, Bloemfontein, South Africa. A township map, obtained from the greater Bloemfontein municipality, was used to make the selection. Women were selected from two informal settlements, and two formal settlements. Plots within the designated areas were counted and numbered, and a proportionate number of respondents were selected randomly from these plots. The size of the sample was considered representative of the population of the Mangaung District. Trained community healthcare workers were responsible for the recruitment of the subjects. The healthcare workers were given detailed instructions about the recruitment of

subjects as well as a detailed map of twenty of the selected plots on a weekly basis. On arrival of the plot, the inhabitants were screened for eligibility.

The ethics Committee of the Faculty of Health Sciences, University of the Free State approved the study (ETOVS number 02/00). The assigned community health workers explained the content and purpose of the study to possible participants. It was required that each recruited subject gave informed consent. Subjects were given R40-00 to participate in the study. Subjects were also given the opportunity to indicate whether they would like to receive their HIV test results, or whether the outcome should be withheld from them. All subjects that chose to be given the outcome of their test results were referred to a medical practitioner, for post-test counselling and if required, a confirmatory test. The research team was unaware of the outcome of the individual HIV tests due to blinding.

Laboratory data collected for the study included HIV status, total lymphocytes, total serum protein, serum albumin, plasma fibrinogen, serum insulin, serum glucose, serum triglycerides and total serum cholesterol. Analysis of data was performed in the clinical laboratories at the Fibrinogen Unit, Central University of Technology, Free State. Fasting blood samples were collected after an overnight fast, using standard procedures.

HIV tests were performed using the Human Immunodeficiency Viruses (HIV-1 / HIV-2): (Recombinant Antigens and Synthetic Peptides) reagent pack (Abbott, Germany, catalogue no. 3D41-20). Total lymphocyte counts were measured by means of a full blood count. Full blood counts were performed on ethyldimethylacetic acid (EDTA) blood using a Coulter Microdiff 18 Cell Counter. Total serum protein was determined

using a colorimetric method (catalogue no. 1553836, Boehringer Mannheim-Roche Diagnostics, Mannheim, Germany). Serum albumin was determined using a colorimetric endpoint method supplied by Roche Diagnostics GmbH, Mannheim, Germany (catalogue no. 1970569). The method of Clauss (1957) was used for the quantitative determination of total plasma fibrinogen concentration. Serum glucose was determined using an enzymatic colorimetric method, supplied by Roche Diagnostics GmbH, Mannheim, Germany (catalogue no. 1448668). The DRG insulin ELISA, a solid phase two-site enzyme immunoassay, was used to determine serum insulin. Fasting triglycerides were determined using the GPO-PAP method supplied by Roche Diagnostics GmbH, Mannheim, Germany (catalogue no. 148872), which is based on an enzymatic colorimetric principle. Total serum cholesterol was determined using the CHOD-PAP method (catalogue no. 1489232) supplied by Roche Diagnostics GmbH, Mannheim, Germany, and is based on an enzymatic colorimetric principle.

STATISTICAL ANALYSIS

Data were processed using the SAS software programme. All data sets were categorised into two age groups: 25 to 34 years, and 35 to 44 years, and according to HIV status into HIV negative and HIV positive groups. For each group continuous variables were described by medians. Categorical variables were described by frequencies and percentages. The median difference between laboratory blood values of young and older HIV negative and HIV positive women was determined by 95 percent non-parametric confidence intervals (CI) and the Mann-Whitney test for significant differences. P values ≤ 0.05 were considered statistically significant.

RESULTS

The highest HIV incidence was in the age group 25-34 years, with 167 of the 273 respondents testing HIV positive. In the age group 35-44 years, 82 of the 215 respondents were HIV infected.

Both younger and older women with HIV had significantly lower median blood values for total lymphocytes ($p=0.0001$ and $p=0.02$ respectively) compared to their HIV negative counterparts (Table 1 and 2).

In comparison with HIV seronegative women, young and older HIV seropositive women had significantly higher median blood levels of total serum protein ($p=0.0001$ in both young and older HIV positive women), but significantly lower median serum albumin concentrations ($p=0.0001$ in both young and older HIV positive women). High median total serum protein values (>82 gram/Liter (g/L)) were observed in a large percentage of HIV negative young and older women (approximately 50 percent), and HIV positive women (approximately 74 percent to 80 percent) from both age groups (Table 3 and 4). Median plasma fibrinogen values were significantly lower in the young HIV positive group ($p=0.002$) than young HIV negative group (Table 1). Approximately 27 percent of both the young and older HIV negative women showed high plasma fibrinogen concentrations. In HIV positive young and older women these figures were lower (17.83 percent and 19.74 percent respectively). Notwithstanding the significant differences found in serum albumin and plasma fibrinogen, these levels were reduced within the normal range of $34-48$ g/L for serum albumin and $1.5-4$ g/L for plasma fibrinogen.

Serum glucose and serum insulin levels were normal in the majority of the total sample. However, compared to young uninfected women, we found significantly lower median serum insulin levels ($p=0.002$) in HIV positive young women. From the older group, more HIV positive women (17.07 percent) than uninfected women (6.77 percent) had elevated serum insulin concentrations (Table 4). In the younger group, the reverse was true (Table 3).

No significant differences were found within groups for serum triglycerides, but 15.85 percent of the older HIV positive women fell in the high risk category for elevated serum triglycerides (≥ 2 millimol/Liter (mmol/L)). Although still within the normal range for the assay, HIV positive older women showed significantly ($p=0.01$) lower median total serum cholesterol levels than HIV negative older women. From the older women, 33.34 percent of the HIV negative women, and 20.73 percent of the HIV positive women were at moderate to high risk for elevated cholesterol ($5.2 < 7.8$ mmol/L).

DISCUSSION

In this cross-sectional study, we determined the metabolic status of HIV-infected individuals, and compared the observed blood values with normal values. The results of the study suggest evidence of distinct biochemical malnutrition in this group of HIV-infected women unaware of their HIV status.

Our data demonstrate significantly reduced total lymphocyte counts in both groups of HIV positive women. Results from an earlier cohort study showed no significant changes in lymphocyte count in HIV asymptomatic subjects during the follow-up period. Total lymphocyte count was however significantly decreased by month 5 in patients

with more advanced disease (McCorkindale *et al.*, 1990). Total lymphocyte counts of HIV positive women in our study were decreased within the normal range for the assay, possibly indicating some disease progression.

Some authors have reported elevated total protein, and reduced serum albumin levels in HIV-infected and AIDS patients (reviewed by Gramlich & Mascioli, 1995). Median values of total serum protein of both groups of HIV positive women in the present study were also significantly higher than the levels in uninfected young and older women (Table 1 and 2). Increased mean serum proteins were also reported for HIV positive women in the Transition and Health during Urbanization of South Africans (THUSA) study performed in the Northwest Province of South Africa (Nienaber *et al.*, 2000). Circulating proteins, including total protein, may be affected by non-nutritional factors such as infection, changes in vascular permeability and state of hydration (Gramlich & Mascioli, 1995), and should be considered as possible explanation in this regard. Decreased albumin levels have been associated with shorter survival in women with HIV infection (Feldman *et al.*, 2000) and in AIDS patients (Zumwalt & Schmidt, 1989; Melchior *et al.*, 1999). In the present study, median serum albumin levels of both younger and older HIV positive women were significantly lower, but within the normal range, than those of their HIV negative counterparts. These results are in general agreement with those of other studies. In the THUSA study, mean serum albumin levels were also decreased, but still within the normal range, in HIV positive women (Nienaber *et al.*, 2000). These reduced serum albumin concentrations could result from poor nutritional status (Melchior *et al.*, 1999), or a normal systemic response to a chronic inflammatory disorder (van Staden *et al.*, 1998; Sabin *et al.*, 2002). Disease progression towards more advanced stages seems to further worsen this state (Niyongabo *et al.*, 1997; van Staden *et al.*, 1998).

The acute-phase response is characterised by increased levels of circulating fibrinogen in HIV-infected patients (Simpson-Haidaris *et al.*, 1998). The metabolic changes associated with sepsis can be seen as an integral part of the body's defense, because they provide the energy and substrate to fuel the acute-phase response. This response is characterized by the hepatic production of excessive amounts of specific proteins that bind to, and increase clearance of infectious agents and cell debris (Fong *et al.*, 1989), in order to limit the damage, and prevent progressive oxidative reactions that could cause microcirculatory collapse and multiple organ failure (Babameto & Kotler, 1997). In the present study, conflicting results were however found, with significantly lower plasma fibrinogen concentrations in young HIV positive women ($p=0.002$) than in young HIV negative women (Table 1), and lower, but not significantly so in the older group of women (Table 2). The mechanism for this remains unclear. In the THUSA study, fibrinogen concentrations were higher in both HIV negative younger and older urbanized women (3.67 g/L and 3.84 g/L respectively), and in the total sample of rural and urban HIV positive women (3.53 g/L) (James *et al.*, 2000) than in our study. Notwithstanding the lower plasma fibrinogen levels that were observed in HIV-infected women in the present study, the percentage of the total sample with elevated plasma fibrinogen levels, placing them at increased risk of cardiovascular disease (Koppel *et al.*, 2002), is a matter of concern. The possible role of contributing factors such as urbanization, obesity, alcohol consumption, smoking, age, gender, physical activity and nutritional status (James *et al.*, 2000), should be considered in this regard.

Abnormalities in glucose metabolism have been reported in HIV patients before the introduction of highly active antiretroviral therapy (HAART). Glucose levels may be

normal or lower than normal, insulin levels may be normal or increased, while insulin sensitivity is increased (reviewed by Salas-Salvadó & Garcia-Lorda, 2001). In the present study, the majority of HIV positive young and older women had normal serum glucose levels (3.05-6.38 mmol/L), and no significant differences between serum glucose levels in HIV positive and HIV negative groups were detected. These results are in general agreement that in HIV-infected individuals not receiving antiretroviral therapy, serum glucose may remain at normal levels. Serum insulin concentrations were significantly ($p=0.002$) lower in the HIV positive young women than HIV negative young group, indicating an increase in serum insulin clearance and the absence of insulin resistance. Hommes *et al.* (1991) previously found no differences between insulin levels and endogenous glucose production in HIV-infected patients and controls. HIV-infected patients however had significantly lower plasma glucose levels than control subjects.

It has been previously reported that the lipid profile of HIV-infected patients is altered even during the early stages of HIV-1 disease (reviewed by Gramlich & Mascioli, 1995, and Salas-Salvadó & Garcia-Lorda, 2001). This atypical pattern has been associated with immunological disturbances, and may be a useful marker of disease progression (Shor-Posner *et al.*, 1993; Fernández-Miranda *et al.*, 1998). Decreased cholesterol levels have been reported from an early stage of HIV infection in patients not receiving antiretroviral therapy (Grunfeld *et al.*, 1992; Gramlich & Mascioli, 1995; Salas-Salvadó & Garcia-Lorda, 2001). Consistently with results from the THUSA study (Nienaber *et al.*, 2000), our findings illustrated that, although also within the normal range for the assay ($>0.92<5.2$ mmol/L), serum cholesterol levels were significantly reduced in HIV positive older women in comparison with their HIV negative counterparts. Furthermore, some studies have confirmed an association between serum cholesterol levels and

stage of disease (Chlebowski et al., 1995; van Staden et al., 1998), despite stable or increased daily dietary intake of saturated fat and cholesterol (Shor-Posner et al., 1993; Chlebowski et al., 1995).

Serum triglyceride levels have shown to be increased during asymptomatic HIV infection (Hellerstein et al., 1993; Gramlich & Mascioli, 1995; Salas-Salvadó & Garcia-Lorda, 2001). In contrast, some studies found no evidence of increased triglyceride levels in HIV-1 infected individuals (Grunfeld et al., 1992; Shor-Posner et al., 1993). Results from the present study also revealed no significant differences between serum triglyceride levels of HIV negative and HIV positive women from the two age groups (Table 1 and 2). In the older group, however, 15.85 percent of the HIV positive women, and 12.12 percent of the HIV negative women fell in the high risk category for elevated serum triglycerides (Table 4). The decreased clearance of triglycerides from blood during HIV infection has been associated with decreased activity of the enzyme lipoprotein lipase that is responsible for clearing circulating triglycerides (Babameto & Kotler, 1997). The possible influence of dietary lipid status should however not be excluded as an explanation for increased serum triglyceride levels.

CONCLUSION

HIV remains a complex and progressive disease (Salas-Salvadó & Garcia-Lorda, 2001). In summary, the results from our study clearly indicated underlying metabolic abnormalities in HIV positive women in this setting. This deterioration may impair nutritional status, and consequently have a critical effect on the course of HIV disease (Calderon et al., 1990). Malnutrition is a significant prognostic factor, particularly in more advanced HIV disease stages (Salomon et al., 2002), thus underscoring the

significance of early nutrition intervention. This can only be achieved if early voluntary testing for HIV is encouraged (Lamprey, 2002) in this disadvantaged community with its great risk of becoming infected with the virus. Following HIV diagnosis, continuous nutritional evaluation and the determination of metabolic parameters for each HIV infected individual must become a reality. Comprehensive management strategies to actively treat and counsel those with malnutrition must be implemented for maximum retention of lean body mass (Salomon et al., 2002), infection resistance, and ongoing quality and productivity of life (Calderon et al., 1990).

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Table 1: Descriptive biochemical parameters of HIV positive and HIV negative younger women (25-34 years)

Biochemical parameters	Age group 25-34 years			
	N	Median	Mann-Whitney p-value	Median difference (negative-positive) [CI]
Total lymphocytes ($\times 10^9/L$)				
HIV negative	104	2.4		0.4
HIV positive	158	2.1	*0.0001	[0.2; 0.5]
Serum total protein (g/L)				
HIV negative	106	82		-7
HIV positive	167	91	*0.0001	[-10; -5]
Serum albumin (g/L)				
HIV negative	106	42.85		2.6
HIV positive	167	40.2	*0.0001	[1.5; 3.7]
Plasma fibrinogen (g/L)				
HIV negative	100	3.56		0.33
HIV positive	157	3.17	*0.002	[0.13; 0.56]
Serum insulin ($\mu U/ml$)				
HIV negative	106	9.1		2.4
HIV positive	166	5.78	*0.002	[1.0; 4.0]
Serum glucose (mmol/L)				
HIV negative	105	4.36		
HIV positive	167	4.28	0.26	
Triglycerides (mmol/L)				
HIV negative	106	0.90		
HIV positive	167	0.97	0.69	
Total cholesterol (mmol/L)				
HIV negative	106	4.25		
HIV positive	167	4.1	0.30	

* Significant difference

Table 2: Descriptive biochemical parameters of HIV positive and HIV negative older women (35-44 years)

Biochemical parameters	Age group 35-44 years			
	N	Median	Mann-Whitney p-value	Median difference (negative-positive) [CI]
Total lymphocytes ($\times 10^9/L$)				
HIV negative	130	2.2		0.2
HIV positive	80	2.0	*0.02	[0.0; 0.4]
Serum total protein (g/L)				
HIV negative	132	82		-9
HIV positive	82	91.5	*0.0001	[-11; -6]
Serum albumin (g/L)				
HIV negative	131	42.2		2.7
HIV positive	82	39.6	*0.0001	[1.7; 3.7]
Plasma fibrinogen (g/L)				
HIV negative	127	3.38		
HIV positive	76	3.19	0.18	
Serum insulin ($\mu U/ml$)				
HIV negative	133	5.75		
HIV positive	82	6.25	0.17	
Serum glucose (mmol/L)				
HIV negative	133	4.39		
HIV positive	82	4.28	1.0	
Triglycerides (mmol/L)				
HIV negative	132	1.10		
HIV positive	82	1.21	0.42	
Total cholesterol (mmol/L)				
HIV negative	132	4.7		0.4
HIV positive	82	4.3	*0.01	[0.1; 0.7]

* Significant difference

Table 3: Frequency and percentage of HIV positive and HIV negative younger women (25-34 years) with reduced, normal and elevated laboratory parameters

Parameter	HIV negative						HIV positive						Normal value
	n	% R	n	% N	n	% I	n	% R	n	% N	n	percent I	
Total lymphocytes	0	0	94	90.38	10	9.62	0	0	145	91.77	13	8.23	0.8-3.3 x 10 ⁹ /L
Serum total protein	0	0	54	50.94	52	49.06	0	0	34	20.36	133	79.64	60-82 g/L
Serum albumin	0	0	90	84.91	16	15.09	14	8.38	134	80.24	19	11.38	34<48 g/L
Plasma fibrinogen	0	0	73	73.00	27	27.00	3	1.91	126	80.25	28	17.83	1.5-4 g/L
Serum glucose	7	6.67	84	80.00	14	13.33	8	4.79	144	86.23	15	8.98	3.05-6.38 mmol/L
Serum insulin	5	4.72	82	77.36	19	17.92	33	19.88	120	72.29	13	7.83	2-25 (μU/ml)
Serum triglycerides	0	0	100	94.34	6	5.66	0	0	157	94.01	10	5.99	<2 mmol/L
Total serum cholesterol	0	0	83	78.30	23	21.69	0	0	135	80.84	32	19.16	>0.9<5.2 mmol/L

n: Number of participants
R: Reduced concentrations
N: Normal concentrations
I: Increased concentrations

Table 4: Frequency and percentage of HIV positive and HIV negative older women (35-44 years) with reduced, normal and elevated laboratory parameters

