THE DIETARY INTAKES OF 10-15 YEARS OLD CHILDREN IN THE NORTH WEST PROVINCE

DISSERTATION SUBMITTED
IN PARTIAL FULFILMENT OF THE REQUIREMENT
FOR A
MATERS DEGREE IN CONSUMER SCIENCE

SCHOOL FOR
PHYSIOLOGY, NUTRITION AND CONSUMER SCIENCE

POTCHEFSTROOM UNIVERSITY FOR CHRISTIAN HIGHER EDUCATION

SUPERVISOR: Dr. H.S KRUGER
CO-SUPERVISOR: DR. U.E MACINTYRE

AUTHOR: HLAMALANI JUDITH NGWENYA
MAY 2002

OPSOMMING

Daar word aanvaar dat kinders se inname van voedsel gekoppel is met die ontwikkeling tot volwasenheid. Daarvoor is `n goeie fondasie vir bevordering en handhawing van` n gesonde lewenstyl gedurende die tiener-stadium belangrik. Die studie is gebaseer op die nutriëntinname van kinders tussen 10-15 jaar in die Noordwes Provinsie van Suid-Afrika.

Die Suid Afrikaanse voedsel-gebaseerde dieetriglyne is ontwikkel deur die SAFBDG werksgroep vir die verbetering van optimale voeding vir alle Suid-Afrikaners, 5 jaar en ouer. Hierdie riglyne is gebaseer op die voorstelle gemaak deur die Wêreld Gesondheid Organisasie (WHO). Die belangrikste kenmerke van die riglyne is dat hulle positief, prakties, beskostigbaar en kultureel sensitief moet wees.

Die skielike verandering wat plaasvind gedurende die tienerstadium noodsaak spesiale voeding vir hierdie ouderdomsgroep. Die verandering van leefwyse en eetgewoontes gedurende hierdie stadium affekteer beide voedelinname en behoeftes. Die tieners se keuse van voedsel word beinvloed deur kultuur, fisologiese sowel as tegnologiese faktore. Vir tieners om optimale gesondheid te behou, moet hulle dieetinname volgens die voorgestelde dieettoelating (RDA) vir hulle ouderdom en geslag wees.

`n Groep van 725 kinders tussen die ouderdom 10-15 jaar in die Noordwes Provinsie van Suid-Afrika is uit verskillende skole gekies om deel te neem in die studie. Van die totaal was 52.2% swart, 25.4% blankes, 11.4% Indiërs en die oorblywende 11.1% was Kleurlinge. Die ondersoekprosedure sluit dieetopnames met behulp van die 24-uur herroep metode en die analise van die data in.

Die resultate van hierdie studie toon aan dat, meer kinders 'n inname van minder as die voorgestelde vlak vir hulle ouderdom en geslag van belangrike nutriënte het. Die inname van die volgende nutriënte was minder as die voorgestelde vlak vir al die ouderdomsgroepe vir seuns en dogters: kalsium, yster, fosfor, magnesium, vitamiene A, D, E en C, folien suur, biotien, pantoteensuur, sink en kopper.

Die resultate toon ook `n swak meewerkenheid van die dieetinname van die kinders in die studie met SAFBDGs. Voorstelle wat sal help om die huidige situasie te verbeter is in hierdie skripsie ingesluit. Van die mees belangrike voorstelle wat gemaak is, is dat voedingvoorligting voorsien moet word vir die kinders deur voedingopvoedingsprogramme. Die Primêre Skool voedingsprogram kan verbter word om dieetvariasie en kwaliteit van voedsel wat gebruik word, te verbeter. Hierdie voedsel moet verkieslik geselekteer word uit die voedselgroepe waarvan die kinders van hierdie studie lae innames het, naamlik vrugte en groente. Snoepwinkels by skole moet gemonitor word om seker te maak dat gesonde en vars happies verkoop word vir die kinders wat geld skool toe bring.

Die resultate van hierdie studie moet bekendgestel word aan die publiek en gesondheidswerkers, sodat die gesondheid en welvaart van die kinders in die Noordwes Provinsie van Suid-Afrika verbeter kan word.

ABSTRACT

It is widely accepted that childhood nutrition is linked with the occurrence of certain diseases in adulthood. It is therefore important to lay a good foundation for prevention, by promoting and maintaining healthful life-style during the adolescence stage. This study aims at examining the dietary intake of the children aged 10-15 years in the North West Province of South Africa and compares it with the South African Food Based Dietary guidelines.