Parameter	HIV negative						HIV positive						Normal value
	n	% R	n	% N	n	% I	n	% R	n	% N	n	percent I	
Total lymphocytes	0	0	121	93.08	9	6.92	2	2.50	75	93.75	3	3.75	0.8-3.3 x 10 ⁹ /L
Serum total protein	0	0	67	50.76	65	49.24	0	0	21	25.61	61	74.39	60-82 g/L
Serum albumin	2	1.53	124	94.66	5	3.82	9	10.98	71	86.59	2	2.44	34<48 g/L
Plasma fibrinogen	2	1.57	90	70.87	35	27.56	0	0	61	80.26	15	19.74	1.5-4 g/L
Serum glucose	9	6.77	120	90.23	4	3.01	4	4.88	73	89.02	5	6.10	3.05-6.38 mmol/L
Serum insulin	27	20.30	97	72.93	9	6.77	13	15.85	55	67.07	14	17.07	2-25 (μU/ml)
Serum triglycerides	0	0	116	87.88	16	12.12	0	0	69	84.15	13	15.85	<2 mmol/L
Total serum cholesterol	0	0	88	66.67	44	33.34	0	0	65	79.27	17	20.73	>0.9<5.2 mmol/L

n: Number of participants
R: Reduced concentrations
N: Normal concentrations
I: Increased concentrations

CHAPTER 11

FACTORS ASSOCIATED WITH HIV INFECTION IN WOMEN (25-44 YEARS) LIVING IN MANGAUNG, SOUTH AFRICA: MODEL 1 (MAINLY CONTINUOUS VARIABLES)

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ABSTRACT

Objective: This study formed part of a cross-sectional study investigating the health and nutritional status of women in Mangaung. *Methodology:* A population-based random sample of 500 women was selected using township maps. The sample was divided into women between 25 and 34 years (n=273) and 35 and 44 years (n=215). Socio-demographic information, anthropometry, dietary intake and blood values were determined using standardised techniques. A logistic regression was performed to determine which of the parameters that differed with $p < 0.10$ between HIV-infected and HIV-uninfected women were associated with HIV infection in the two age groups. *Results:* In the younger group, the odds of being HIV positive for women who smoke were 3.47 times that of women who do not smoke, with 95 percent Confidence Interval (CI) [1.38; 8.70]. The odds of being HIV positive for women who were neither married nor traditionally married were 4.35 times that of women who were married or traditionally married, with 95 percent CI [1.27; 14.95]. For every gram/Liter (g/L) increase in total serum protein, the odds of being HIV positive increase by 1.24, with 95 percent CI [1.15; 1.34]. For every g/L increase in serum albumin, the odds of being HIV positive decrease by 0.68, with 95 percent CI [0.57; 0.80]. In the older group of women, the odds of being

HIV positive for women with none/primary school education are 0.18 times that of women with other (better) education, with 95 percent CI [0.06; 0.60]. For every g/L increase in total serum protein, the odds of being HIV positive increase by 1.1, with 95 percent CI [1.04; 1.19]. For every g/L increase in serum albumin, the odds of being HIV positive decrease by 0.82, with 95 percent CI [0.70; 0.96]. For every milligram (mg) increase in non-haem iron intake, the odds of being HIV positive decrease by 0.57, with 95 percent CI [0.40; 0.82]. *Conclusions:* In both younger and older women, increasing serum total protein and decreasing serum albumin are associated with HIV infection. In the younger women, smoking and being unmarried increase the odds of being HIV-infected and in older women, a higher level of education and decreasing non-haem iron intake are factors associated with HIV infection.

Key words: South Africa; HIV; African women; HIV-associated variables

INTRODUCTION

Since the start of the HIV epidemic, more than forty million individuals have been infected with HIV (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2003). Of these, more than 90 percent occur in developing countries (Semba & Tang, 1999). The epidemic continues to expand in Sub-Saharan Africa, and has been declared by the World Health Organization (WHO, 1995) as one of the major public health threats. Approximately 3.0-3.4 million new infections occurred in Sub-Saharan Africa during 2003, and 2.2-2.4 million Africans died of the disease (UNAIDS, 2003).

The HIV/AIDS epidemic poses a major health challenge to South Africans. During 2000, this part of the African continent showed the fastest growing rates for HIV in the world (Medical Research Council of South Africa (MRC, SA), 2000), with 4.7 million people

being infected with the virus (UNAIDS, 2001; Department of Health, South Africa (DoH, SA), 2002), and more than 1 500 new infections occurring every day (National Institute Community Development and Management (NICDAM), 2000). In a survey conducted in 2002 among antenatal clinic attendees, the Free State province ranked third in the country on the list of highest HIV prevalence rates (DoH, SA, 2002).

In South Africa, the HIV/AIDS epidemic has resulted in a catastrophic change from the previous relatively commendable public health situation, to one where life expectancy could drop drastically by 2010. By the end of this decade, the AIDS epidemic could contribute to 50 percent of all deaths in this country (Walker, 2001).

In developing countries such as South Africa, factors associated with urbanisation (Gordon, 2000) such as smoking and being unmarried, poverty (Passwater, [s.a.] and poor education (UNAIDS, 2001) possibly contribute to the distressing pace at which the epidemic is spreading.

With this study, we intended to identify possible factors that could affect HIV infection amongst women living in an urbanized community in South Africa.

METHODOLOGY

An epidemiological study was undertaken with the main objective of investigating the nutritional health of women in Mangaung, the African residential community of the city Bloemfontein. A random sample of 500 African women, from the two age groups 25-34 and 35-44 years was selected using township maps obtained from the Greater Bloemfontein Municipality. The sample included respondents from two formal

settlements, namely Phahameng and Botchabela, and two informal settlements, namely Joe Slovo and Namibia. Respondents took part in the study voluntarily. Written informed consent was obtained, and the study was approved by the Ethics committee of the Faculty of Health Sciences, University of the Free State (ETOVS no. 02/00).

Socio-economic status, anthropometric measurements (body mass index (BMI), waist-hip-ratio and fat percentage), dietary intake, and biochemical markers of nutritional status were determined using standard methods as described elsewhere.

A logistic regression was performed to determine which of the parameters that differed with $p < 0.10$ between HIV-infected and HIV-uninfected women were associated with HIV infection in the two age groups.

STATISTICAL ANALYSIS

For each age group separately, continuous variables were described by the mean and standard deviation or median and percentiles as applicable, and compared between the two HIV groups by the student t-test or Mann-Whitney test. Categorical variables were described by frequencies and percentages, and compared between the two HIV groups by the Chi-square or Fisher's exact test where applicable.

Due to the large number of variables, a p-value of < 0.10 was used to identify factors that differentiate between the HIV-infected and HIV-uninfected groups in order to identify variables significantly associated with the presence of HIV. These variables were entered into a stepwise logistic regression model (using forward selection) with HIV status as outcome. Continuous variables were assessed by Spearman correlations.

Categorical variables associated with HIV infection were compared by the Chi-square or Fisher's exact test. Continuous variables associated with HIV infection were compared between the categories of categorical variables by the Mann-Whitney test.

RESULTS

Of the 500 women recruited for the study, 488 were eligible to participate (4 women were found to be pregnant during the medical examination and 8 women were either older or younger than the required age). Of the 488 women, 273 were 25-34 years old and 215 were 35-44 years old. Sixty one percent of the younger group and 38 percent of the older group were HIV positive.

Continuous variables that differed with $p < 0.10$ between HIV-infected and HIV-uninfected younger (25-34 years) and older (35-44 years) women are presented in Tables 1 and 2 respectively, while the categorical variables that differed with $p < 0.10$ of the two age groups are indicated in Tables 3 and 4.

In both the older and younger groups, significantly more HIV positive women had lived in an urban area for longer (Tables 1 and 2), smoked, were unmarried, and did not have a husband as the head of the household (Tables 3 and 4). Interestingly, more HIV-infected younger women lived in brick houses compared to HIV-uninfected women, and in the older group more HIV-infected women had a higher level of education compared to HIV-uninfected women.

As far as anthropometry is concerned, median BMI of younger HIV-infected women was significantly lower than that of HIV-uninfected women (Table 1).

In the younger group, median energy intake, total protein, total fat and polyunsaturated fatty acid (PUFA) intake of HIV-infected women was higher than that of younger uninfected women (Table 1). Median mineral and trace element intake of younger HIV-infected women was higher than that of HIV-uninfected women for calcium, chromium, potassium, magnesium, sodium and phosphorus (Table 1), while in the older HIV-infected group it was lower than that of HIV-uninfected women for chromium, haem iron, non-haem iron and selenium (Table 2).

When compared with their HIV negative counterparts, median vitamin intake of HIV-infected younger women were consistently higher for vitamin D, vitamin E, thiamin, niacin, folate, vitamin B12 and pantothenic acid (Table 1). In the older group, median intakes of folate were lower in HIV-infected than in HIV-uninfected women (Table 2).

As far as parameters of iron status are concerned, HIV-infected younger women had higher median serum ferritin and lower haemoglobin and haematocrit concentrations than HIV-uninfected women (Table 1). Older HIV-infected women also had higher median serum ferritin and serum transferrin levels than HIV negative women (Table 2).

Other median blood measures that differed with $p < 0.10$ between HIV groups included total lymphocytes (lower in HIV-infected women in both age groups), serum total proteins (higher in HIV-infected women in both age groups) and serum albumin (lower in HIV-infected women in both age groups). In the younger group, HIV-infected women had lower median plasma fibrinogen and serum insulin (Table 1), while in the older group, the serum cholesterol of HIV-infected women was also lower than that of the HIV-uninfected women (Table 2).

The association between continuous variables of HIV is indicated in Table 5 for women 25-34 years and in Table 6 for women 35-44 years. Due to the large number of variables, only those with a Spearman Correlation of >0.6 are reported ($p < 0.0001$ for all those indicated). In the younger group, a large number of correlations >0.6 were found between the intake of energy, macronutrients and micronutrients. No correlations between any of the other continuous variables such as years living in an urban area, BMI, or any of the blood measures other than the expected haemoglobin and haematocrit (0.9) were found (Table 5).

In the older group, the numbers of associations between continuous variables of HIV were fewer than in the younger group, due to the fact that there were far fewer variables that differed between the HIV-infected and uninfected women in this age group (Table 2). Spearman Correlations >0.6 were found for all included nutrients with each other, with the exception of haem iron that was not associated with any other nutrient intake.

Table 7 indicates the association between categorical variables of HIV. Due to the large number of variables, only those with a p-value of <0.05 are reported. In the younger group smoking status was associated with type of dwelling ($p = 0.009$). A significant association was also found between marital status and head of the household in both the younger ($p < 0.0001$) and older ($p < 0.0001$) groups.

Table 8 shows the difference between continuous variables for each categorical variable. Due to the large number of variables, only those with a p-value of <0.05 are reported. In the younger group, serum ferritin, serum albumin and serum insulin levels as well as vitamin D intake differed significantly between the two smoking categories. In younger women, years living in an urban area and BMI differed significantly between married and unmarried women, while in the older group, lymphocytes, serum total proteins and haem iron intake was significantly different between married and unmarried women. In both

the younger and older women, years living in an urban area was significantly different between households where the husband was the head of the household or not. In the younger group BMI and folate intake was also significantly different for households with or without a husband as the head of the household, while in the older group, lymphocyte count, total serum proteins and haem iron intake differed for households with or without a husband as the head of the household. For younger women, years living in an urban area, haematocrit, total serum proteins, albumin and all included parameters of dietary intake were significantly different between women living in a brick house and those living in other housing such as an informal settlement. In the older group, years living in an urban area, serum total proteins and the included dietary intake parameters were significantly different between women with no or primary level education and women with a higher level of education.

In order to determine which variables were associated with HIV infection, a logistic regression was performed, including all parameters that differed by $p < 0.10$ between HIV-infected and HIV-uninfected women. Table 9 indicates the classification used for the logistic regression. In all cases the 1 code refers to the risk, while code 0 indicates the category that is not associated with risk.

The results of the logistic regression are tabulated in Table 10 for women 25-34 years and in Table 11 for women 35-44 years. In the younger group, the odds of being HIV positive for women who smoke were 3.47 times that of women who do not smoke, with 95 percent CI [1.38; 8.70]. The odds of being HIV positive for women who were neither married nor traditionally married were 4.35 times that of women who were married or traditionally married, with 95 percent CI [1.27; 14.95]. For every g/L increase in total serum protein, the odds of being HIV positive increased by 1.24, with 95 percent CI

[1.15; 1.34]. For every g/L increase in serum albumin, the odds of being HIV positive decreased by 0.68, with 95 percent CI [0.57; 0.80].

In the older group of women, the odds of being HIV positive for women with none/primary school education are 0.18 times that of women with other (better) education, with 95 percent CI [0.06; 0.60]. For every g/L increase in total serum protein, the odds of being HIV positive increase by 1.1, with 95 percent CI [1.04; 1.19]. For every g/L increase in serum albumin, the odds of being HIV positive decrease by 0.82, with 95 percent CI [0.70; 0.96]. For every mg increase in non-haem iron intake, the odds of being HIV positive decrease by 0.57, with 95 percent CI [0.40; 0.82].

DISCUSSION

This dataset from women in Mangaung, South Africa, provides valuable information about possible factors that contribute to the spread of HIV infection in this area. Mangaung is a rapidly urbanizing African residential area situated near the outskirts of Bloemfontein, the capital city of the Free State Province. HIV infection has apparently spread at an alarming rate in this township, with 61 percent from the age group 25-34 testing HIV positive, and 38 percent in the age group 35-44 years being HIV positive. A possible bias could have been present in the fact that the sample was contacted during the day. If no one was found at home, the household on the left was selected. For this reason, it is possible that a larger percentage of unemployed persons were included in the sample than is representative of the community of Mangaung. On the other hand, however, participation was voluntary, and thus very ill persons could not have agreed to participate. These factors could have had an influence on the prevalence of HIV infection reported in this study. Results from this study indicated that in younger women who smoke, the odds of being HIV positive were 3.47 times that of women who do not

smoke. According to earlier figures released on smoking patterns in South Africa, less than 10 percent of African women smoked (Yach et al., 1992). In this sample, 21.7 percent of HIV-uninfected, and 40.12 percent younger women smoked or used snuff. Concerning health-promoting behaviour in the broad population, individuals with higher education and higher incomes are more likely to give up smoking than those of lower socio-economic status (Centers for Disease Control, 1992). In the younger women included in this study, however, more women that smoked lived in brick houses (Table 7). Several HIV positive related opportunistic infections are associated with cigarette smoking (Collins et al., 2001), thereby emphasizing the importance of good health practices for the person living with HIV/AIDS.

A recent South African survey found that 72 percent of households are headed by women, and 31 percent of all household heads are HIV positive (UNAIDS, 2002). In our study, only a small percentage of all women were married (less than 25 percent of the total sample). Of those that were married, a larger percentage were HIV uninfected (Tables 3 and 4). As a result, few women in all groups had a husband as the head of the household (ranging from 22.75 percent of HIV-infected women to 36.79 percent of HIV-uninfected younger women, and from 21.95 percent of HIV-infected to 42.86 percent of HIV-uninfected older women (Tables 3 and 4). In both age groups marital status was associated with head of the household (Table 7). The results of the logistic regression indicated that the odds of being HIV-infected for younger women who were neither married nor traditionally married were 4.35 that of women who were married or traditionally married. Being unmarried or not having a husband as the head of the household places women at greater risk for financial insecurity than households headed by a husband. The possibility of HIV positive women having multiple sexual relationships cannot be excluded in this regard (NICDAM, 2000). Similar levels of HIV infection were

found among child-bearing women in Zambia, where the OR in urban areas for unmarried and married women was 1:0.81 (Fylkesnes et al., 1997).

Disadvantaged people are often deprived of access to mass media, thereby limiting their access to information and education about HIV. It can be assumed that those with a higher education are expected to be the first to receive the message, and apply the information on HIV prevention (Fylkesnes et al., 1997). Results from the present study however showed the opposite, with older women having a better chance of not being HIV-infected if they had a poor education (OR 0.18). These results were in concordance with higher HIV infection rates that have been reported amongst groups with higher educational attainment in Zambia (Fylkesnes et al., 1997).

Older women in the present study had an increased chance of being HIV-infected if they had a lower dietary intake of non-haem iron (OR 0.57). This form of iron, mainly found in plants such as grains, vegetables and fruit, but also in animal sources like eggs, and in small amounts in meat, fish and poultry, has an absorption rate of only 3 to 8 percent (Kasdan, 2000, p. 786). In many developing countries where meat consumption is economically unfeasible, non-haem iron is the major source of dietary iron (Smolin & Grosvenor, 2003, p. 524). Maize is a poor source of iron, and it is therefore not surprising that cultures, consuming a core diet primarily of maize, have high prevalence rates of iron deficiency anaemia (Anderson, 2000, p. 125). In the older women, non-haem iron intake was not associated with the intake of any other nutrient (Table 6).

The metabolic changes associated with sepsis can be seen as an integral part of the body's defense, because they provide the energy and substrate to activate the acute-phase response. This response is characterized by the excessive production of specific proteins by the liver, that bind to, and increase clearance of infectious agents and cell

debris (Fong et al., 1989), in order to limit the damage, and prevent progressive oxidative reactions that could cause microcirculatory collapse and multiple organ failure (Babameto & Kotler, 1997). Acute-phase proteins include the positive acute-phase proteins (such as C-reactive protein, ferritin and fibrinogen) which are increased, and the negative acute-phase proteins (including albumin and transferrin), which are decreased (Winkler & Manchester, 2000, p. 722). Some authors have reported elevated total protein, and reduced serum albumin levels in HIV-infected and AIDS patients (reviewed by Gramlich & Mascioli, 1995). HIV positive women participating in the Transition and Health during Urbanization of South Africans (THUSA) study performed in the Northwest Province of South Africa, also showed increased mean serum protein concentrations (Nienaber et al., 2000). In both younger and older women in the present study, the odds of being HIV positive increased with an increase in total serum protein (OR 1.24 and 1.1 respectively), while with an increase in serum albumin, the odds of being HIV positive decreased (OR of 0.68 in young women and 0.82 in older women). Total serum proteins may be affected by non-nutritional factors such as infection, changes in vascular permeability and state of hydration (Gramlich & Mascioli, 1995), and should be considered as possible explanation in this regard. Decreased albumin levels have previously been associated with shorter survival in women with HIV infection (Feldman et al., 2000) and in AIDS patients (Zumwalt & Schmidt, 1989; Melchior et al., 1999). As in our study, results from the THUSA study also showed decreased serum albumin levels in HIV positive women (Nienaber et al., 2000). These reduced serum albumin concentrations could result from poor nutritional status (Melchior et al., 1999), or a normal systemic response to a chronic inflammatory disorder (van Staden et al., 1998; Sabin et al., 2002), such as HIV infection.

CONCLUSION

It is clear that HIV remains a complex disease (Salas-Salvadó & Garcia-Lorda, 2001). With this study, we attempted to elucidate the dynamics and trends of HIV infection in this African population. The factors associated with HIV infection that came to the fore in the study may be applied in future health policy, strategies and programmes in the prevention of HIV.

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Table 1: Continuous variables of HIV-infected and HIV-uninfected women (25-34 years) differing with p <0.10

Variable	HIV status	n	Median	P value
SOCIO-ECONOMIC STATUS:				
Years living in an urban area	HIV+	167	14	0.0001
	HIV-	106	8.5	
ANTHROPOMETRY:				
BMI (kg/m ²)	HIV+	167	24.4	0.0002
	HIV-	106	27.6	
MACRONUTRIENT INTAKE:				
Energy (kJ)	HIV+	167	12024	0.049
	HIV-	106	10447	
Total protein (g)	HIV+	167	84.0	0.09
	HIV-	106	75.5	
Total fat (g)	HIV+	167	101.3	0.06
	HIV-	106	94.2	
Polyunsaturated fat (g)	HIV+	167	27.4	0.03
	HIV-	106	24.9	
MINERAL & TRACE ELEMENT INTAKE:				
Calcium (mg)	HIV+	167	679.42	0.046
	HIV-	106	533.87	
Chromium (µg)	HIV+	167	43.60	0.098
	HIV-	106	35.95	
Potassium (mg)	HIV+	167	3024.8	0.04
	HIV-	106	2594.0	
Magnesium (mg)	HIV+	167	388.95	0.08
	HIV-	106	342.31	
Sodium (mg)	HIV+	167	2708.4	0.06
	HIV-	106	2555.9	
Phosphorus (mg)	HIV+	167	1397.0	0.04
	HIV-	106	1206.2	
VITAMIN INTAKE:				
Vitamin D (µg)	HIV+	167	5.36	0.03
	HIV-	106	4.50	
Vitamin E (mg)	HIV+	167	16.45	0.04
	HIV-	106	14.11	
Thiamin (mg)	HIV+	167	1.72	0.08
	HIV-	106	1.46	
Niacin (mg)	HIV+	167	21.78	0.07
	HIV-	106	18.97	
Folate (µg)	HIV+	167	252.72	0.06
	HIV-	106	233.82	

Table 1: Continuous variables of HIV-infected and HIV-uninfected women (25-34 years) differing with p <0.10 (Continued)

Variable	HIV status	n	Median	P value
Vitamin B12 (µg)	HIV+	167	5.38	0.01
	HIV-	106	4.18	
Pantothenic acid (mg)	HIV+	167	5.90	0.09
	HIV-	106	5.34	
IRON STATUS:				
Serum ferritin (µg/L)	HIV+	95	74.06	0.09
	HIV-	77	63.85	
Haemoglobin (g/dL)	HIV+	166	13.55	0.0002
	HIV-	106	14.05	
Haematocrit (L/L)	HIV+	166	39.15	0.0003
	HIV-	106	40.95	
METABOLIC PARAMETERS:				
Total lymphocytes (x 10 ⁹ /L)	HIV+	158	2.1	0.0001
	HIV-	104	2.4	
Serum total protein (g/L)	HIV+	167	91	0.0001
	HIV-	106	82	
Serum albumin (g/L)	HIV+	167	40.2	0.0001
	HIV-	106	42.85	
Plasma fibrinogen (g/L)	HIV+	157	3.17	0.0002
	HIV-	100	3.56	
Serum insulin (µU/ml)	HIV+	166	5.78	0.002
	HIV-	106	9.1	

Table 2: Continuous variables of HIV-infected and HIV-uninfected women (35-44 years) differing with p <0.10

Variable	HIV status	n	Median	P value
SOCIO-ECONOMIC STATUS:				
Years living in an urban area	HIV+	82	12.5	0.0001
	HIV-	133	10	
MINERAL & TRACE ELEMENT INTAKE:				
Chromium (µg)	HIV+	82	34.74	0.05
	HIV-	133	45.58	
Iron haem (mg)	HIV+	82	0.24	0.03
	HIV-	133	0.35	
Iron non-haem (mg)	HIV+	82	3.13	0.04
	HIV-	133	3.70	
Selenium (µg)	HIV+	82	30.42	0.04
	HIV-	133	38.42	
VITAMIN INTAKE:				
Folate (µg)	HIV+	82	220.63	0.08
	HIV-	133	250.70	
IRON STATUS:				
Serum ferritin (µg/L)	HIV+	46	80.02	0.02
	HIV-	62	57.41	
Transferrin (g/L)	HIV+	46	3.0	0.04
	HIV-	58	2.8	
METABOLIC PARAMETERS:				
Total lymphocytes (x 10 ⁹ /L)	HIV+	80	2.0	0.02
	HIV-	130	2.2	
Serum total protein (g/L)	HIV+	82	91.5	0.0001
	HIV-	132	82	
Serum albumin (g/L)	HIV+	82	39.6	0.0001
	HIV-	131	42.2	
Total cholesterol (mmol/L)	HIV+	82	4.3	0.01
	HIV-	132	4.7	

Table 3: Categorical variables of HIV-infected and HIV-uninfected women (25-34 years) differing with $p < 0.10$

Variable	HIV STATUS				p value
	HIV negative		HIV positive		
	N	%	N	%	
SMOKE:					
No	83	78.30	100	59.88	0.0016
Yes	23	21.70	67	40.12	
MARITAL STATUS:					
Married/Trad. married	26	24.53	26	15.57	0.0662
Other	80	75.47	141	84.43	
HEAD OF HOUSE:					
Husband	39	36.79	38	22.75	0.0120
Other	67	63.21	129	77.25	
TYPE OF DWELLING:					
Brick	71	66.98	129	77.25	0.0618
Other	35	33.02	38	22.75	

Table 4: Categorical variables of HIV-infected and HIV-uninfected women (35-44 years) differing with $p < 0.10$

Variable	HIV STATUS				p value
	HIV negative		HIV positive		
	N	%	N	%	
MARITAL STATUS:					
Married/Trad. married	38	28.57	11	13.41	0.0101
Other	95	71.43	71	86.59	
EDUCATION:					
Other	69	51.88	56	68.29	0.0178
None/primary school	64	48.12	26	31.71	
HEAD OF HOUSE:					
Husband	57	42.86	18	21.95	0.0018
Other	76	57.14	64	78.05	

Table 5: Association between continuous variables of HIV in women 25-34 years (n=279)

Due to the large number of variables, only those with a Spearman Correlation of >0.6 or <-0.6 are reported (p <0.0001 for all those indicated)

N=279	Energy	Tot prot	Tot fat	PUFA	Ca	Cr	K	Mg	Na	P	Vit D	Vit E	B1	B3	Folate	B12	Pant	Hb	Hct
Energy	1.00	0.92	0.88	0.80	0.76	0.62	0.93	0.93	0.79	0.95	0.65	0.73	0.79	0.79	0.81	0.63	0.81		
Tot prot		1.00	0.85	0.74	0.75	0.66	0.90	0.88	0.79	0.94	0.65	0.69	0.80	0.87	0.81	0.73	0.90		
Tot fat			1.00	0.92	0.75		0.82	0.73	0.76	0.83	0.68	0.83	0.64	0.75	0.68	0.64	0.76		
PUFA				1.00	0.61		0.73	0.68	0.65	0.72	0.65	0.92		0.66	0.63		0.67		
Ca					1.00		0.84	0.73	0.68	0.86			0.61	0.64	0.68	0.66	0.70		
Cr						1.00	0.64			0.63					0.65		0.61		
K							1.00	0.92	0.76	0.95	0.63	0.67	0.76	0.78	0.81	0.68	0.81		
Mg								1.00	0.72	0.94		0.62	0.81	0.76	0.78	0.61	0.75		
Na									1.00	0.77			0.78	0.79	0.72	0.60	0.66		
P										1.00	0.68	0.67	0.79	0.81	0.81	0.72	0.84		
Vit D											1.00	0.60				0.67	0.64		
Vit E												1.00					0.63		
Vit B1													1.00	0.83	0.71		0.66		
Vit B3														1.00	0.74	0.65	0.82		
Folate															1.00	0.65	0.73		
VitB12																1.00	0.66		
Pant																	1.00		
Hb																		1.00	0.90
Hct																			1.00

Table 6: Association between continuous variables of HIV in women 35-44 years (n=217)

Due to the large number of variables, only those with a Spearman Correlation of >0.6 or <-0.6 are reported (p <0.0001 for all those indicated)

N=217	Cr	Folate	H-Fe	Non-h Fe	Se
Cr	1.00	0.74		0.88	0.84
Folate		1.00		0.76	0.72
H Fe			1.00		
NH Fe				1.00	0.79
Se					1.00

Table 7: Association between categorical variables of HIV

Variable 1	Variable 2	N	p-value (Chi-square)
Women 25-34 years			
Smoking	Type of dwelling	273	0.009
Marital status	Head of household	273	<0.0001
Women 35-44years			
Marital status	Head of household	215	<0.0001

Table 8: Difference between continuous variables for each categorical variable

Categorical variable	Continuous variable	N	Mann-Whitney p-value
Smoking (25-34yrs)	Ferritin	172	0.0014
	Serum albumin	273	0.026
	Serum insulin	272	0.0065
	Vitamin D intake	273	0.0236
Marital status (25-34yrs)	Years living in urban area	273	0.0125
	BMI	273	0.0002
Marital status (35-44yrs)	Lymphocytes	210	0.0238
	Serum total proteins	214	0.0063
	Haem iron intake	215	0.0474
Head of household (25-34 yrs)	Years living in urban area	273	<0.0001
	BMI	273	0.0004
	Folate intake	273	0.0486
Head of household (35-44 yrs)	Years living in urban area	215	0.0387
	Lymphocytes	210	0.0330
	Total serum proteins	214	0.0028
	Haem iron intake	215	0.0277
Type of dwelling (25-34 yrs)	Years living in urban area	273	0.0014
	Haematocrit	272	0.0346
	Total serum proteins	273	0.0005

Table 8: Difference between continuous variables for each categorical variable (Continued)

Categorical variable	Continuous variable	N	Mann-Whitney p-value
	Albumin	273	0.0357
	Energy intake	273	0.0033
	Total protein intake	273	0.0011
	Total fat intake	273	0.0109
	PUFA	273	0.0092
	Calcium intake	273	0.0971
	Chromium intake	273	0.0378
	Potassium intake	273	0.0072
	Magnesium intake	273	0.0089
	Sodium intake	273	0.0051
	Phosphorus intake	273	0.0061
	Vitamin D intake	273	0.0066
	Thiamin intake	273	0.0061
	Niacin intake	273	0.0005
	Folate intake	273	0.0034
	Pantothenic acid	273	0.0044
Level of education (35-44 yrs)	Years living in urban area	215	<0.0001
	Serum total proteins	214	0.0296
	Chromium intake	215	0.0002
	Haem iron intake	215	0.0258
	Non-haem intake	215	0.0002
	Selenium intake	215	<0.0001

Table 9: Classification of categorical variables for logistic regression

Variable	Category	Code in Logistic Regression
Smoking	Yes	1
	No	0
Marital status	Other	1
	Married or traditionally married	0
Head of household	Other	1
	Husband	0
Type of dwelling	Other	1
	Brick house	0
Level of education	None or primary school	1
	Other	0

Table 10: Results of logistic regression (25-34 years)

Variable	Coefficient (β)	Standard error	Wald ?2	P Value	Odds Ratio	95% CI for OR
Intercept	-4.059	3.415	-	-	-	-
X ₁ Smoking	1.243	0.470	7.00	0.008	3.47	1.38; 8.70
X ₂ Marital status	1.470	0.630	5.44	0.020	4.35	1.27; 14.95
X ₃ Total serum protein	0.212	0.040	28.93	<.0001	1.24	1.15; 1.34
X ₄ Serum albumin	-0.393	0.085	21.52	<.0001	0.68	0.57; 0.80
X ₅ Chromium intake	0.017	0.008	4.26	0.039	1.02	1.001; 1.03

Table 11: Results of logistic regression (35-44 years)

Variable	Coefficient (β)	Standard error	Wald ?2	P Value	Odds Ratio	95% CI for OR
Intercept	1.864	4.152	-	-	-	-
X ₁ Level of education	-1.702	0.610	7.81	0.005	0.18	0.06; 0.60
X ₂ Total serum protein	0.105	0.035	9.15	0.003	1.11	1.04; 1.19
X ₃ Serum albumin	-0.201	0.083	5.88	0.015	0.82	0.70; 0.96
X ₄ Non-haem iron intake	-0.557	0.184	9.11	0.003	0.57	0.40; 0.82

CHAPTER 12

FACTORS ASSOCIATED WITH HIV INFECTION IN WOMEN (25-44 YEARS) LIVING IN MANGAUNG, SOUTH AFRICA: MODEL 2 (MAINLY CATEGORICAL VARIABLES)

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ABSTRACT

Objective: A cross-sectional study was undertaken with the aim of investigating the health and nutritional status of women in Mangaung. *Methodology:* A population-based random sample of 500 women was selected and divided into women between 25 and 34 years (n=273) and 35 and 44 years (n=215). Socio-demographic information, anthropometry, dietary intake and blood values were determined using standardised techniques. A logistic regression was performed to determine which of the mainly categorical parameters that differed with $p < 0.10$ between HIV-infected and HIV-uninfected women were associated with HIV infection in the two age groups. *Results:* In both age groups, the model demonstrated quasicomplete separation. In the younger group, a zero cell for the variable albumin, led to this outcome (none of the HIV- subjects had albumin values below normal, $p = 0.0076$), and in the older group, the variable lymphocyte count led to this outcome (low frequencies in the category with raised lymphocyte count, $p = 0.13$). In order to work around the problem, a subject in the HIV- group (100% of them had albumin values of normal and above) was chosen randomly and forced to the risk category of lowered albumin. Although the problem of separation disappeared, the random choice of different subjects, led to different final models. Keeping this in mind, the level of significance for inclusion in the model was lowered to 0.10. The inclusion of the variable albumin still led to separation, and it was omitted from the list of variables included in the

model. *Conclusions:* The model should be interpreted with great care, as albumin, which was not included in the regression, is highly associated with HIV status ($p = 0.0076$).

Key words: South Africa; HIV; African women; HIV-associated factors

INTRODUCTION

The seriousness of the HIV/AIDS pandemic in Africa is well documented. This part of the world accounts for nine out of ten new cases of HIV infection, and 83 percent of all AIDS deaths; more than the number of people killed by any war (Food and Agriculture Organization (FAO), [s.a.]). In developing countries, HIV infection is growing more rapidly in females than in males (Piwoz & Preble, 2000), with women of childbearing age the fastest growing subgroup of the HIV infected population.

The World Health Organization (WHO, 1995) described HIV infection as one of the major public health concerns in Sub-Saharan Africa. During 2003, between 2.2 and 2.4 million African people died of AIDS, while 3.0 to 3.4 million were estimated to be newly infected bringing the total number of people living with AIDS to between 25.0 and 28.2 million (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2003).

Dissimilar to women in other regions of the world, among people aged fifteen to twenty four, women were 2.5 times more likely to become HIV infected than young men of the same age group (UNAIDS, 2003). The greater risk for HIV infection amongst women is caused by biologic, social (Piwoz & Preble, 2000; FAO, 2001) economic, and cultural factors (Piwoz & Preble, 2000). With this study, we intended to identify factors associated with HIV infection amongst women living in an urbanized community in South Africa.

METHODOLOGY

An epidemiological study was undertaken with the main objective of investigating the nutritional health of women in Mangaung, the African residential community of the city Bloemfontein. A random sample of 500 African women, from the two age groups 25-34 and 35-44 years was selected using township maps obtained from the Greater Bloemfontein Municipality. The sample included respondents from two formal settlements, namely Phahameng and Botchabela, and two informal settlements, namely Joe Slovo and Namibia. Respondents took part in the study voluntarily. Written informed consent was obtained, and the study was approved by the Ethics committee of the Faculty of Health Sciences, University of the Free State (ETOVS no. 02/00).

Socio-economic status, anthropometric measurements (body mass index (BMI), waist-hip-ratio and fat percentage), dietary intake, and biochemical markers of nutritional status were determined using standard methods as described elsewhere.

A logistic regression was performed to determine which of the mostly categorical parameters that differed with $p < 0.10$ between HIV-infected and HIV-uninfected women were associated with HIV infection in the two age groups.