The South African food-based dietary guidelines (SAFBDGs) were developed by the SAFBDG working group in order to promote optimal nutrition for all South Africans 5 years and above. These guidelines were based on the recommendations made by World Health Organisation. The major character of the guidelines is that they should be positive, practical, affordable and culturally sensitive.

The sudden changes that occur during adolescence create special nutritional needs for this age group. This stage is considered especially vulnerable nutritionally because there is an increased demand for nutrients related to dramatic increases in physical growth and development. The change of life-style and food habits during this stage also affects both nutrient intakes and needs. The adolescents' choice of food is influenced by cultural, psychological as well as technological factors. For adolescents to maintain optimal health, they should follow the recommended dietary allowance (RDA) for their age and gender.

A group of seven hundred and twenty five (725) children aged 10-15 years in the North West Province of South Africa was randomly sampled to participate in this study. Of the sample, 52.1% were blacks, 25.4% were whites, 11.4% were Indians and the remaining 11.1% were coloureds. The survey procedure included the collection data using the 24-hour recall, coding and the analysis of data.

The findings of this study indicated that on the nutrient intakes, more children had intakes of less the than recommended level for their age and gender for a number of important nutrients. The mean intakes of the following nutrients were below the recommended level in all the age groups and gender: calcium, iron, phosphorus, magnesium, vitamin A, vitamin D, vitamin E, vitamin C, folic acid, biotin, pantothenic acid, zinc and copper.

The findings also indicated an extremely poor compliance of the dietary intake of the children in the study with the South African food based dietary guidelines. Making recommendations that would help improve the current situation concluded this section. Some of the most important recommendations made were that nutrition information be provided to children through nutrition education programmes; the current menus of the primary school nutrition programs are reviewed with a view to improve dietary variety and quality of food used; these foods should preferably be selected from the food groups in which the children of this study had low intakes; this includes fruit and vegetables; tuck-shops at schools should be monitored in order to ensure that healthy and nutritious snacks are sold to those children who bring money to school

and lastly, the key findings of this study need to be widely disseminated to the public and health workers in order to increase awareness of the level and nature of food and nutrient insecurity together with its effect on the health and well being of the children in the North West Province of South Africa.

ACKNOWLEDGEMENT

A useful dissertation is never the work of one person. It develops into a planned product through the dedication and committed hands and hearts of a number of people. It will be impossible to name all individuals who were involved in this study, but several people deserve special recognition. Firstly, my heartfelt gratitude goes to God my Creator for having made me such a precious and a unique human being, capable of realizing my own potential. Secondly, my utmost thanks and appreciation goes to the Department of Nutrition - Potchefstroom University for Christian Higher Education (PU for CHE) for having awarded me an opportunity to do this study, without their help this dissertation would never have been started and most definitely, never have been completed.

Thirdly, words cannot begin to express how thankful I am to Dr.H.S Kruger for believing in me. When my enthusiasm waned and the project seemed to be just too large and complicated ever to be completed, her words and attitude gave me an enormous encouragement, which provided me with the drive to carry on. I also thank her for proof reading my original text and for her many useful suggestions on how to improve it, and the kindness, encouragement and sensitivity with which she offered this. Thank you.

Fourthly, my thanks go to the THUSABANA team. Dr. Hans De Ridder for directing the project in a professional manner and sense of humour, Theo Nell and Conrad Greer, for coordinating the project. To the fieldworkers, Shamima, Shireen, Rashida, Khalala, Dorothy, Suzan, Winnie and Alleta as well as the third and fourth year Dietetic and Nutrition students of PU

for CHE of 2000. Thank you so much for assisting with the collection of data. Special thanks also go to all the participating schools in the North West Province for allowing us to conduct this study.

I also wish to extend my heartfelt gratitude to the statistician, Prof. H.S Steyn for assisting in the statistical analysis of the data.

Last but not least, I want to thank my family. My father Ntlaweni, my mother Alda, my sisters Masingita, Rirhandzu, Nkhensani, Khongoteli, my brother Nchongi as well as my brother-in-law Nathaniel. These beautiful people never cease to provide their loving support for all my work, and to each one of them I am eternally grateful.

Table of content

Table of content continued

CHAPTER 4:EMPIRICAL STUDY

CHAPTER 5:RESULTS, DISCUSSIONS AND RECOMMENDATIONS

ADDENDUM

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

PU for CHE - Potchefstroom University for Christian higher education

SAFBDGs - South African food based dietary guidelines

FBDGs - Food based dietary guidelines

SAVACG - South African vitamin A consultative group

CHD - Coronary heart disease

RDA - Recommended dietary allowance

USA - United States of America

NIDDM - Non-insulin dependent diabetes mellitus

BMI - Body mass index

BED - Binge eating disorder

NES - Night eating syndrome

CHO - Carbohydrate

Kcal - Kilo calories

KJ - Kilojoules

WHO World Health Organisation

FAO Food and Agriculture Organisation

1

INTRODUCTION AND PROBLEM STATEMENT

1.1 Introduction

It is well recognized that nutrition is very important for normal physical, mental and psychological development of children and fundamental for their future health. Recent studies have focused on the correlation between various risk factors established during childhood and subsequent adult diseases (Roma-Giannikou *et al.*, 1997). Many investigators believe that eating habits are established in childhood and remain almost unchanged throughout a person's life (Boulton, 1985; Sub-committee on Nutritional Surveillance, 1989; Oliveira, 1992).

Newman *et al.* (1986) indicated that dietary assessment of children is important because many diet associated chronic diseases of adulthood originate in childhood. More accurate assessment of children's diets could increase awareness of changes needed to help establish healthful eating habits in children that would decrease the risk of chronic diseases in adults. In the light of growing evidence indicating an association between dietary patterns during childhood and increased risk of development of chronic disease many organizations have established nutrition guidelines specifying increasing or decreasing the consumption of certain food or nutrients to reduce the risk (Ganji *et al.*, 1995).

1.2 Motivation, aim and objectives of the study

It is now widely accepted that childhood nutrition is linked with the occurrence of specific diseases such as cancer, obesity and risk factors of cardiovascular disease during adulthood. As these links become evident, researchers are becoming more aware of the necessity for monitoring and reporting children's overall nutrition patterns. To help decrease the prevalence of chronic conditions such as heart disease, cancer, diabetes, and obesity in Americans, governmental and nonprofit agencies have promoted healthy eating habits (Mahan & Escott-Stump, 2000). The current study therefore aims to compare the dietary practices of children between the ages of 10-15 years in the North-West Province of South Africa with the (SAFBDGs). The objectives are to: -

- Examine the eating habits of the above-mentioned age group.
- Compile a detailed analysis of the children's nutrient intake.
- Compare their dietary intake with the SAFBDGs, and finally
- Make dietary recommendations, which will be user-friendly and practical for all age groups in the North West Province, because it is a province with a wide diversity of culture and food consumption patterns.

1.3 Why children aged 10-15 years.

Various studies on childhood nutrition have been conducted in South Africa. The South African Vitamin A Consultative Group (SAVACG) concentrated on children from the age of six months to six years. The National Food Consumption Survey included the children of one to nine years, and the THUSA study paid attention to the children between the ages of 15 to 18. Little attention has previously been paid to the nutrition of the children between the ages of 10 to 15 years, hence, they were chosen for this study.

The age between 10 to 15 years is the beginning of an adolescent state. According to Wang *et al.,* (1998), adolescents comprise 20 % of the global population, and about 80 % of them live in developing countries. During this period of growth and maturation, children gain a certain percent of their adult height and weight. Sexual maturation and the shift towards independence make this an important period (Wang *et al.,* 1998).

Adolescents are not only maturing physically, but also cognitively and psychosocially. They search for identity, strive for independence and acceptance, and are concerned about appearance. Irregular meals, snacking, eating away from home, and following alternative dietary patterns characterize the food habits of adolescents (Mahan & Escott-Stump, 2000). Health habits and beliefs established during this age are among the most crucial, because it can have a profound effect on a person's lifestyle and health status in adulthood (Elder & Hui, 1993).

It is therefore, very important at this stage to lay out a foundation for prevention, by promotion and maintenance of healthful life-style. Hence, this period represents a period of peak concern.

1.4 Hypothesis

The following hypothesis has been formulated: The dietary intake of the children aged 10-15 years in the North West Province does not comply with the SAFBDGs.

1.5 The structure of the dissertation

The dissertation consists of five chapters, which are organised as follows: -The introductory chapter, which is chapter one. Chapter two and three consist of a review of relevant literature. The literature to be reviewed for this study will cover the following topics: growth and development of adolescents; the nutritional requirements of adolescents; and the nutrition related problems. Chapter four will focus on the methods that were used in conducting the study; this includes the design of the study,

the selection of sample population, ethical consideration, organisational procedures, measuring procedures and tools, as well as quality control.