STATISTICAL ANALYSIS

For each age group separately, the following was done:

In the case where Recommended Dietary Allowances (RDA's) or Adequate Intakes (AI) exist for nutrients, intake was categorised as ≤ 67 percent of the RDA/AI or >67 percent of the RDA/AI. If an RDA/AI does not exist for a nutrient, the intake was kept continuous and median intake used. Iron and metabolic parameters were categorised according to normal ranges. In most cases the three categories: less than normal; normal; and higher than normal were used. Where normal ranges do not exist, parameters were kept continuous.

Continuous variables were described by the mean and standard deviation or median and percentiles as applicable, and compared between the two HIV-groups by the student t-test or Mann-Whitney test. Categorical variables were described by frequencies and percentages, and compared between the two HIV-groups by the chi-square or Fisher's exact test. A p-value of <0.10 (see motivation in discussion of results) was used to identify variables that differed between the HIV groups in order to identify factors that are significantly associated with the presence of HIV. These variables were entered into a stepwise logistic regression model (using forward selection) with HIV status as outcome.

Categorical variables were compared by the Chi-square or Fisher's exact test. Continuous variables were compared between the categories of categorical variables by the Mann-Whitney test.

RESULTS

Of the 500 women recruited for the study, 488 could be included (4 women were found to be pregnant during the medical examination and 8 women were either older or younger than the required age). Of the 488 women, 273 were 25-34 years old and 215 were 35-44 years old. Sixty one percent of the younger group and 38 percent of the older group were HIV positive.

Continuous variables that differed with $p < 0.10$ between HIV-infected and HIV-uninfected younger (25-34 years) and older (35-44 years) women are presented in Tables 1 and 2 respectively, while the categorical variables that differed with $p < 0.10$ of the two age groups are indicated in Tables 3 and 4.

In both the older and younger groups, significantly more HIV positive women had lived in an urban area for longer (Tables 1 and 2), smoked, were unmarried, and did not have a husband as the head of the household (Tables 3 and 4). Interestingly, more HIV-infected younger women lived in brick houses compared to HIV-uninfected women, and in the older group, more HIV-infected women had a higher level of education compared to HIV-uninfected women.

In the younger group, significantly more HIV-uninfected women had nutrient intakes ≤ 67 percent of the RDA or AI for total protein, magnesium, manganese, niacin, phosphorus, pantothenic acid, vitamin B6 and zinc (Table 3). Median intakes of the two included continuous variables, polyunsaturated fatty acids (PUFA) and potassium were also significantly higher in HIV-infected women (Table 1). In the older HIV-infected group, however, significantly more HIV-infected women had intakes ≤ 67 percent of the RDA for folate, selenium and vitamin E (Table 4). Median intakes of both haem and non-haem iron were also lower in HIV infected women (Table 2).

Significantly more HIV-uninfected women had a BMI that fell in the overweight or obese category (62.26 percent of HIV-uninfected women compared to 46.99 percent of HIV-infected women (Table 3).

As far as parameters of iron status are concerned, the percentage of HIV-infected younger women with low haemoglobin and haematocrit were significantly higher than their HIV-uninfected counterparts (Table 3). This was even more pronounced in the older group, where 12.20 percent of HIV-infected women had a haematocrit below 0.35 L/L compared to the 2.29 percent of HIV-uninfected women (Table 4). Low serum iron levels were however, higher in HIV-uninfected older women as were higher serum transferrin, indicating a high incidence of iron deficiency in the HIV-uninfected older group (Table 4).

Other categorical blood measures that differed with $p < 0.10$ between HIV groups included serum total proteins, serum albumin and serum insulin in both age groups as well as serum cholesterol in the older group. In both age groups, significantly more HIV-infected women had high serum total proteins and low serum albumin (Tables 3 and 4). In the younger group, significantly fewer HIV-infected women had elevated insulin levels, while in the older group the opposite was found, with significantly more HIV-infected women having serum insulin levels higher than 25 $\mu\text{U/ml}$ compared to their HIV-uninfected counterparts. In the older group, significantly more HIV-uninfected women had elevated serum cholesterol levels (Table 4).

Tables 5 and 6 indicate the associations between categorical variables of HIV for younger and older women respectively. Due to the large number of variables, only those with a p-value of <0.05 are reported.

In the younger group, smoking status was associated with type of dwelling ($p = 0.009$). A significant association was also found between marital status and head of the household in both the younger ($p < 0.0001$) and older ($p < 0.0001$) groups, and with BMI in the younger group ($p = 0.001$). In the younger group, head of the household was associated with BMI, total protein intake and vitamin B6 intake (Table 5) and in the older group with serum total protein ($p = 0.04$). Type of dwelling was associated with serum total protein and vitamin B6 intake in the younger group, while BMI was associated with haemoglobin, haematocrit and total protein intake (Table 5). In the older group, level of education was closely associated with serum total proteins and serum insulin, as well as with all three included nutrients, namely folate, selenium and vitamin E (Table 6).

As expected, both haemoglobin and haematocrit were associated with each other as well as with mean corpuscular haemoglobin concentration (MCHC) and serum albumin in the younger group where these parameters were included. In this group, serum total proteins were related to the intake of protein ($p = 0.048$) as well as magnesium, manganese and vitamin B6 (Table 5). In the older group, transferrin was related to haematocrit, serum iron and serum albumin, and associations were also found between serum albumin, haematocrit and serum cholesterol (Table 6).

Tables 5 and 6 indicate that most nutrients included were associated with each other, except for manganese that was only associated with the intake of vitamin B6 in the younger group ($p = 0.047$).

Tables 7 and 8 show the difference between continuous variables for each categorical variable in the younger and older groups respectively. Due to the large number of variables, only those with a p-value of <0.05 are reported. In the younger group, the variable “years living in an urban area” was significantly different between married and unmarried women (Table 7), and in both the younger and older women, it was significantly different between households where the husband was the head of the household or not (Table 7 and 8). In younger women, years living in an urban area also differed between women that lived in brick or other housing (Table 7), and in the older group between women with no or primary education and women with better education (Table 8). In younger women, years living in an urban area was also associated with serum total proteins and the intake of a number of nutrients, including pantothenic acid, vitamin B6, and zinc. As expected, in both groups the intake of nutrients was generally different between women with intakes ≤ 67 percent of the RDA/AI.

In order to determine which variables were associated with HIV infection, a logistic regression was performed, including all parameters that differed by $p < 0.10$ between HIV-infected and HIV-uninfected women. Table 9 indicates the classification used for the logistic regression. In all cases the 1 code refers to the risk, while code 0 indicates the category that is not associated with risk.

The results of the logistic regression are tabulated in Table 10 for women 25-34 years and in Table 11 for women 35-44 years.

In the younger group:

The odds of being HIV-infected for women who smoke are 2.32 times that of women who do not smoke, with 95% Confidence Interval (CI) [1.24; 4.34].

The odds of being HIV infected for women who are not married or traditionally married are 2.49 times that of women who are not married or traditionally married, with 95% CI [1.20; 5.14].

The odds of being HIV infected for women who have haematocrit values below 0.35 L/L are 5.45 that of women with haematocrit values of 0.35 and higher, with 95% CI [1.69; 17.58].

The odds of being HIV infected for women who have MCHC values below 32g/dL are 0.2 times that of women with MCHC values of \geq 32g/dL, with 95% CI [0.05; 0.74].

The odds of being HIV infected for women who have serum total protein values of above normal are 4.74 times that of women with values of normal or below, with 95% CI [2.61; 8.63].

The odds of being HIV infected for women who have serum insulin values above normal are 0.41 times that of women with insulin values of normal or below normal, with 95% CI [0.17; 0.96].

The odds of being HIV infected for women with a PUFA intake \leq 67% of the RDA, are 1.03 times that of women with a PUFA intake $>$ 67% of the RDA with 95% CI [1.01; 1.04].

In the older group:

The odds of being HIV infected for women with none/ primary school education are 0.12 times that of women with other (better) education, with 95% CI [0.04; 0.39].

The odds of being HIV infected for women who have serum albumin levels below normal, are 26.96 times that of women with serum albumin levels of normal and higher, with 95% CI [2.34; 310.72].

The odds of being HIV infected for women who have elevated insulin levels are 7.69 times that of women with normal or decreased insulin levels, with 95% CI [1.44; 41.02].

For every unit increase in non-haem iron intake, the odds of being HIV infected decrease by 0.48, with 95% CI [0.33; 0.69].

DISCUSSION

Initially, a p-value of <0.15 was used to identify variables that differed between the groups in order to identify significant factors associated with the presence of HIV. These variables were entered into a stepwise logistic regression model (using forward selection) with HIV status as outcome.

Quasicomplete separation was demonstrated by the model in both age groups. Complete separation depends on the sample size, the number of subjects with the outcome present and the number of variables included in the model (Hosmer and Lemeshow, 1989, p. 130). In the younger group, a zero cell for the variable albumin, led to this outcome (none of the HIV- subjects had albumin values below normal, $p = 0.0076$), and in the older group, the variable lymphocyte count led to this outcome (low frequencies in the category with raised lymphocyte count, $p = 0.13$).

In order to work around the problem, a subject in the HIV- group (100% of them had albumin values of normal and above) was chosen randomly and forced to the risk category of lowered albumin. Although the problem of separation disappeared, the random choice of different subjects, led to different final models.

Keeping this in mind, it was decided to lower the level of significance for the inclusion in the model to 0.10. The inclusion of the variable, albumin, still led to separation and it was omitted from the list of variables included in the model. Therefore, the model should be interpreted with great care, as albumin is highly associated with HIV status ($p = 0.0076$).

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Table 1: Continuous variables of HIV-infected and HIV-uninfected women (25-34 years) differing with p <0.10

Variable	HIV STATUS	n	Median	P value
SOCIO-ECONOMIC STATUS:				
Years living in an urban area	HIV positive	167	14	0.0001
	HIV negative	106	8.5	
MACRONUTRIENT INTAKE:				
Polyunsaturated fat (g)	HIV positive	167	27.4	0.03
	HIV negative	106	24.9	
MINERAL & TRACE ELEMENT INTAKE:				
Potassium (mg)	HIV positive	167	3024.8	0.04
	HIV negative	106	2594.0	

Table 2: Continuous variables of HIV-infected and HIV-uninfected women (35-44 years) differing with p <0.10

Variable	HIV STATUS	n	Median	P value
SOCIO-ECONOMIC STATUS:				
Years living in an urban area	HIV positive	82	12.5	0.0001
	HIV negative	133	10	
MINERAL & TRACE ELEMENT INTAKE:				
Iron haem (mg)	HIV positive	82	0.24	0.03
	HIV negative	133	0.35	
Iron non-haem (mg)	HIV positive	82	3.13	0.04
	HIV negative	133	3.70	

Table 3: Categorical variables of HIV-infected and HIV-uninfected women (25-34 years) differing with p <0.10

Variable	HIV STATUS				p value
	HIV negative		HIV positive		
	N	%	N	%	
SOCIO-ECONOMIC STATUS:					
SMOKE:					
No	83	78.30	100	59.88	0.0016
Yes	23	21.70	67	40.12	
MARITAL STATUS:					
Married/Trad. Married	26	24.53	26	15.57	0.0662
Other	80	75.47	141	84.43	
HEAD OF HOUSE:					
Husband	39	36.79	38	22.75	0.0120
Other	67	63.21	129	77.25	
TYPE OF DWELLING:					
Brick	71	66.98	129	77.25	0.0618
Other	35	33.02	38	22.75	
NUTRIENTS:					
Total protein					
≤ 67% of RDA (46 g)	14	13.21	5	2.99	0.0012
> 67% of RDA	92	86.79	162	97.01	
Magnesium					
≤ 67% of RDA (320 mg)	18	16.98	16	9.58	0.0711
> 67% of RDA	88	83.02	151	90.42	
Manganese					
≤ 67% of RDA (1800 µg)	11	10.38	7	4.19	0.0447
> 67% of RDA	95	89.62	160	95.81	
Niacin					
≤ 67% of RDA (14 mg)	14	13.21	10	5.99	0.0401
> 67% of RDA	92	86.79	157	94.01	
Phosphorus					
≤ 67% of RDA (700 mg)	6	5.66	3	1.80	0.0943 (F)*
> 67% of RDA	100	94.34	164	98.20	

Table 3: Categorical variables of HIV-infected and HIV-uninfected women (25-34 years) differing with p <0.10 (Continued)

Variable	HIV STATUS				p value
	HIV negative		HIV positive		
Pantothenic acid					
≤ 67% of AI (5 mg)	24	22.64	19	11.38	0.0128
> 67% of AI	82	77.36	148	88.62	
Vitamin B6					
≤ 67% of RDA (1.3 mg)	27	25.47	27	16.17	0.0600
> 67% of RDA	79	74.53	140	83.83	
Zinc					
≤ 67% of RDA (8 mg)	18	16.98	13	7.78	0.0196
> 67% of RDA	88	83.02	154	92.22	
ANTHROPOMETRY:					
BMI					
< 24.9 kg/m ²	40	37.74	88	53.01	0.0492 (F)
≥ 25 kg/m ²	66	62.26	78	46.99	
IRON STATUS					
Haemoglobin (g/dL)					
<11.7	5	4.72	16	9.64	0.0468 (F)
≥11.7	101	95.28	150	90.36	
Haematocrit (L/L)					
<0.35	5	4.72	22	13.25	0.0005 (F)
≥0.35	101	95.28	144	86.75	
MCHC (g/dL)					
< 32	9	8.49	5	3.01	0.0261
≥ 32	97	91.51	161	96.99	
METABOLIC PROFILE:					
Serum total proteins (g/L)					
≤ 82	54	50.94	34	20.36	<0.0001
> 82	52	49.06	133	79.64	
Serum albumin (g/L)					
< 34	0	0.00	14	8.38	0.0076
≥ 34	106	100	153	91.62	
Serum insulin (μU/ml)					
≤ 25	87	82.08	153	92.17	0.0003
> 25	19	17.92	13	7.83	

*F = Fishers exact test

Table 4: Categorical variables of HIV-infected and HIV-uninfected women (35-44 years) differing with p <0.10

Variable	HIV STATUS				p value
	HIV negative		HIV positive		
SOCIO-ECONOMIC STATUS:					
MARITAL STATUS:					
Married/Trad. married	38	28.57	11	13.41	0.0101
Other	95	71.43	71	86.59	
EDUCATION:					
Other	69	51.88	56	68.29	0.0178
None/primary school	64	48.12	26	31.71	
HEAD OF HOUSE:					
Husband	57	42.86	18	21.95	0.0018
Other	76	57.14	64	78.05	
NUTRIENTS:					
Folate					
≤ 67% of RDA (400 µg)	76	57.14	60	70.73	0.0458
> 67% of RDA	57	42.86	24	29.27	
Selenium					
≤ 67% of RDA (55 µg)	62	46.62	51	62.20	0.0263
> 67% of RDA	71	53.38	31	37.80	
Vitamin E					
≤ 67% of RDA (15 mg)	31	23.31	32	39.02	0.0139
> 67% of RDA	102	76.69	50	60.98	
IRON STATUS:					
Haematocrit (L/L)					
< 0.35	3	2.29	10	12.20	0.0126 (F)
≥ 0.35	128	97.71	72	87.81	
MCHC (g/dL)					
< 32	10	7.63	1	1.22	0.0638
≥ 32	121	92.36	81	98.78	
Serum iron (mg/L)					
< 0.7	25	40.32	13	24.53	0.0034
≥ 0.7	37	59.68	40	75.47	

Table 4: Categorical variables of HIV-infected and HIV-uninfected women (35-44 years) differing with p <0.10 (Continued)

Variable	HIV STATUS				p value
	HIV negative		HIV positive		
Transferrin (g/L)					
< 2	0	0.0	2	4.35	0.0251 (F)
2-3	32	55.17	33	71.74	
>3	26	44.83	11	23.91	
METABOLIC PROFILE:					
Serum total proteins (g/L)					
≤ 82	67	50.76	21	25.61	0.0003
> 82	65	49.24	61	74.39	
Serum albumin (g/L)					
< 34	2	1.53	9	10.98	0.0099
≥ 34	129	98.48	73	89.03	
Serum insulin (μU/ml)					
≤ 25	124	93.23	68	82.92	0.0544
> 25	9	6.77	14	17.07	
Serum cholesterol (mmol/L)					
< 5.2	88	66.67	65	79.27	0.0578 (F)
≥ 5.2	44	33.34	17	20.73	

*F = Fishers exact test

Table 5: Association between categorical variables associated with HIV in women 25-34 years

Variable 1	Variable 2	N	p-value (Chi-square)
Smoking	Type of dwelling	273	0.0094
Marital status	Head of household	273	<0.0001
	BMI	272	0.0012
Head of household	BMI	272	0.0024
	Total protein intake	273	0.0142
	Vitamin B6 intake	273	0.0223
Type of dwelling	Serum total protein	273	0.0056
	Vitamin B6 intake	273	0.0243
BMI	Haemoglobin	271	0.0583
	Haematocrit	271	0.0298
	Total protein intake	272	0.0009
Haemoglobin	Haematocrit	272	<0.0001
	MCHC	272	0.0021 (F)
	Serum albumin	272	0.0159 (F)
Haematocrit	MCHC	272	0.0387 (F)
	Serum albumin	272	0.0071 (F)
Serum total protein	Magnesium intake	273	0.0178
	Manganese intake	273	0.0425 (F)
	Total protein intake	273	0.0486
	Vitamin B6 intake	273	0.0321
Magnesium intake	Total protein intake	273	<0.0001
	Niacin intake	273	<0.0001
	Phosphorus intake	273	0.0060 (F)
	Pantothenic acid intake	273	<0.0001
	Vitamin B6 intake	273	<0.0001