The results and discussion of the study, as well as the recommendations will be discussed in chapter five. The structure of the dissertation is summarized in figure 1.1

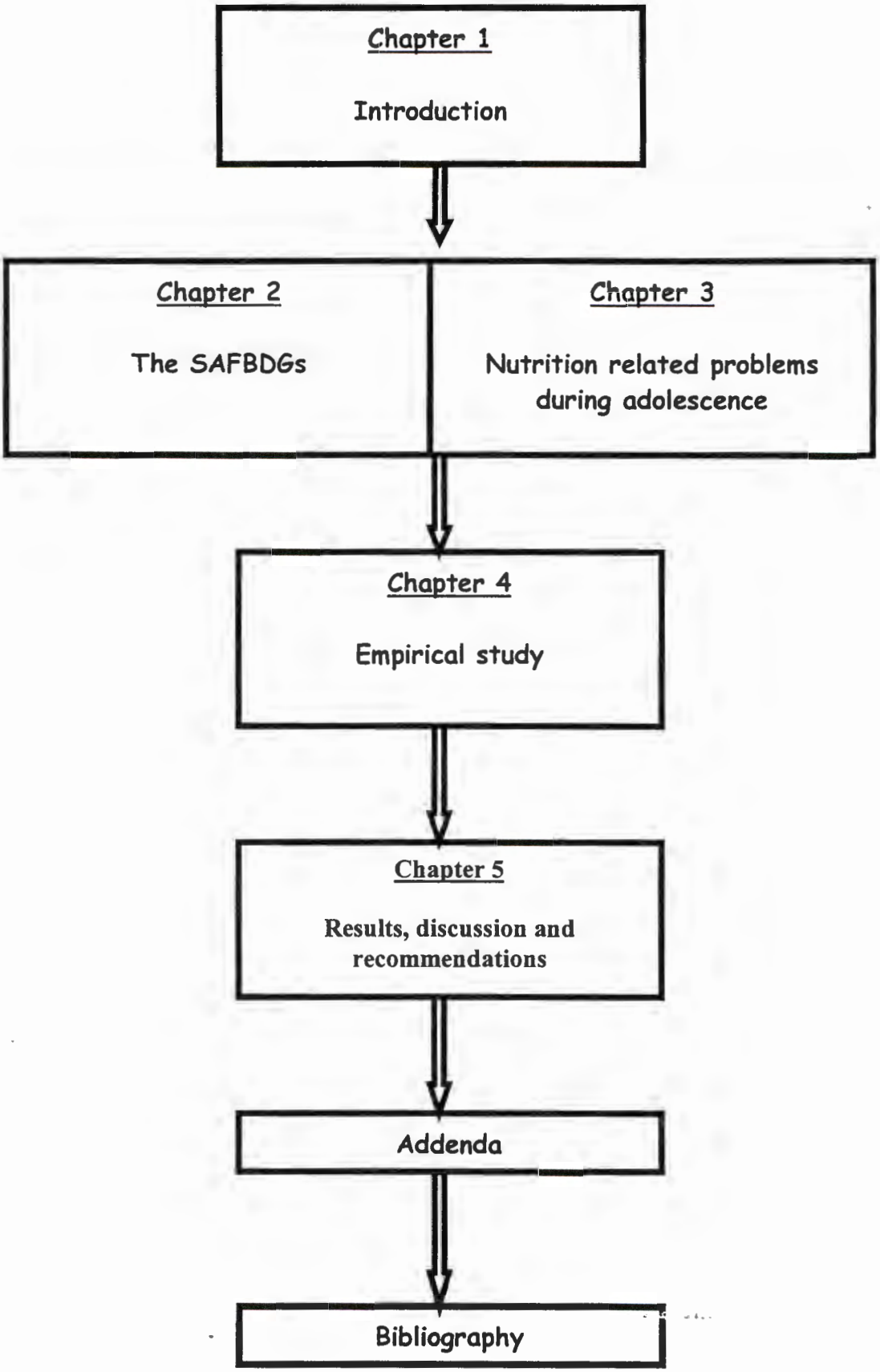


Figure 1.1 The structure of the dissertation

2

LITERATURE REVIEW:

THE SOUTH AFRICAN FOOD-BASED DIETARY GUIDELINES (SAFBDGs)

2.1 Introduction

Since the international meetings of the World Health Organization (WHO) and the Food and Agricultural Organization (FAO) held in Cyprus in 1995 (Vorster *et al.*, 2001), SAFBDGs have become the nutrition buzzwords of the decade. After decades of promoting food groups, nutritionists have now succumbed to guidelines (Gibney & Vorster, 2001). In nutrition education and intervention programmes, the use of a food based dietary approach is becoming more popular, substituting the well known and long used food groups, which emphasize the nutrients more (Gibney & Vorster, 2001).

The massive global burden of dietary-related diseases and the growing perception that nutrient-based dietary guidelines are not effective in promoting appropriate diets and healthy lifestyles have motivated a number of countries and regions to develop food-based dietary guidelines (Gibney & Vorster, 2001). South Africa is no exception.

In 1997, a South African (FBDG) Working Group was established to develop a core set of (FBDGs) (Smale-Lovely *et al.*, 2001). This Working Group should be commended for developing one set of guidelines aimed at optimal nutrition for all South Africans 5 aged years and older (Gibney & Vorster: 2001). The SAFBDGs were based on existing eating patterns and are commensurate with the various South African dietary cultures. Clearly, the dietary guidelines demonstrate the striving towards equity in diet and health, aiming to optimise nutritional status in both disadvantaged and affluent communities (Gibney & Vorster: 2001).

Indicated below in Table 2.1 are the positive, practical, affordable, sustainable and culturally sensitive food-based dietary guidelines (FBDGs) to help South Africans over 5 years of age to choose an adequate but prudent diet (Vorster *et al:* 2001). The guidelines consist of 10 short, clear and simple messages, which have been tested for comprehension, appropriateness and applicability in consumer groups of different ethnic backgrounds in both rural and urban areas. It was found that people could translate these guidelines from the English version without modifying the meaning to any one of the eleven official languages in the country to make it more understandable (Vorster *et al:* 2001).

Table 2.1 South African Food Based Dietary Guidelines (Vorster *et al.*, 2001)

Enjoy a variety of foods
Be active
Make starchy foods the basis of most meals
Eat plenty of fruits and vegetable every day
Eat dry beans, peas, lentils and Soya often.
Food from animals can be eaten everyday
Use fat sparingly
Use salt sparingly
Drink a lot of clean, safe water
If you drink alcohol, drink sensibly

Vorster *et al.*, (2001) made the following recommendations about the above-mentioned guidelines: -

- The guidelines should be adapted for groups with special dietary needs.
- The guidelines could or should be used in the Integrated Nutrition Program and they could form the basis on Nutrition education in South Africa.
- The guidelines should be regularly reviewed, based on their impact and changes in South African society due to socio-economic transition and as new knowledge of nutrition-health relationships become available.

2.2 The value of SAFBDGs

There are a number of reasons for developing the food-based dietary guidelines. Diets are made up of food, which are more than a mere collection of nutrients. People with little or no education think in terms of food and not in terms of nutrients. Therefore, when talking about food instead of nutrients, people are more likely to follow irrespective of their educational background. Unlike nutrients, food and diets have cultural, ethnic and social meaning, which can be incorporated into the FBDGs.

2.3 Characteristics of the SAFBDGs

As mentioned earlier, FBDGs should be based on locally consumed foods. They should address existing nutrient deficiencies and excesses, and the resulting nutrition-related public health problems of a specific country or community. Below are some of the characteristics of the FBDGs based on the FAO/WHO (1996) recommendations.

- Each guideline should have only one, easy, simple understandable message. Guidelines should be formulated or illustrated in such a way that people from different cultures and literacy backgrounds will grasp the meaning.
- It should be 'user-friendly' and not confusing.

- It should be formulated in a positive way. No negative message using words such as avoid, decrease, limit, cut out or eat less, should be used. The FBDGs should not create guilt feelings about, or negative association with foods.
- It should be compatible with different cultures and eating patterns of the target populations.
- It should be based on affordable, available foods, which are widely consumed.
- It should be sustainable.
- It should encourage environmentally friendly agriculture.
- It should lead to selection of foods that are usually eaten together- in groupings that are compatible with existing dietary practices.
- It should address both over- and under-nutrition. It should help people to choose the most appropriate diet they can afford. Encourage undernourished people to choose a more adequate and overnourished people to choose a more prudent diet.
- It should emphasise the joy of eating.
- It should be formulated and communicated to the target population using marketing skills based on the knowledge, perception, attitudes and behaviours of the target population.

2.4 Analysis of the South African food-based dietary guidelines (SAFBDGs).

'Enjoy a variety of foods'

'Enjoy a variety of foods' is the first of the ten South African food-based dietary guidelines (SAFBDGs). This guideline attempts to focus on some of the consequences arising from a lack of dietary variety (Maunder *et al.*, 2001). This guideline therefore, aims at encouraging diversification, with the belief that the more dietary variety one has, the better the possibility of attaining optimal nutrition.