Table 5: Association between categorical variables associated with HIV in women 25-34 years (Continued)

	Zinc intake	273	<0.0001
Manganese intake	Vitamin B6 intake	273	0.0475 (F)
Niacin intake	Total protein intake	273	<0.0001
	Phosphorus intake	273	<0.0001
	Pantothenic acid intake	273	<0.0001
	Vitamin B6 intake	273	<0.0001
	Zinc intake	273	<0.0001
Phosphorus intake	Total protein intake	273	<0.0001
	Magnesium intake	273	<0.0001
	Niacin intake	273	<0.0001
	Pantothenic acid intake	273	<0.0001
	Vitamin B6 intake	273	<0.0001
	Zinc intake	273	<0.0001
Pantothenic acid Intake	Total protein intake	273	<0.0001
	Magnesium intake	273	<0.0001
	Niacin intake	273	<0.0001
	Phosphorus intake	273	<0.0001
	Vitamin B6 intake	273	<0.0001
	Zinc intake	273	<0.0001
Vitamin B6 intake	Total protein intake	273	<0.0001
	Magnesium intake	273	<0.0001
	Manganese intake	273	0.0475 (F)
	Niacin intake	273	<0.0001
	Phosphorus intake	273	<0.0001
	Pantothenic acid intake	273	<0.0001
	Zinc intake	273	<0.0001
Zinc intake	Total protein intake	273	<0.0001
	Magnesium intake	273	<0.0001
	Niacin intake	273	<0.0001
	Phosphorus intake	273	<0.0001
	Pantothenic acid	273	<0.0001
	Vitamin B6 intake	273	<0.0001

* F = Fisher's exact test

Table 6: Association between categorical variables associated with HIV in women 35-44 years

Variable 1	Variable 2	N	p-value (Chi-square)
Marital status	Head of household	215	<0.0001
Level of education	Serum total proteins	214	0.0369
	Serum insulin	215	0.0118
	Folate intake	215	0.0111
	Selenium intake	215	0.0001
	Vitamin E intake	215	0.0012
Head of household	Serum total protein	215	0.0371
Serum ferritin	Haematocrit	108	0.0017 (F)
Transferrin	Haematocrit	104	<0.0001
	Serum iron	104	0.0302 (F)
	Serum albumin	103	<0.0001
Serum albumin	Haematocrit	211	0.0016 (F)
	Serum cholesterol	213	0.0362
Serum cholesterol	Haematocrit	212	0.0219 (F)
Folate intake	Selenium intake	215	<0.0001
	Vitamin E intake	215	<0.0001
Selenium intake	Vitamin E intake	215	<0.0001

* F = Fisher's exact test

Table 7: Difference between continuous variables for each categorical variable in women 25-34 years

Categorical variables	Continuous variables	N	Mann-Whitney p-value
Marital status	Years living in urban area	273	0.0125
Head of household	Years living in urban area	273	<0.0001
Type of dwelling	Years living in urban area	273	0.0014
	PUFA	273	0.0092
	Potassium intake	273	0.0072
BMI	Potassium intake	272	0.0456
	PUFA intake	272	0.0065
Serum total proteins	Years living in urban area	273	0.0300
Total protein intake	Potassium intake	273	<0.0001
	PUFA intake	273	<0.0001
Magnesium intake	Potassium intake	273	<0.0001
	PUFA intake	273	<0.0001
Manganese intake	Potassium intake	273	<0.0001
	PUFA intake	273	<0.0001

Table 7: Difference between continuous variables for each categorical variable in women 25-34 years (Continued)

Categorical variables	Continuous variables	N	Mann-Whitney p-value
Niacin intake	Potassium intake	273	<0.0001
	PUFA intake	273	<0.0001
Phosphorus intake	Potassium intake	273	<0.0001
	PUFA intake	273	<0.0001
Pantothenic acid intake	Years living in urban area	273	0.0034
	Potassium intake	273	<0.0001
	PUFA intake	273	<0.0001
Vitamin B6 intake	Years living in urban area	273	0.0002
	Potassium intake	273	<0.0001
	PUFA intake	273	<0.0001
Zinc intake	Years living in urban area	273	0.0158
	Potassium intake	273	<0.0001
	PUFA intake	273	<0.0001

Table 8: Difference between continuous variables for each categorical variable in women 35-44 years

Categorical variables	Continuous variables	N	Mann-Whitney p-value
Marital status	Haem iron intake	215	0.0474
Head of household	Years living in urban area	215	0.0387
	Haem iron intake	215	0.0277
Level of education	Years living in urban area	215	<0.0001
	Haem iron intake	215	0.0258
	Non-haem iron intake	215	0.0002
Serum total proteins	Haem iron intake	214	0.0460
	Non-haem iron intake	214	0.0412
Folate intake	Haem iron intake	215	<0.0001
	Non-haem iron intake	215	<0.0001
Selenium intake	Haem iron intake	215	<0.0001
	Non-haem iron intake	215	<0.0001
Vitamin E intake	Haem iron intake	215	<0.0001
	Non-haem iron intake	215	<0.0001
Vitamin E intake	Haem iron intake	215	0.0001
	Non-haem iron intake	215	<0.0001

Table 9: Classification of categorical variables for logistic regression

Variable	Category	Code in Logistic Regression
Smoking	Yes	1
	No	0
Marital status	Other	1
	Married or traditionally married	0
Head of household	Other	1
	Husband	0
Type of dwelling	Other	1
	Brick house	0
Level of education	None or primary school	1
	Other	0
Nutrient intake	≤ 67% of the RDA/ AI	1
	> 67% of the RDA/ AI	0
BMI	≥ 25 kg/m ²	1
	< 25 kg/m ²	0
Haemoglobin	< 11.7 g/dL	1
	≥ 11.7 g/dL	0
Haematocrit	< 0.35 L/L	1
	≥ 0.35 L/L	0
MCHC	< 32 g/dL	1
	≥ 32 g/dL	0
Serum iron	< 0.7mg/L	1
	≥ 0.7 mg/L	0
Transferrin	< 2 g/L	1
	2 – 3 g/L	0
	> 3 g/L	1
Serum total proteins	> 82 g/L	1
	≤ 82 g/L	0
Serum albumin	< 34 g/L	1
	≥ 34 g/L	0
Serum insulin	> 25 μU/ml	1
	≤ 25 μU/ml	0
Serum cholesterol	≥ 5.2 mmol/L	1
	< 5.2 mmol/L	0

Table 10: Results of logistic regression (25-34 years)

Variable	Coefficient (β)	Standard error	Wald ?2	P Value	Odds Ratio	95% CI for OR
Intercept	-2.257	0.523	-	-	-	-
X ₁ Smoking	0.842	0.319	6.95	0.008	2.32	1.24; 4.34
X ₂ Marital status	0.911	0.370	6.05	0.014	2.49	1.20; 5.14
X ₃ Haematocrit	1.695	0.598	8.03	0.005	5.45	1.69; 17.58
X ₄ MCHC	-1.606	0.668	5.78	0.016	0.20	0.05; 0.74
X ₅ Serum total proteins	1.557	0.305	25.98	<0.0001	4.74	2.61;8.63
X ₆ Serum insulin	-0.899	0.436	4.26	0.040	0.41	0.17; 0.96
X ₇ PUFA intake	0.026	0.009	8.19	0.004	1.03	1.01; 1.04

Table 11: Results of logistic regression (35-44 years)

Variable	Coefficient (β)	Standard error	Wald ?2	P Value	Odds Ratio	95% CI for OR
Intercept	3.072	0.837	-	-	-	-
X ₁ Level of education	-2.111	0.598	12.45	0.0004	0.12	0.04; 0.39
X ₂ Serum albumin	3.294	1.247	6.98	0.0083	26.96	2.34; 310.72
X ₃ Serum insulin	2.040	0.854	5.71	0.0169	7.69	1.44; 41.01
X ₄ Non-haem iron intake	-0.742	0.186	15.91	< 0.0001	0.48	0.33; 0.69

CHAPTER 13

CONCLUSIONS AND RECOMMENDATIONS

13.1 INTRODUCTION

In this study of women living in a community undergoing rapid urbanization, HIV infection has apparently spread at an alarming rate. In the age group 25 to 34 years, 61 percent tested HIV positive, while in the age group 35 to 44 years, 38 percent were HIV positive. Considering the numerous consequences of HIV infection, this population is at great risk of health- and nutrition-related problems.

13.2 CONCLUSIONS

The following conclusions evolved from the study:

13.2.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS

- HIV positive younger women had lived in an urban area for a significantly longer period than HIV negative young women.
- Significantly more of the HIV positive young women than uninfected young women smoked and/or used nasal snuff.
- A fairly large percentage of all the women were living together with a partner.
- Significantly more of the HIV negative older women than HIV positive older women were either married or traditionally married.

- A very small percentage of all young women had no formal schooling.
- A fairly large percentage of all the older women had primary school education, or St 6-8.
- Unemployment rates were high amongst all the women.
- Significantly more of the HIV negative young and older women had a husband-headed household.
- Most women stayed in brick houses with a tap for drinking water and a flush toilet on site.
- The majority of households had a working stove, while about half of all the households had a working refrigerator and/or freezer.
- No significant differences were found in room density between HIV positive and HIV negative women in the two age groups.

13.2.2 ANTHROPOMETRY

- According to body mass index (BMI), almost 50 percent or more of all women were either overweight or obese.
- BMI was significantly lower in the younger HIV positive women.
- Significantly more of the young HIV negative women than young HIV positive women had a BMI placing them in the overweight category.
- In the older group of women, the median BMI of both HIV positive and HIV negative women fell in the overweight category.
- Median waist-hip ratio (WHR) of younger and older HIV negative and HIV positive women was smaller than 0.8, indicating a gynoid fat distribution.

- A larger percentage of women from the older group had an android fat distribution.
- According to fat percentage, most women were either fat or obese.
- The mean fat percentage of HIV negative young women was significantly higher than that of the HIV positive young women.

13.2.3 DIETARY INTAKE

- Median total energy intake of HIV positive and HIV negative women from both the younger and older age group exceeded the Estimated Energy Requirement.
- Median energy intake of young HIV positive women was significantly higher than the median energy intake of HIV negative young women.
- Median total protein intake of all participants exceeded the Recommended Dietary Allowance (RDA).
- Median total carbohydrate intake of the sample as a whole was more than double the RDA.
- Median fibre intake fell below the Adequate Intake (AI) of 25 gram/day in all the participants.
- Median total fat intake of HIV positive and HIV negative women from both age groups exceeded the recommended intake of less than 30 percent of the total daily energy intake.
- Low median intakes of calcium, total iron and selenium were reported for the total sample.
- The percentage of women with an inadequate fat soluble vitamin intake was high in both the younger and older HIV-infected and uninfected women.

- Median intake of vitamin A was sufficient only in the older group of HIV negative women.
- Median intakes of vitamin D and E were inadequate in most women.
- Median intakes of the B vitamins were slightly higher to even double the RDA or AI.
- The total sample had median vitamin C intakes much lower than the RDA of 75 milligram/day, and almost half of all participants consumed less than 67 percent of the RDA for vitamin C.
- Median intake of folate was low amongst all the women, and more than half of all the women consumed less than 67 percent of the RDA for folate.
- Young women with HIV had significantly higher intakes of calcium, phosphorus, potassium, vitamin B12, vitamin D and vitamin E than young uninfected women.
- Older HIV positive women had significantly lower intakes of haem iron, nonhaem iron and selenium than older HIV negative women.

13.2.4 PHYSICAL ACTIVITY

- Physical activity level of all respondents were low.

13.2.5 IRON STATUS

- Median values for parameters of iron status fell within the normal ranges, but,
- HIV positive younger women had significantly lower median haemoglobin and haematocrit levels than their HIV negative counterparts.
- Older HIV positive women had significantly higher serum ferritin and significantly lower transferrin values than their HIV negative counterparts.

- Significantly more HIV positive younger and older women had haematocrit values below 0.35 Liter per Liter (L/L).
- Significantly more HIV negative older women had low serum iron and high transferrin concentrations.

13.2.6 METABOLIC PROFILE

- Median values for most biochemical parameters fell within the normal range.
- Young and older HIV positive women had significantly lower median total lymphocytes and serum albumin, compared to HIV negative women.
- Median serum total protein levels were significantly higher in HIV positive young and older women than in the uninfected women.
- Plasma fibrinogen levels were significantly reduced in HIV positive young women.
- Older HIV positive women had significantly lower serum cholesterol values than HIV negative older women.
- No significant differences were found for serum triglycerides between HIV positive and HIV negative women within the two age groups.
- Serum glucose levels showed no significant differences between HIV positive and HIV negative women within the two age groups.
- Serum insulin concentrations were significantly lower in HIV positive young women.

LOGISTIC REGRESSION

- In both younger and older women, increasing serum total protein and decreasing serum albumin are factors associated with HIV infection.
- In the younger women, smoking and being unmarried increase the odds of being HIV-infected.
- In older women, a higher level of education and decreasing non-haem iron intake are variables associated with HIV infection.

13.3 RECOMMENDATIONS

13.3.1 SOCIO-DEMOGRAPHY

- Strategies for intersectoral collaboration should be intensified in order to improve the current infrastructure and socio-economic status of women (Gilbert & Walker, 2002).
- HIV prevention efforts should focus strongly on young girls, and those currently uninfected with HIV (Mukherjee et al., 2003).
- A culture of voluntary testing for HIV should be established in this community, by drastically addressing the stigma associated with an HIV positive status, and service-related barriers that may hinder participation in such programmes (van Dyk & van Dyk, 2003).
- The necessary supportive environment should be created within the Mangaung community in order to maintain or improve quality of life of those infected with the virus.

13.3.2 ANTHROPOMETRY

- Monitoring weight changes may be worthwhile for diagnostic, therapeutic and nutritional intervention, and should be considered as minimal standard of care for those infected with HIV (Gramlich & Mascioli, 1995).
- Providing adequate nutrients, maintaining optimal digestion and absorption, preserving lean body mass, and maintaining functional status and quality of life can be achieved by nutritional therapy (Gramlich & Mascioli, 1995; Keithley, 1998).
- Close monitoring of nutritional and clinical status is essential to identify nutrition problems (Keithley, 1998).
- The role of exercise as beneficial adjunct to the health treatment of HIV-infected patients should be recommended (Jones et al., 2001) and further investigated.

13.3.3 DIETARY INTAKE

- The main focus of intervention for all women should be to improve the quality of their food intake by consuming a nutrient-dense, rather than an energy-dense diet.
- The guidelines purported in the South African Department of Health's manual on nutrition for people living with TB, HIV/AIDS and other chronic debilitating conditions should be recommended for HIV-infected individuals (Department of Health, South Africa (DoH, SA), 2001).
- HIV negative women should reduce their total intake of energy, carbohydrates, protein, fat and cholesterol to within recommended levels to alleviate and prevent the conditions of overnutrition, as indicated by unfavourable anthropometric and biochemical parameters.

- All women should increase their fibre intake (Insel *et al.*, 2001, p. 89) unless contra-indicated for HIV positive individuals with diarrhea.
- Baseline energy needs of HIV positive individuals should be determined before recommendations can be made in this regard (World Health Organization (WHO), 2003).
- As HIV disease progresses, WHO recommendations for increased energy intake should be considered (WHO, 2003).
- Since HIV positive individuals probably need more than the RDA/AI of some micronutrients, and might experience difficulties in meeting recommendations solely through dietary intake, nutrition intervention focusing on current deficient intakes, accompanied by nutrient supplementation (WHO, 2003), are essential to ensure sound immune function, optimal health and longevity.
- It is important to establish safe RDA's of macro- and micronutrients for people living with HIV, during various disease stages (WHO, 2003).
- The ideal diet to maintain or improve nutritional status in HIV-infected individuals in poor settings prior to the initiation of antiretroviral therapy needs to be investigated.

13.3.4 PHYSICAL ACTIVITY

- It is recommended that physical activity levels of all women should be increased.
- HIV positive women should follow the South African National Guidelines on Nutrition for people living with TB, HIV/AIDS and other Chronic debilitating conditions, stating that even simple daily activities around the house and regular walking could help to increase activity, and therefore help to keep muscles strong (DoH, SA, 2001).

13.3.5 IRON STATUS

- Iron supplementation is warranted in anemic patients with proven iron deficiency (Clark & Semba, 2001).
- Where anemia of chronic disease is present, treatment of underlying pathology (such as opportunistic infections) is recommended (Heyns & Badenhorst, 1986, p. 47).
- Routine iron supplementation for HIV positive women is not recommended (Semba, 2003; Olsen *et al.*, 2004).

13.3.6 METABOLIC PROFILE

- Since metabolic abnormalities may impair nutritional status (Salomon *et al.*, 2002), early voluntary testing for HIV should be encouraged (Lamprey, 2002), in order to timely commence nutrition intervention, thus preventing malnutrition.
- Ongoing nutritional evaluation and monitoring of metabolic parameters should form an integral part of care of HIV-infected individuals (Casey, 1997).
- Extensive management strategies to actively treat and counsel HIV-infected persons with malnutrition have to be implemented for maximum retention of lean body mass (Salomon *et al.*, 2002), infection resistance and ongoing quality and productivity of life (Calderon *et al.*, 1990).