For both consumers and nutritional scientists, variety is conceptualised as including different foods and different food groups as part of the diet, as well as altering the

method of food preparation (Maunder *et al.*, 2001). In their paper "Enjoy a variety of foods-difficult but necessary in developing countries" Maunder *et al.*, (2001) indicated a number of potential problems, which may arise in implementing this guideline, namely: -

- The high level of household food insecurity in South Africa could be a constraint.
- The recommendation of increasing dietary variety could be misinterpreted as increasing the number of processed foods, which in the urban context at least, could lead to an increase in the consumption of processed foods of poor micronutrient and phytochemical content.
- Increasing dietary diversity could lead to an increased dietary energy intake, thereby exacerbating the increasing prevalence of obesity in certain sections of the South African population.

'Be active'

South Africa is a country of many contrasts, in which various communities are undergoing rapid epidemiological, nutritional and demographic transition (Vorster *et al.*, 1999; Lambert *et al.*, 2001). As the consequences of this transition, chronic diseases of lifestyle coexist with communicable disease associated with undernutrition and lower socio-economic conditions (Lambert *et al.*, 2001). A survey conducted on transitional African communities in the North West Province of South Africa demonstrated that inactivity, independently of the degree of urbanisation was associated with increasing obesity levels (Kruger *et al.*, 1999).

It is a general and widely understood message that regular physical activity is health promoting. This statement is concurred by Lambert *et al.*, (2001) when they indicated that the guideline 'Be active' is based on the now-well established link between physical activity and lowered risk of all-cause mortality, as well as mortality and morbidity associated with many chronic diseases of lifestyle.

'Make starchy food the basis of most meals'

The guideline 'Make starchy food the basis of most meals' is aimed at 'optimum' intakes of cereals and grains such as maize, wheat, sorghum, oats and rice in the form of porridges, bread, pasta, rice, samp, maize rice, breakfast cereals and other products (Vorster & Nell, 2001). Make starchy food the basis of most meals suggest that in planning of meals, the starchy food should be the central or the main food, and the rest of the meal planned around this food. This guideline is easy to live with for the majority of South Africans because starch is their staple food, particularly the poor living in rural areas.

Starchy foods are the main source of carbohydrates. There is a lot of convincing evidence that support the importance of this guideline. FAO/WHO (1997) indicated that carbohydrates are the most important source of energy in the world, providing 40-80% of the total energy intake, influenced by geographical location, cultural considerations and economic status. In addition to being the main provider of dietary energy, carbohydrate functions as sweeteners, making the diet more palatable. Further more, it influences the satiety mechanism in the control of food intake. The dietary fibre components, moderate digestion and absorption of the other nutrients in the small bowel and together with digested starch form the major substrate for microbial formation in the large bowel, influencing bowel habits, metabolism and health (FAO/WHO, 1997).

The guideline 'Make starchy food the basis of most meals' has a sound scientific base. It is supported by convincing results from epidemiological observations, clinical intervention studies and extensive experimental work on the mechanism of how foods and their carbohydrate constituents influence health and prevent disease (Vorster & Nell, 2001). This guideline is positive, practical, affordable and culture sensitive.

'Eat plenty of vegetables and fruits everyday'

In their paper 'Eat plenty of vegetables and fruits everyday' Love and Sayed, (2001) indicated that throughout the history, civilisations across the world have recognised the use of plant material to improve health. Today, eating more vegetables and fruits for better health is a concept with which most of the general public is familiar. However, only in the recent times, with new research findings, have we begun to understand the mechanisms of action of vegetables and fruits in health promotion and disease prevention (Love & Sayed, 2001).

Vegetables and fruits are the main sources of many vitamins, minerals, fibre and other substances. Therefore, 'Eating plenty of vegetables and fruits everyday' is an ideal way of overcoming micronutrient deficiencies, providing antioxidants and ensuring a diet high in fibre. This guideline does not specify amounts, but puts more emphasis on variety and frequency.

Although aware of the health benefits of eating plenty of vegetables and fruits everyday, Love *et al.*, (2001) as participants of the South African Food-Based Dietary Guideline Consumer Study conducted in KwaZulu-Natal and the Western Cape provinces indicated a number of constraints, namely:

- Among black rural, informal urban and formal urban dwellers, affordability (lack of household income) was cited as a primary constraint on compliance with this guideline. Cost was not mentioned as a constraint among Indian and white urban formal groups.
- For all groups (black, coloured, Indian and white), fruit consumption was strongly related to availability and highly contingent on seasonal fluctuations.
- In terms of household taste preferences, all groups stated that most resistance to vegetable and fruit consumption came from children and, in some cases, the men in the household (Love *et al.*, 2001).