13.3.7 HEALTH STATUS

- Due to the fact that the initial study was aimed at evaluating diseases of lifestyle, HIV status was determined to describe the sample. The high HIV prevalence was unexpected.
- CD4 cell counts and viral loads were not done, but would be useful to determine stage of HIV infection.

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APPENDICES

APPENDIX A

CONSENT FORM

NUTRITIONAL HEALTH OF WOMEN (25-44 YEARS) IN MANGAUNG, 2000

Ethics committee reference number: 02/00

Declaration by or on behalf of the participant:

Respondent number

I, the undersigned,

???

[ID.....]

.....(address)

A confirm that:

1. I have been asked to participate in the above-mentioned research survey carried out by the Technikon Free State and University of the Orange Free State
2. It has been explained to me that:
 - 2.1 The purpose of the research survey is to collect information on usual food intake, activity level, attitude towards health, risk for developing illnesses related to eating habits and lifestyle of women in the ages 25 to 45 years in Mangaung. The information collected will be used to determine nutritional problems and to develop solutions for these problems.
 - 2.2 In order to collect this information I have been told that I will be asked a number of questions regarding:
 - general background information;
 - the types and amounts of foods I eat and how often I eat these foods;
 - how active I am every day;
 - my attitude towards leanness and fatness;
 - 2.3 I also understand that a medical doctor will perform a free medical examination and that blood samples will be drawn by a registered nurse. One of these blood samples will include a test for HIV-AIDS. I also agree to be weighed and measured. I will not eat or drink anything after 10:00 of the evening preceding the research day. I will bring a list of the medication that I usually use with me on the research day.
 - 2.4 I have been told that this information will be collected from over 500 women in Mangaung and I will only be asked these questions once. The measurements and blood samples will also be taken once only.

- 2.5 I have been told that it will not take more than one day to collect the information.
3. I have been told that the measurements will not cause any harm to me in any way.
4. It was also explained to me that by participating in the research survey I will help other women in the country.
5. It was also explained to me that the information will be kept confidential but that it will be used anonymously for making known the findings to other scientists.
6. I understand that I will have no direct access to the results of the survey but I can contact the researcher who will inform me of the findings.
7. It was also clearly explained to me that I can refuse to participate in this research survey. If I refuse, it will not be held against me in any way.
8. The information in this consent form was explained to me by(name of interviewer) in(language) and I confirm that I have a good command in this language and understood the explanations. I was also given the opportunity to ask questions on things I did not understand clearly.
9. No pressure was applied on me to take part in this research survey.
10. Finally, after completion of my participation in this research survey I will receive a payment of R40. I will be responsible for my own transport home.

B I hereby agree voluntarily to take part in this research survey.

Signed/confirmed at on 2000

.....

Signature or hand mark of
Participant

.....

Signature or hand mark of
Witness

APPENDIX B

WOMENS NUTRITIONAL HEALTH SURVEY: WOMEN 25-44 YEARS OLD

SOCIO-DEMOGRAPHIC QUESTIONNAIRE
 (All information in this questionnaire is confidential).

Name: _____

Respondent number:

<input type="text"/>	<input type="text"/>	<input type="text"/>	1-3
<input type="text"/>	<input type="text"/>	<input type="text"/>	4-5

Interviewer: _____

D	D	M	M	Y	Y	Y	Y	6-13
<input type="text"/>	14-21							
<input type="text"/>	22-23							

Birth Date:

Interview Date:

Age (years) if Birth Date unknown: _____

Address: _____

Tel No (H): _____ **(W):** _____

How many years have you been living in an urban area (like Mangaung)?

<input type="text"/>	<input type="text"/>	24-25
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Encircle the appropriate answer:

Language:

1. Sotho
2. Tswana
3. English
4. Afrikaans
5. Other, specify _____

<input type="text"/>	26
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Number of children: (born): _____

<input type="text"/>	<input type="text"/>	27-28
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Number of children: (alive): _____

<input type="text"/>	<input type="text"/>	29-30
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Do you smoke at all?

1. Yes
 2. No
- If yes, how many cigarettes per day?

<input type="text"/>	31
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<input type="text"/>	<input type="text"/>	32-33
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Household composition:

How many persons live in the house permanently (5-7 days per week)? _____

<input type="text"/>	<input type="text"/>	34-35
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Number of children (< 18 yrs): _____

<input type="text"/>	<input type="text"/>	36-37
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Number of adults (≥ 18 yrs): _____

<input type="text"/>	<input type="text"/>	38-39
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Marital status of respondent:

<input type="text"/>	40
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1. Unmarried
2. Married
3. Divorced
4. Separated
5. Widowed
6. Living Together
7. Traditional Marriage
8. Other,
specify _____

What is your highest level of education?

41

1. None
2. Primary School
3. Std 6-8
4. Std 9-10
5. Tertiary Education
6. Don't Know

Employment status of respondent

42

1. Housewife by choice
2. Unemployed
3. Self Employed
4. Full time wage earner (receive a salary)
5. Other, specify (part-time, piece job
etc.) _____
6. Don't Know

Husband/ partner's employment status

43

1. Retired by choice
2. Unemployed
3. Self Employed
4. Full time wage earner (receive a salary)
5. Other, specify (part-time, piece job
etc.) _____
6. Not Applicable e.g. dead

Who is the head of this household?

44

1. Self
2. Husband
3. Child/ren
4. Parent
5. Grandparent
6. Friend
7. Other, specify _____

Type of dwelling:

45

1. Brick, Concrete
2. Traditional mud
3. Tin
4. Plank, wood
5. Other, specify _____

Number of rooms in house (excluding bathroom, toilet and kitchen, if separate)

46-47

Where do you get drinking water most of the time?

48

1. Own tap
2. Communal tap
3. River, dam
4. Borehole, well
5. Other, specify _____

What type of toilet does this household have?

49

1. Flush
2. Pit
3. Bucket, pot
4. VIP
5. Other, specify _____

What fuel is used for cooking most of the time?

50

1. Electric
2. Gas
3. Paraffin
4. Wood, Coal
5. Sun
6. Open fire

Do you use a cast iron pot for cooking?

51

1. Never
2. ≤ Once a week
3. > Once a week
4. Every day

Does the home have a working:

Refrigerator and/or freezer

52

1. Yes
2. No

Stove (Gas, Coal or electric) or Hot Plate

53

1. Yes
2. No

Primus or Paraffin Stove

54

1. Yes
2. No

Microwave

55

1. Yes
2. No

Radio and/or Television

56

1. Yes
2. No

How many people contribute to the total income? _____

57-58

Household income per month (including wages, rent, sales of vegs, etc. State grants).

59

1. None
2. R100-R500
3. R501- R1000
4. R1001-R3000
5. R3001-R5000
6. Over R5000
7. Don't know

Is this more or less the income that you had over the past six months?

60

1. Yes
2. No

If no, is it more or less?

61

1. More
2. Less

How much money is spent on food weekly?

62-63

1. R0-R50
2. R51-R100
3. R101-R150
4. R151-R200
5. R201-R250
6. R251-R300
7. R301-R350
8. R351-R400
9. Over R 400

APPENDIX C

Nutritional Health of Women (25-44yrs) in Mangaung, 2000

Anthropometry

Name: _____

Respondent number:

<input type="text"/>	<input type="text"/>	<input type="text"/>	1-3
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Measurer (interviewer): _____

<input type="text"/>	<input type="text"/>	4-5
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Weight (kg): _____

<input type="text"/>	<input type="text"/>	<input type="text"/>	.	<input type="text"/>	6-10
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Height (m): _____

<input type="text"/>	.	<input type="text"/>	<input type="text"/>	11-14
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Circumferences (cm):

Upper-arm: _____

<input type="text"/>	<input type="text"/>	.	<input type="text"/>	15-18
----------------------	----------------------	---	----------------------	-------

Waist: _____

<input type="text"/>	<input type="text"/>	.	<input type="text"/>	19-23
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Hip: _____

<input type="text"/>	<input type="text"/>	.	<input type="text"/>	24-28
----------------------	----------------------	---	----------------------	-------

Bio-impedance:

Age (yrs): _____

<input type="text"/>	<input type="text"/>	29-30
----------------------	----------------------	-------

Elbow width (cm): _____

<input type="text"/>	.	<input type="text"/>	31-33
----------------------	---	----------------------	-------

Bodystat count: _____

<input type="text"/>	<input type="text"/>	34-36
----------------------	----------------------	-------

Frame size

<input type="text"/>	37
----------------------	----

1. Small
2. Medium
3. Large

% Fat: _____

<input type="text"/>	<input type="text"/>	.	<input type="text"/>	38-41
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% Lean mass: _____

<input type="text"/>	<input type="text"/>	.	<input type="text"/>	42-45
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APPENDIX D

NUTRITIONAL HEALTH OF WOMEN (25-44 YRS) IN MANGAUNG, 2000
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Name: _____

Respondent number:

Interviewer: _____

			1-3
			4-5

QUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE

Greeting

Thank you for giving up your time to participate in this survey. We would like to find out what women 25 to 44 years of age and living in the Free State, usually eat and drink. This information is important to know as it will tell us whether you eat the right foods, and if you are healthy.

Please think carefully about the food and drinks you have consumed during the past 6 months. I will now go through a list of foods and drinks with you and I would like you to tell me:

- if you eat these particular foods,
- how the food is prepared,
- how much of the food you eat at a time, and
- how many times a day you eat it and if you do not eat it every day, how many times a week or a month it is eaten?

To help you to describe the amount of a food, I will show you pictures or models of different amounts of the food. Please say which picture or model is the closest to the amount eaten, or if it is smaller, between sizes or bigger than the pictures or models. Amounts can also be reported as cups (c), tablespoons (T) or teaspoons (t).

- **THERE ARE NO RIGHT OR WRONG ANSWERS.**
- **EVERYTHING YOU TELL ME IS CONFIDENTIAL.**
- **IS THERE ANYTHING YOU WANT TO ASK NOW?**
- **ARE YOU WILLING TO GO ON WITH THE QUESTIONS?**
- **ENCIRCLE APPROPRIATE ANSWER**

Do you follow any special diet?

YES (1) NO (2)

	6
	7

If yes, please specify (encircle appropriate answer)

1. Diabetic diet
2. Slimming diet
3. Allergies
4. Other (Specify) _____

• Do you use salt in your food?

YES (1) NO (2) DON'T KNOW (3)

	8
--	---

HOW OFTEN DO YOU EAT AT THE FOLLOWING PLACES AWAY FROM HOME?

Family	1. Never	2. > once/week	3. Weekly	4. Monthly	5. > once a month	<input type="checkbox"/>	29
Friends	1. Never	2. > once/week	3. Weekly	4. Monthly	5. > once a month	<input type="checkbox"/>	30
Café	1. Never	2. > once/week	3. Weekly	4. Monthly	5. > once a month	<input type="checkbox"/>	31
Restaurant, Fast food	1. Never	2. > once/week	3. Weekly	4. Monthly	5. > once a month	<input type="checkbox"/>	32
Other, specify _____	1. Never	2. > once/week	3. Weekly	4. Monthly	5. > once a month	<input type="checkbox"/>	33

Do you drink coffee with your meals?

34

- 1. Yes
- 2. No

If yes, at which meals

Breakfast	1. Yes	2. No	<input type="checkbox"/>	35
Lunch	1. Yes	2. No	<input type="checkbox"/>	36
Supper	1. Yes	2. No	<input type="checkbox"/>	37
Snacks	1. Yes	2. No	<input type="checkbox"/>	38

Do you drink tea (except Rooibos) with your meals?

39

- 1. Yes
- 2. No

If yes, at which meals

Breakfast	1. Yes	2. No	<input type="checkbox"/>	40
Lunch	1. Yes	2. No	<input type="checkbox"/>	41
Supper	1. Yes	2. No	<input type="checkbox"/>	42
Snacks	1. Yes	2. No	<input type="checkbox"/>	43

With how many meals per day do you eat meat, fish or poultry?

44

- 1. One meal
- 2. Two meals
- 3. All meals
- 4. None

Do you eat fresh fruit and/or vegetables with the following meals?

- | | | |
|------------------|--------|-------|
| Breakfast | 1. Yes | 2. No |
| Lunch | 1. Yes | 2. No |
| Supper | 1. Yes | 2. No |
| Snacks | 1. Yes | 2. No |

<input type="checkbox"/>	45
<input type="checkbox"/>	46
<input type="checkbox"/>	47
<input type="checkbox"/>	48

SUMMARY OF FOOD FREQUENCY QUESTIONNAIRE

FOOD	CALCULATIONS	CODE								AMOUNT PER DAY (g)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Maize-meal porridge	Stiff (pap)						3400	
Maize-meal porridge	Soft (slappap)						3399	
Maize-meal porridge	Crumbly (phutu)						3401	
Sour porridge	Specify ratio Mabella/Maize						3399	
Mabella porridge	Stiff, coarse, fine						3437	
Mabella porridge	Soft, coarse, fine						3437	
Oats porridge	Brand name:						3239	
Breakfast cereals	Puffed Wheat, plain						3325	
	Corn Flakes, plain						3243	
	Weet Bix						3244	
	Puffed Rice, sweet						3372	
	Specify types usually eaten _____ _____ Brand names of cereals available at home now: _____							
Milk on porridge or cereal: Circle type usually used	None							
	Whole/fresh						2718	
	Sour						2787	
	2% fat						2772	
	Fat free/skimmed						2775	
	Milk blend						2771	
	Soy milk						2737	
	Condensed (whole,sweet)						2714	
	Condensed (skim, sweet)						2744	
	Evaporated whole						2715	
Evaporated low fat						2827		
Non-dairy creamer						2751		
Is sugar added to porridge or cereal? (Tick box)	None	ð					3989	
	White	ð					4005	
	Brown	ð					3988	
	Syrup	ð					3984	
	Honey	ð						
Sweetener: type _____								
Is fat added to porridge or cereal? (Tick box)	None	ð					3479	
	Animal fat (butter)	ð					3484	
	Hard margarine	ð					3496	
	Soft margarine	ð					3507	
	Oil	ð					3485	
Peanut Butter	ð							
Samp/Maize rice	Bought						3250	
	Self ground						3725	
	Specify ratio (1:1)						3402	
Samp and beans	Specify ratio							
Samp and peanuts	Specify ratio							
Rice: specify brands names:	White						3247	
	Brown						3315	
	Sorghum rice						3437	
Stamped wheat						3249		
Pastas	Macaroni						3262	
	Spaghetti						3262	
	Spaghetti in tomato sauce						3258	
	Other:							

HOW MANY TIMES A WEEK DO YOU EAT PORRIDGE OR BREAKFAST CEREAL AT ANY TIME OF THE DAY (NOT ONLY BREAKFAST)? _____

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Bread/Bread rolls	White						3210	
	Brown						3211	
	Whole wheat						3212	
Other breads	Specify types e.g.							
	Raisin						3214	
	Maize meal						3278	
	Sweetcorn						3379	
	Rye						3213	
	Other							
Pizza (specify toppings)	Cheese, tomato & onion						3353	
Hot Dogs(specify sausage)	_____							
Hamburgers (specify meat)	_____							

Are any the following spreads used on bread? Fat spreads (Tick box)	Butter	ø					3479	
	Butro	ø					3523	
	Animal fat (beef tallow)	ø					3494	
	Lard	ø					3495	
	Hard margarine (brick)	ø					3484	
	Soft margarine (light)	ø					3496	
	Cooking Fat	ø					3516	
Peanut butter							3485	
Sweet spreads	Jam						3985	
	Syrup						3988	
	Honey						3984	
Marmite/ OXO/ Bovril							4030	
							4029	
							4029	
Fish paste							3109	
Meat paste							2917	
Cheese	Specify types:							
	Cottage low-fat cheese						2760	
	Cream cheese						2725	
	Gouda						2723	
	Cheddar						2722	
	Other: _____							
Cheese spreads	Low fat						4310	
	Full fat						2730	
	Specify types							
Atchar							3117	
Other spreads: (Specify types)	_____							

Dumpling							3210	
Vetkoek							3257	
Provita Crackers (refined)							3235	
							3331	
							3391	
Crackers (whole wheat)								

Rusks <i>Home-made:</i>	Bran						3330	
	Buttermilk						3329	
	White						3364	
	Boerebeskuit, white						3364	
	All-bran						3380	
	Raisins						3380	
	Buttermilk, white						3215	
Buttermilk, whole wheat						3255		
Other								
Scones							3237	
Muffins	Plain						3408	
	Bran						3407	

HOW MANY TIMES A DAY DO YOU EAT BREAD? _____

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Chicken Do you eat the chicken with the skin? Yes <input type="checkbox"/> No <input type="checkbox"/>	Boiled: with skin						2926	
	without skin						2963	
	Fried: in batter/crumbs						3018	
	Fried, but not coated						2925	
	Roasted/grilled with skin						2925	
	without skin						2950	
Chicken bones stew							A003	
Chicken heads, raw							2999	
Chicken stew, with veg. & skin							3005	
Chicken feet, raw							2997	
Chicken offal	Giblets						2998	
Chicken pie	Commercial						2954	
	Home-made						2954	
Red meat: Beef	Fried/grilled: with fat						2908	
	without fat						2959	
	Stewed/boiled: with fat						3006	
	without fat						2909	
	Mince with tomato and onion						2987	
Red meat: Mutton	Fried/grilled: with fat						2927	
	without fat						2934	
	Stewed/boiled: with fat						3040	
Red meat: Pork	without fat						2916	
	Fried/grilled: with fat						2930	
	without fat						2977	
Red meat: Goat	Stewed/boiled: with fat						3046	
	without fat						3045	
	Fried/grilled: with fat						4281	
	without fat							
	Stewed/boiled: plain						4281	
Offal: Specify type:	with veg						4282	
	Intestines: boiled, nothing added						3003	
	"Vetderm" fried						3003	
	Stewed with vegetables							
	Liver						2955	
	Kidney						2956	
	Tripe "pens" trotters, head						3003	
Pluck (lungs, heart, gullet)						3019		

Specify vegetables used in meat stews (only if not mentioned elsewhere)								
Wors / sausage	Fried							2931
Bacon								2906
Cold meats	Polony							2919
	Ham							2967
	Vienna's canned							2936
	Russian							2948
	Frankfurter							2937
	Other (specify)							
Canned meat	Bully beef							2940
	Other (specify)							
Meat pie	Bought							2939

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/D AY
			Per day	Per week	Per month	Seldom/ Never		
Legumes: specify dried beans/peas/ Lentils	Stews & curries (specify)						3157 3174	
	Soups							
	Salad							
Baked beans							3176	
Soya products e.g. Toppers/ Imana	Brands at home now Don't know _____ Show examples						3196	
Fried fish (fresh or frozen fried in sun oil)	With batter/crumbs						3072	
	Without batter/crumbs						3060	
Fresh water fish Specify type	Specify cooking method Medium fat, batter, fried						3094	
Canned fish:								
Pilchards	In brine						3055	
	In tomato sauce						3102	
	Mashed with fried onion						A005	
Sardines	In oil						3087	
	In tomato sauce						3087	
Tuna	In oil						3093	
	In brine						3054	
Mackerel							3113	
Salmon							3101	
Pickled fish/curried							3076	
Do you remove fish bones before eating canned fish	YES ð NO ð							
Fish cakes Specify canned or other	Fried: oil/butter/margarine, commercial						3080	
Salted dried fish							3077	

Eggs	Boiled/poached							2867	
	Scrambled in: oil							2889	
	butter							2886	
	margarine							2887	
	Fried in: oil							2869	
	butter							2868	
	margarine							2877	
bacon fat							2870		
Curried							2902		

HOW MANY TIMES A WEEK DO YOU EAT MEAT _____,

BEANS _____,

CHICKEN _____,

FISH _____ **AND**

EGGS _____?

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Cabbage	Boiled, nothing added						3756	
	Boiled with potato and onion and fat						3813	
	Fried, in margarine (nothing added)						3810	
	Fried, in oil (nothing added)						3912	
	Boiled, then fried with potato, onion						A006	
	Other:							
Spinach/morogo/im fino/other green leafy vegetables: List names	Boiled, nothing added						3913	
	Boiled fat added (margarine)						3898	
	Boiled with onion/tomato and fat						A011	
	-onion & potato (margarine)						3901	
	- onion, tomato & potato							
	- with peanuts							
	Other:							
Tomato and onion 'gravy'/relish/chow	Home made -with fat						3910	
	without fat						3925	
	Canned						4129	
Pumpkin Specify type:	Cooked in fat & sugar						A010	
	Boiled, little sugar and fat						A010	
	Boiled						4164	
_____	Other:							
Carrots	Boiled, sugar & fat						3819	
	Boiled, nothing added						3757	
	Boiled, potato, onion, no fat						3934	
	Boiled, potato, onion, margarine						3822	
	Boiled, with sugar						3818	
	With potato/onion						3934	
	Raw, salad (orange juice)						3711	
	Chakalaka							

	Other:							
Mealies/Sweet corn	On cob							3725
	Off cob -creamed sweet corn							3726
	Off cob whole kernel							3942
Beetroot	Cooked							3698
	Salad (bought or home-made)							3699
Potatoes	Boiled with skin							4155
	- without skin							3737
	Baked in skin(flesh and skin)							3736
	- in skin (flesh only)							3970
	Mashed - skim milk, margarine							3875
	Mashed - whole milk, margarine							3876
	Roasted in beef fat							3878
	French fries/potato chips (oil)							3740
Salad (mayonnaise and egg)							3928	
	Other:							
Sweet potatoes	Boiled with skin							3748
	without skin							3903
	Baked with skin							3748
	- without skin							3903
	Mashed							3903
	Other:							
Peas	Green, frozen							4146
	Green, frozen with sugar							3720
	With sugar and butter							3859
	Tinned peas							4149
Green peppers	Raw							3733
	Cooked (stew with oil)							3865
Brinjal/egg plant	Cooked							3700
	Fried in oil							3802
	Stew (oil, onions, tomato)							3798
Mushrooms	Raw							3842
	Sautéed in brick margarine							3839
	Sautéed in oil							3841
Onions	Sauteed in sun oil							3730
	Sauteed in margarine							3844
Salad vegetables	Raw tomato							3750
	Lettuce							3723
	Cucumber							3718
	Avocado's							3656
Green Beans	Boiled, nothing added							3696
	Cooked, potato, onion, margarine							3792
	Cooked, potato, onion, no fat							3933
Cauliflower	Boiled							
Other vegetables; specify	_____							

If you fry veg or add fat specify type of fat usually used	Butter	ð						3479	
	Butro	ð						3523	
	Animal fat (beef tallow)	ð						3494	
	Lard	ð						3495	
	Hard margarine (brick)	ð						3484	
	Soft margarine (tub)	ð						3496	
	Soft margarine (light)	ð						3524	
	Sunflower oil	ð						3507	

HOW MANY TIMES A WEEK DO YOU EAT VEGETABLES? _____

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Mayonnaise/salad dressing	Mayonnaise: bought						3488	
	home-made						3506	
	Cooked salad dressing						3503	
	Salad dressing low-oil						3505	
	Salad dressing French						3487	
	Oil: Olive						3509	
	Sunflower						3507	
Canola						4280		
Apples	Fresh						3532	
	Canned, unsweetened						4216	
Pears	Fresh						3582	
	Canned, in syrup						3583	
Bananas							3540	
Oranges							3560	
Naartjie							3558	
Grapes							3550	
Peaches	Fresh						3565	
	Canned, in syrup						3567	
Apricots	Fresh						3534	
	Canned, in syrup						3535	
Mangoes	Fresh						3556	
Pawpaw	Raw						3563	
Pineapple	Raw						3581	
	Canned (syrup)						3648	
Guavas	Fresh						3551	
	Canned (syrup)						3553	
Watermelon							3576	
Spanspek	Orange flesh						3541	
	Green flesh						3575	
Wild fruit/berries (Specify types)	_____							

Dried fruit (also as snacks)	Raisins						3552	
	Prunes (raw)						3596	
	Prunes (cooked with sugar)						3564	
	Peaches (raw)						3568	
	Peach (cooked with sugar)						3569	
	Apples (raw)						3600	
	Dried fruit sweets						3995	
	Other							

Other fruit	_____	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____	_____

HOW MANY TIMES A WEEK DO YOU EAT FRUITS? _____

WE NOW WILL ASK YOU QUESTIONS ABOUT WHAT YOU USUALLY DRINK

BEVERAGES	DESCRIPTION	AMOUNT USUALLY TAKEN	TIMES TAKEN				CODE	AMOUNT/DAY	
			Per day	Per week	Per month	Seldom/ Never			
Water							4042		
Tea	Ceylon						4038		
	Rooibos						4054		
Coffee							4037		
Sugar per cup of tea or coffee	White						3989		
	Brown						4005		
Milk per cup of tea or coffee What type of milk do you put in tea and/or coffee?	Fresh/long life whole						2718		
	Fresh/long life 2% Goat						2772 2738		
	Fresh/long life/fat free (skimmed)						2775		
	Whole milk powder, reconstituted Specify brand: _____						2831		
	Skimmed milk powder, reconstituted Specify brand: _____						2719		
	Milk blend, reconstituted Specify brand: _____						2771		
	Whitener/non-dairy creamer Specify brand: _____						2751		
	Condensed milk (whole)						2714		
	Condensed milk (skim)						2744		
	Evaporated milk (whole)						2715		
	Evaporated milk (low-fat)						2827		
	None								
	Milk as such: What type of milk do you drink as such?	Fresh/long life/whole						2718	
		Fresh/long life/2%						2772	
Fresh/longlife/fat free (skimmed)							2775		
Goat							2738		
Sour / Maas							2787		
Buttermilk						2713			

BEVERAGES	DESCRIPTION	AMOUNT USUALLY TAKEN	TIMES TAKEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Milk drinks Specify brands, Including milk supplements and type of milk used	Nestle Nesquik						4287	
	Milo						2735	
	Flavoured milk						2774	
	Other							
Yoghurt	Drinking yoghurt						2756	
	Thick yoghurt, plain, fruit						2732	
Squash	SixO						3990	
	Oros						3982	
	Lecol with sugar						3982	
	-artificial sweetener						3990	
	Kool Aid						3982	
Other _____								
Fruit juice	Fresh/Liquifruit/Ceres/						2866	
	"Tropica"/ mixtures with milk						2791	
Fruit syrups	Average						2865	
	Guava syrup						2864	
Fizzy drinks Coke, Fanta	Sweetened						3981	
	Diet						3990	
Mageu/Motogo							4056	
Alcoholic beverages such as Sorghum beer	Sorghum beer						4039	
Specify:								
Other , specify:	Beer average						4031	
	Wine						4033	
	Cider						4057	

PLEASE INDICATE WHAT TYPES AND AMOUNTS OF SNACKS, PUDDINGS AND SWEETS YOU EAT:

FOODS	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Potato crisps/chips							3417	
Peanuts	Roasted, unsalted						3452	
	Roasted, salted						3458	
Cheese curls: Niknaks etc.	Average						3267	
	Savoury						3418	
Popcorn	Plain (no salt and butter)						3332	
	Plain (salt and butter added)						3359	
	Sugar coated							
Raisins (seeds)							4231	
Chocolates	Milk						3987	
	Kit Kat						4024	
	Peppermint crisp						3997	
	Specify types and names							
Candies	Sugus, gums, hard sweets (specify)						3986	
	Peppermint						4004	

Sweets	Toffees Hard boiled Fudge, caramels (specify)							3991 3986 3991	
Biscuits/cookies	Specify type Home made plain Shortbread, butter Commercial, plain Commercial with filling							3233 3296 3216 3217	
Cakes & tarts	Chocolate, plain							3419	
Pancakes/ crumpets								3344	
Koeksisters								3231	
Savouries	Sausage rolls Samoosas - vegetable Samoosa - mutton Biscuits e.g. bacon kips Other: _____							2939 3414 3355 3331	
Pudding: jelly								3983	
Baked pudding	Plain batter							3429	
Instant pudding	Skim milk Whole milk							3314 3266	
Ice cream	Commercial regular Commercial rich Soft serve Sorbet Ice lollies Chocolate coated individual ice creams (e.g. Magnum)							3483 3519 3518 3491 3982	
Custard	Home made, whole milk Ultramel							2716 2716	
Cream	Fresh							3520/ 3480	
Other puddings (Specify):	_____								

HOW MANY TIMES A WEEK DO YOU EAT SNACK FOODS? _____

SAUCES / GRAVIES / CONDIMENTS

FOODS	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		
Tomato Sauce							3139	
Worcester sauce							4309	
Chutney	Fruit						3168	
	Tomato						3114	
Pickles							3866	
Packet soups							3158	
Beef/chicken stock							4029	
Others:								

WILD BIRDS, ANIMALS, INSECTS OR FRUITS AND BERRIES (hunted or collected in rural areas or on farms: (specify)								

- **PLEASE MENTION ANY OTHER FOODS YOU EAT MORE THAN ONCE EVERY TWO WEEKS WHICH WE HAVE NOT TALKED ABOUT AND OR FOODS EATEN IN OTHER HOMES OR PLACES DURING THE PAST WEEK**

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		

- **ARE THERE ANY FOODS THAT YOU EAT WHICH WE HAVEN'T TALKED ABOUT? PLEASE LIST THEM.**

FOODS	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		

**THANK YOU FOR YOUR CO-OPERATION AND PATIENCE.
GOOD BYE!**

ADAPTED FROM THE QUESTIONNAIRES OF THE THUSA STUDY (WITH ACKNOWLEDGEMENT TO THE RESEARCH GROUP OF PUCHO) AND THE NATIONAL FOOD CONSUMPTION SURVEY

APPENDIX E

PHYSICAL ACTIVITY OF WOMEN (25 – 44 YRS) IN MANGAUNG

MARK THE APPROPRIATE BOX WITH AN 'X' OR WRITE IN THE APPROPRIATE ANSWER

Name: _____

Respondent number: _____

Interviewer number: _____

1. What is your main occupation ?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1-3
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	4-5

2. Is your workplace away from home?
IF NO, OR UNEMPLOYED GO TO
QUESTION 20

Yes (1)	No (2)
---------	--------

<input type="checkbox"/>	<input type="checkbox"/>	6-7
--------------------------	--------------------------	-----

3. How many days per week do you work?

<input type="checkbox"/>	8
--------------------------	---

4. How long per day do you work?(min)

<input type="checkbox"/>	<input type="checkbox"/>	9-10
--------------------------	--------------------------	------

5. At work I sit .

Yes (1)	No (2)
---------	--------

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11-13
--------------------------	--------------------------	--------------------------	-------

6. IF YES, how long?(min)

<input type="checkbox"/>	14
--------------------------	----

7. At work I walk.

Yes (1)	No (2)
---------	--------

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	15-17
--------------------------	--------------------------	--------------------------	-------

8. IF YES, how long?(min)

<input type="checkbox"/>	18
--------------------------	----

9. At work I lift heavy loads.

Yes (1)	No (2)
---------	--------

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	19-21
--------------------------	--------------------------	--------------------------	-------

10. IF YES, how long?(min)

<input type="checkbox"/>	22
--------------------------	----

11. At work I am tired.

Yes (1)	No (2)
---------	--------

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	23-25
--------------------------	--------------------------	--------------------------	-------

12. IF YES, how long?(min)

<input type="checkbox"/>	26
--------------------------	----

13. At work I sweat as a result of the
work I do.

1. never	2. seldom	3. some- times	4. often	5. alway s
----------	-----------	-------------------	----------	---------------

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	27-29
--------------------------	--------------------------	--------------------------	-------

14. How do you get to work?

1. walk	2. cycle	3. bus	4. taxi	5. car
---------	----------	--------	---------	--------

<input type="checkbox"/>	30
--------------------------	----

15. If by bus or taxi how long does it take you to
walk to the bus or taxi rank(mins)

<input type="checkbox"/>	<input type="checkbox"/>	31
--------------------------	--------------------------	----

16. If you walk to work, what is your usual
pace?

1. casua l strolling	2. fairly brisk	3. bris k	4. fast
----------------------------	--------------------	--------------	---------

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	32-34
--------------------------	--------------------------	--------------------------	-------

<input type="checkbox"/>	35
--------------------------	----

17. How long do you take to get to walk to
work?(min)

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	36-38
--------------------------	--------------------------	--------------------------	-------

18 If you cycle, what is your usual pace?	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; padding: 2px;">1. casual cycling</td> <td style="width: 25%; padding: 2px;">2. fairly brisk</td> <td style="width: 25%; padding: 2px;">3. brisk</td> <td style="width: 25%; padding: 2px;">4. fast</td> </tr> </table>	1. casual cycling	2. fairly brisk	3. brisk	4. fast	<input type="checkbox"/> 39	
1. casual cycling	2. fairly brisk	3. brisk	4. fast				
19. How long do you take to get to cycle to work? (min)	_____	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 40-42					
20. How long do you work at home? (min)	_____	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 43-45					
21. At home I sit .	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 2px;">Yes (1)</td> <td style="width: 50%; padding: 2px;">No (2)</td> </tr> </table>	Yes (1)	No (2)	<input type="checkbox"/> 46			
Yes (1)	No (2)						
22. IF YES, how long?(min)	_____	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 47-49					
23. At home I walk.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 2px;">Yes (1)</td> <td style="width: 50%; padding: 2px;">No (2)</td> </tr> </table>	Yes (1)	No (2)	<input type="checkbox"/> 50			
Yes (1)	No (2)						
24. IF YES, how long?(min)	_____	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 51-53					
25. At home I lift heavy loads.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 2px;">Yes (1)</td> <td style="width: 50%; padding: 2px;">No (2)</td> </tr> </table>	Yes (1)	No (2)	<input type="checkbox"/> 54			
Yes (1)	No (2)						
26. IF YES, how long?(min)	_____	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 55-57					
27. At home I am tired.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 2px;">Yes (1)</td> <td style="width: 50%; padding: 2px;">No (2)</td> </tr> </table>	Yes (1)	No (2)	<input type="checkbox"/> 58			
Yes (1)	No (2)						
28. IF YES, how long?(min)	_____	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 59-61					
29. At home I sweat as a result of the things I do at home	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%; padding: 2px;">1. Never</td> <td style="width: 20%; padding: 2px;">2. Seldom</td> <td style="width: 20%; padding: 2px;">3. Some-times</td> <td style="width: 20%; padding: 2px;">4. Often</td> <td style="width: 20%; padding: 2px;">5. Always</td> </tr> </table>	1. Never	2. Seldom	3. Some-times	4. Often	5. Always	<input type="checkbox"/> 62
1. Never	2. Seldom	3. Some-times	4. Often	5. Always			
30. If you walk at home, what is your usual pace?	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; padding: 2px;">1.casual strolling</td> <td style="width: 25%; padding: 2px;">2. fairly brisk</td> <td style="width: 25%; padding: 2px;">3. brisk</td> <td style="width: 25%; padding: 2px;">4. fast</td> </tr> </table>	1.casual strolling	2. fairly brisk	3. brisk	4. fast	<input type="checkbox"/> 63	
1.casual strolling	2. fairly brisk	3. brisk	4. fast				
31. How long do you walk outside your home? (min)	_____	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 64-66					
32. At home I cycle? IF NO,GO TO QUESTION 35	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 2px;">Yes(1)</td> <td style="width: 50%; padding: 2px;">No(2)</td> </tr> </table>	Yes(1)	No(2)	<input type="checkbox"/> 67			
Yes(1)	No(2)						
33. If you cycle, what is your usual pace?	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; padding: 2px;">1.Casual cycling</td> <td style="width: 25%; padding: 2px;">2. Fairly brisk</td> <td style="width: 25%; padding: 2px;">3. Brisk</td> <td style="width: 25%; padding: 2px;">4. Fast</td> </tr> </table>	1.Casual cycling	2. Fairly brisk	3. Brisk	4. Fast	<input type="checkbox"/> 68	
1.Casual cycling	2. Fairly brisk	3. Brisk	4. Fast				
34. How long do you cycle?(min)	_____	<input type="checkbox"/> 69					
35.Do you climb stairs often? IF NO GO TO QUESTION 38	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 2px;">Yes (1)</td> <td style="width: 50%; padding: 2px;">No(2)</td> </tr> </table>	Yes (1)	No(2)	<input type="checkbox"/> 70			
Yes (1)	No(2)						
36. If yes, how many flights of stairs do you climb per day? (1 flight = 10 steps)	_____	<input type="checkbox"/> <input type="checkbox"/> 71-73					