Similar barriers to the consumption of fruits and vegetables were also highlighted in the study among low income, multi-ethnic worksite groups in the USA, namely: Perishability, inconvenience, cost, storage difficulties, preparation time, taste dislike, poor availability and difficulty in changing the old habit (Cox *et al.*, 1996; Cohen *et al.*, 1998).

'Eat dry beans, peas, lentils and soy often'

The guideline 'Eat dry beans, peas, lentils and soy often' aims to improve the overall health of all South Africans (Venter & van Eyssen, 2001). Dry beans, peas, lentils and soy are known as legumes. People have grown and used legumes as a dietary staple since early biblical times long before modern nutrition researchers endorsed their significant health virtues (Geil & Anderson, 1994).

Legumes are unique foods because of their rich nutrient content, including starch, vegetable protein, dietary fibre, oligosaccharides, phytochemicals and minerals (Venter & Van Eyssen, 2001). Their carbohydrate and dietary fiber contents contribute to their low glycaemic indices, which benefit diabetic individuals (Jenkins *et al.*, 1991), and reduce the risk of developing diabetes mellitus (Salmeron *et al.*, 1997). Soy protein is now regarded as a complete protein, with a protein digestibility-corrected amino acid score of one, which is equivalent to that of egg albumin (Young, 1991). The dietary fibre components include both soluble and insoluble fibre, which have many health benefits (Anderson *et al.*, 1990). Finally, the minerals in legumes are important in reducing the risk of hypertension (Appel *et al.*, 1997).

From the above discussion of the nutrient content of legumes, it is clear that their contribution of protein, carbohydrate and micronutrients will contribute to address undernutrition (Venter & van Eyssen, 2001).

'Food from animals can be eaten everyday'

The guideline 'Food from animals can be eaten everyday' was formulated to indicate that animal foods have a place in a healthy, balanced diet, but that carefully chosen vegetarian diets can also be adequate without these foods (Scholtz *et al.,* 2001).

Foods from animals as stated in the guideline, include milk and its products such as yogurt and cheese; fish, both fresh and tinned; eggs; and meat, both red meat and chicken. These foods contribute valuable nutrients to the diet, preventing undernutrition, especially iron deficiency anemia, calcium and zinc deficiencies.

This guideline may be difficult to achieve in some population groups and substantial nutrition education of consumers would be necessary to change behaviours so that these foods are consumed in the recommended quantities to ensure optimal and adequate, but prudent dietary intakes (Scholtz *et al.,* 2001).

'Eat fat sparingly'

Dietary fat plays an important role in the health and functioning of the human body, but over consumption is linked with coronary heart disease (CHD), obesity, cancer such as breast, colon and prostate cancer (Bray & Popkin, 1998; Lewis & Yetley, 1999).

A review of the nutritional status of South Africans from 1975 to 1996 (Vorster *et al.,* 1997) showed that total fat intake in white, coloured and Indian South Africans exceeded the recommended 30% of energy, while blacks had low fat intakes, urban blacks were found to be following diets higher in fat than the rural diet, although less than 30% of energy. According to Wolmarans and Oosthuizen (2001) the guideline 'Eat fat sparingly' is therefore aiming at lowering fat intakes, especially of saturated fatty acids (SFAs), among those who follow a typical Western diet high in fat, and

control fat intake for those following a diet low in fat (Wolmarans & Oosthuizen, 2001).

'Eat salt sparingly'

Ecological studies have demonstrated an association between average salt consumption and blood pressure levels in populations with differing lifestyles (Law *et al.,* 1991). In South Africa, it is estimated that about 3.3 million people are hypertensive (defined as blood pressure > 160/95 mm Hg and/ or on antihypertensive medication) (Dept. of Health, 1999).

Despite the controversial issues surrounding the salt-hypertension relationship, strong evidence does point to the validity of restricting salt intake to lower blood pressure, (Charlton & Jooste, 2001).

2.5 Summary

The South African Working Group is commended for developing the FBDGs. The challenge which faces the South African nutritional professionals is to ensure that the guidelines be implemented within the context of high household food insecurity and increasing urbanisation. South African nutritionists have an advocacy role in ensuring that these FBDGs receive sufficient media and political exposure to be incorporated into health policy. They also have an educational role in ensuring that all professionals in public health understand the potential of the guideline to help improve dietary intakes, nutritional status and health, and in the prevention of diet-related diseases (Gibney & Vorster, 2001).

3

LITERATURE REVIEW: NUTRITIONAL REQUIREMENTS OF ADOLESCENCE

3.1 Introduction

Adolescence is one of the most challenging periods in human development. This is the period when one experiences changes in weight, height and secondary sexual development, which vary from individual to individual and between males and females. Because of the extent of the physical and psychological changes taking place, a number of important issues arise that influence the nutritional well-being of the teenager (Mahan & Arlin, 1992). It is therefore very important to know the development process of adolescents in order to understand the nutritional aspects of life in this stage.