37. How many days per week do you climb the steps?	_____	<input type="checkbox"/>	74		
38. Do you play sport? IF NO GO TO QUESTION 42	<table border="1"><tr><td>Yes(1)</td><td>No(2)</td></tr></table>	Yes(1)	No(2)	<input type="checkbox"/>	75
Yes(1)	No(2)				
39. IF YES which type of sport do you play?	_____	<input type="checkbox"/>	76-78		
40. How long do you practice per week?(min)	_____	<input type="checkbox"/>	79-81		
41. How many months per year?	_____	<input type="checkbox"/>	82-83		
42. Do you have leisure time?*	<table border="1"><tr><td>Yes (1)</td><td>No(2)</td></tr></table>	Yes (1)	No(2)	<input type="checkbox"/>	84
Yes (1)	No(2)				
43. IF YES, do you watch television during leisure time?	<table border="1"><tr><td>Yes (1)</td><td>No(2)</td></tr></table>	Yes (1)	No(2)	<input type="checkbox"/>	85
Yes (1)	No(2)				
44. Do you do other sitting activities?*	<table border="1"><tr><td>Yes(1)</td><td>No(2)</td></tr></table>	Yes(1)	No(2)	<input type="checkbox"/>	86
Yes(1)	No(2)				
45. IF YES, which type of activity?*	_____	<input type="checkbox"/>	87-88		
46. During leisure time, do you walk or do standing activities?*	<table border="1"><tr><td>Yes(1)</td><td>No(2)</td></tr></table>	Yes(1)	No(2)	<input type="checkbox"/>	89
Yes(1)	No(2)				
47. IF YES, how long per day? (min)	_____	<input type="checkbox"/>	90-92		
48. Do you have any other leisure time activities?*	<table border="1"><tr><td>Yes(1)</td><td>No(2)</td></tr></table>	Yes(1)	No(2)	<input type="checkbox"/>	93
Yes(1)	No(2)				
49. IF YES, which type? _____		<input type="checkbox"/>	94-95		
50. IF YES, how long per day ? (min)	_____	<input type="checkbox"/>	96-98		

*

NOTES TO THE INTERVIEWER

ITEM 43:

Sitting activities: watch tv, listen radio, reading, writing, knitting, needlework, playing cards, visiting friends

ITEM 45:

Standing activities: gardening, walking with friends, after work at your own home

LEISURE TIME:

Time after work when housework is finished.

APPENDIX F

Nutritional Health of Women (25-44yrs) in Mangaung, 2000

Medical examination

Name: _____

Respondent number: 1-3

Blood pressure: _____ 4-9

Chronic medication:

Yes (1)	No (2)
---------	--------

 10

(including birth control)

If yes, specify 1. _____

2. _____

3. _____

4. _____

11-
12
 13-
14
 15-
16
 17-
18

1. Are any of the following visible/tangible?

Jaundice	Yes (1)	No (2)	<input type="text"/> <input type="text"/> 19
Anaemia (Pale)	Yes (1)	No (2)	<input type="text"/> <input type="text"/> 20
Clubbing	Yes (1)	No (2)	<input type="text"/> <input type="text"/> 21
Cyanosis	Yes (1)	No (2)	<input type="text"/> <input type="text"/> 22
Glands	Yes (1)	No (2)	<input type="text"/> <input type="text"/> 23
Oedema	Yes (1)	No (2)	<input type="text"/> <input type="text"/> 24

2. Are there any cardiovascular abnormalities?

Yes (1)	No (2)
---------	--------

 25

If yes, specify

1. _____

26-
27

2. _____

28-
29

3. Are there any respiratory abnormalities?

Yes (1)	No (2)
---------	--------

 30

If yes, specify

1. _____

31-
32

2. _____

33-
34

4. Is there any abdominal pathology?

Yes (1)	No (2)
---------	--------

If yes, specify

1. _____

<input type="checkbox"/>	35
<input type="checkbox"/>	36-
<input type="checkbox"/>	37

2. _____

<input type="checkbox"/>	38-
<input type="checkbox"/>	39

Do you want to be informed of the results of your HIV/AIDS result?

Yes (1)	No (2)
---------	--------

<input type="checkbox"/>	35
--------------------------	----

Comments:

APPENDIX G



Technikon
Vrystaat • Free State • Foreistata

THE COMMUNITY OF NAMIBIA

This letter serves to inform the community of a research project titled “ The nutritional health of women (25-44 years) in Mangaung” that will be undertaken by the Technikon Free State, University of the Orange Free State and the National Research Foundation during 2000. The project is aimed at investigating the change from the traditional healthy diet to a more Western unhealthy diet. The influence of this change of diet on health will be determined.

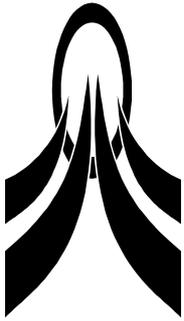
A random selection of 500 households in Bochabela, Phahameng, Joe Slovo and Namibia will be made to be included in the study. The women living in these households will be contacted by the community health workers and they will be asked whether they are interested in participating in the study. If they agree they will be fetched from Mangaung and taken to the Technikon for one day. No one will be forced to participate in the study.

On the day that they participate in the study a free medical examination will be done, blood will be drawn (including a HIV test), and they will be asked a number of questions about general background, what they eat, how active they are, and attitude towards health. None of the questions are difficult and anyone will be able to answer these questions.

The information will help to determine nutritional problems in women and to develop solutions for these problems. The project will benefit the community since we will be able to determine what interventions are required to improve the health of women in South Africa. The project will not cause any harm to the participants in any way. By participating in the research survey you will help other women in the country. The individual information will be kept strictly confidential. Women that participate will be paid an amount of R40.00 for their time. Please feel free to contact the community health workers at any time if you have any questions about the project.

DR CORINNA WALSH
PROJECT COORDINATOR

APPENDIX H



Technikon
Vrystaat • Free State • Foreistata

THE EMPLOYER

This letter serves to certify that _____ has been randomly selected to participate in a research project, undertaken by the Technikon Free State, University of the Orange Free State and the National Research Foundation on the _____ (date).

The project will investigate the nutritional health of women (25-45 years) living in Mangaung. The purpose of the project is to collect information on usual food intake, activity level, attitude toward health, as well as risk for developing diseases related to eating habits and life-style. The information collected will be used to determine nutritional problems and to develop solutions to these problems. The participant will be required to be available for the full duration of the day.

Your kind consideration is appreciated.

Die werkgewer

Hiermee word bevestig dat _____ gekies is om deel te neem aan 'n navorsingsprojek wat onderneem word deur Technikon Vrystaat, die Universiteit van die Oranje Vrystaat en die Nasionale Navorsings Stigting op die _____ (datum).

Die projek ondersoek die voedinggesondheid van vroue (25-45 jaar) wat in Mangaung woonagtig is. Die doel van die projek is om inligting te versamel oor gewoontelike voedselinname, aktiwiteitsvlak, houding teenoor gesondheid, sowel as risiko om siektes te ontwikkel wat verband hou met eetgewoontes en lewenstyl. Die inligting sal gebruik word om voedingsprobleme te identifiseer en om oplossings vir daardie probleme te ontwikkel. Die deelnemer sal die hele dag beskikbaar moet wees.

U goedgunstige oorweging word waardeur.

DR CORINNA WALSH
PROJECT COORDINATOR/ PROJEK KOÖRDINEERDER

SUMMARY

Human Immunodeficiency Virus infection causes Acquired Immune Deficiency Syndrome, which has caused millions of deaths, with more expected, particularly in developing countries like South Africa, where poverty is a critical factor.

The intake, digestion, absorption and metabolism of food and nutrients emerge as a vicious cycle. The undernourished HIV-infected individual develops micronutrient deficiencies, immunosuppression and oxidative stress, thereby accelerating disease progression. Symptoms include weight loss and wasting, with increased risk of secondary infections.

A representative sample of 500 African women (25-34 and 35-44 years) from Mangaung in South Africa's Free State Province participated in the study.

Socio-demographic composition and physical activity levels were determined by questionnaire. Weight, height, circumference (waist and hip) and bioimpedance measurements were used to calculate body mass index and fat distribution and percentage. Dietary intake was determined using a food frequency questionnaire, and nutrient intake was analysed. Biochemical nutritional status was determined through blood samples.

Socio-demographic characteristics indicated high unemployment rates. Significantly more HIV positive than HIV negative young women had lived in urban areas for over ten years, and smoked and/or used nasal snuff. Few young women had no education, while more older women had only a primary school or Grade 8-10 education. Significantly more younger and older HIV positive women headed their own households. No significant differences were found in housing conditions, room density and household facilities of younger and older HIV positive and HIV negative women.

Anthropometric results showed that approximately 50% of all women were overweight/obese. Most women had a gynoid fat distribution and were fat/obese according to fat percentage. However, young HIV positive women had significantly lower body mass index and fat percentage than young HIV negative women. The entire sample had low physical activity levels.

Median dietary intakes of energy, macronutrients and cholesterol were high, with young HIV positive women having a significantly higher median energy intake than young HIV negative women. Low median intakes of calcium, total iron, selenium, fat-soluble vitamins, folate and vitamin C, but high median intakes of the B vitamins, were reported overall. Younger women with HIV had significantly higher intakes of calcium, phosphorus, potassium, and vitamins B12, D and E than young HIV negative women. Older HIV positive women had significantly lower intakes of haem iron, nonhaem iron and selenium than older HIV negative women.

Although median values for most biochemical parameters were normal, younger HIV positive women had significantly lower median haemoglobin and haematocrit levels, while older HIV positive women had significantly higher serum ferritin and lower transferrin values than their HIV negative counterparts. Significantly more HIV positive younger and older women had low haematocrit values, while significantly more HIV negative older women had low serum iron and high transferrin concentrations. Compared to HIV negative women, younger and older HIV positive women had significantly lower median blood values for total lymphocytes and serum albumin, but significantly higher median blood levels of total serum protein. Plasma fibrinogen and serum insulin concentrations were significantly reduced in young HIV positive women. Older HIV positive women had significantly lower total serum cholesterol values than older HIV negative women. Serum glucose and serum triglycerides did not differ significantly between HIV positive and HIV negative women within both age groups.

In younger and older women, increased serum total protein and decreased serum albumin were associated with HIV infection. In younger women, smoking and being unmarried increase the odds of HIV infection, while in older women a higher education level and a decreased non-haem iron intake are associated with HIV infection.

An adequate diet, nutritional counselling and active physical activity can improve immune function, quality of life and biochemical nutritional status. Dietary intake alone, however, may be insufficient to correct nutritional deficiencies in this poor community, and the role of food-based approaches and micronutrient supplementation merits further attention.

Key words: South Africa; African women; HIV; socio-demographic status; anthropometry; dietary intake; physical activity; iron status; metabolic profile

OPSOMMING

Verworwe Immuniteitsgebreksindroom is die eindresultaat van infeksie met die Menslike Immuniteitsgebrekvirus. Miljoene mense het reeds vanweë die siekte gesterf, en die ergste word nog verwag. Alhoewel veelvuldige faktore tot infektering met die virus bydra, is armoede 'n kritieke faktor.

'n Vernietigende kringloop wat die inname, vertering, absorpsie en metabolisme van voedsel en voedingstowwe beïnvloed, ontstaan. Die ondervoede MIV-geïnfekteerde individu ontwikkel mikrovoedingstoftekorte, immuniteitsonderdrukking en oksidatiewe stres, wat die siekte aanwakker. Simptome soos gewigsverlies, met 'n verhoogde risiko vir sekondêre infeksies, kom algemeen voor.

'n Verteenwoordigende steekproef van 500 swart vroue (ouderdomsgroepe 25 tot 34 en 35 tot 44 jaar) van Mangaung, Bloemfontein is vir die studie gekies.

Sosio-demografiese samestelling en fisiese aktiwiteitsvlakke is deur middel van 'n vraelys bepaal. Gewig, lengte, middel- en heupomtrek en bio-impedansmates is gebruik om liggaamsmassa-indeks, vetpersentasie en vetverspreiding te bepaal. Dieetinname is deur middel van 'n voedsel-frekwensie vraelys bepaal en ontleed om voedingstofinname te bepaal. Bloedmonsters is versamel om biochemiese voedingstatus te bepaal.

Sosio-demografiese eienskappe het hoë werkloosheidsvlakke onder alle respondente getoon. Betekenisvol meer van die MIV-positiewe as MIV-negatiewe jong vroue was vir langer as tien jaar in 'n stedelike gebied woonagtig, en het gerook en/of gesnuif. Min jong vroue het geen skoolopleiding gehad nie, terwyl ouer vroue meestal slegs primêre skoolopleiding of Graad 8-10 gehad het. Betekenisvol meer van die MIV-positiewe vroue van albei ouderdomsgroepe was self hoof van die huishouding. Geen betekenisvolle verskille in behuisingstoestande, vertrekdigtheid en huishoudelike fasiliteite is tussen jonger en ouer MIV-positiewe en MIV-negatiewe vroue gevind nie.

Volgens antropometriese resultate en vetpersentasie-meting was ongeveer 50% van die respondente oorgewig of vetsugtig. Vetverspreiding was hoofsaaklik ginoid. Ten spyte hiervan was die liggaamsmassa-indeks en vetpersentasie van jong MIV-positiewe vroue betekenisvol laer as dié van MIV-negatiewe jong vroue. Fisiese aktiwiteitsvlakke van alle respondente was laag.

Mediaan dieetinnames vir energie, makrovoedingstowwe en cholesterol was hoog. Mediaan energie-inname van jong MIV-positiewe vroue was onverwags betekenisvol hoër as dié van MIV-

negatiewe jong vroue. Lae mediaaninnames van kalsium, totale yster, selenium, vetoplosbare vitamieë, folaat en vitamien C, gepaardgaande met hoë mediaaninnames van B-vitamieë, is deur die totale steekproef gerapporteer. Jong MIV-positiewe vroue het betekenisvol meer kalsium, fosfor, kalium, vitamien B12, D en E ingeneem. Ouer MIV-positiewe vroue het betekenisvol laer innames van heemyster, nie-heemyster en selenium as ouer MIV-negatiewe vroue getoon.

Alhoewel mediaanwaardes van die meeste biochemiese parameters normaal was, was mediaan hemoglobien- en hematokritvlakke van HIV-positiewe jong en ouer vroue betekenisvol laer, terwyl ouer MIV-positiewe vroue betekenisvol hoër serum ferritien- en betekenisvol laer transferriënwaaardes as MIV-negatiewe ouer vroue getoon het. Betekenisvol meer MIV-positiewe jong en ouer vroue het lae hematokritwaardes getoon, terwyl betekenisvol meer MIV-negatiewe ouer vroue lae serum yster- en hoë transferriënvlakke getoon het. Mediaan bloedwaardes van totale limfosiete en serum albumien van jong en ouer MIV-positiewe vroue was betekenisvol laer, maar betekenisvol hoër vir totale serum proteïen in vergelyking met waardes van MIV-negatiewe jong en ouer vroue. Plasma fibrinogeen- en serum insulienkonsentrasies was betekenisvol verlaag in MIV-positiewe jong vroue. Totale serum cholesterolwaardes van ouer MIV-positiewe vroue was betekenisvol laer as dié van MIV-negatiewe ouer vroue. Geen betekenisvolle verskille is vir serum glukose en serum trigliseriede tussen MIV-positiewe en MIV-negatiewe vroue gevind nie.

Verhoogde serumproteïen- en verlaagde serumalbumiënvlakke is in beide ouderdomsgroepe met MIV-infeksie geassosieer. Rook en 'n ongetroude status in jong vroue, en 'n hoër vlak van opleiding en verlaagde nie-heemyster inname in ouer vroue is met MIV-infeksie geassosieer.

'n Voldoende dieet, voedingsberading en aktiewe fisiese aktiwiteit is regverdigbaar ter verbetering van immuunfunksie, lewenskwaliteit en biochemiese voedingstatus. Dieetinname alleen mag egter onvoldoende wees om voedingstoftekorte in hierdie arm gemeenskap reg te stel. Die rol van voedselgebaseerde benaderings en mikrovoedingstofsupplementasie benodig verdere aandag.