The adolescent is considered especially vulnerable nutritionally for several reasons:

- There is an increased demand for nutrients related to the dramatic increase in physical growth and development.
- The change of life-style and food habits of adolescents affects both nutrient intakes and needs.
- There are special nutrient needs associated with participation in sports, development of eating disorder, excessive dieting or other situations common to adolescents (Spear, 1996).

3.2 Growth and development

3.2.1 Physiological

Adolescence is a period of maturation for both mind and body. Physiological changes of adolescence are referred to as puberty, and their result is the capacity to reproduce (Alford & Ekvall, 1994). This process of changing from childhood to adulthood is initiated by physiological factors and includes maturation of the total body (Mahan & Escott-Stump, 2000). The adolescent gains about 20% of adult height and 50% of weight during this period. This growth continues throughout the approximately 5 to 7 years of pubertal development (Mahan & Escott-Stump, 2000).

3.2.2 Social and psychological changes

Along with the physical growth of puberty, emotional and intellectual development is rapid. Sociologically, a child is becoming an adult with the resultant rejection of authority and assumption of independence. During this stage, adolescents gain the ability to use abstract thinking as opposed to the concrete thought patterns of childhood. Seeking peer group acceptance is a high priority as the young adolescent begins to move away from home and the parental authority. The emotional turmoil of this stage commonly affects adolescents' eating habits. For example, the drive towards independence often results in temporary rejection of the family dietary pattern (Mahan & Arlin, 1992).

The major psychological task at this stage is the establishment of an identity and an adult personality. Development of self-image is related to both social and physical growth. The adolescents' sense of worth may be derived from feelings about their own physical attributes. Desire to change rate of growth or proportion can lead adolescents to dietary manipulations that may have negative consequences and are subject to exploitation by commercial interest (Mahan & Arlin, 1992).

3.3 Why adolescents eat what they eat

A level of physical and emotional growth, which often results in stress and anxiety, marks adolescence. The question why adolescents eat what they eat is rather complex, involving social, cultural, economic aspects as well as technological changes. All these affect one's nutritional behaviour (WHO, 1997).

3.3.1 Cultural influence on food intake

Culture affects both food intake and physical activity pattern. Cultural behaviour and beliefs are learned in childhood, are often deeply held, and are seldom questioned by adults who pass this knowledge to their offspring (WHO, 1997). Cultural factors are among the strong determinants of food choice. These include peer group pressure, social conventions, religious practices, status value afforded to different foods, the influence of other members of the household and individual life-style. Human beings value food for a lot more than its nutrient content and food is used to express relationships between people as well as celebrating religious festivals, weddings and other important social occasions. In some cultures, high-fat meals are provided for entertainment and celebrations. (WHO, 1997)

3.3.2 Psychological factors and food consumption

In recent years the effects of psychological factors on consumption of particular foods have received much attention. Eating to satisfy needs other than hunger forms the basis for the psychological influence on food intake. Many people eat certain food, as

a response to their initiated needs, which are psychogenic. Psychogenic needs include the ego bolstering "social status items" and ego-defensive needs "such as food considered essential for good health" (Burk, 1961). Beliefs that result in nutrient inadequacies are common in adolescents. For example, concerns that certain foods will aggravate acne or will make one gain weight are additional contributors to poor nutrition (WHO, 1997).

Some people overeat as a response to or compensation of frustration, tension, anxiety, and other emotional stress (Crisp & McGuiness, 1975; Plutchik, 1976). Chenault (1984) associates the development of severe obesity in children with some fairly clear-cut patterns in family behaviour. The families with obese children (obesogenic families) usually use food as their main source of comfort, reward of good behaviour and relief of distress. In these cases, a child learns to eat in response to external rather than internal reasons. Normally, eating is the appropriate response to the internally generated sensation of hunger. For a person who has grown up in an obesogenic family setting, however, eating becomes a learned response to a huge battery of external cues, which are unrelated to appetite or body's need for fuel. One eats to reward oneself for achievement "have another, you deserve it"; to avoid feeling of guilt "mother's fixed your favourite cake and you can't even eat the whole slice"; and to comfort for any hurt or failure, including depression one feels about being fat and unattractive (Chenault, 1984).

3.3.3 Technological changes and food consumption

Technological advances in cultivating, preserving, producing, transporting and storing of food have increased the availability of a wider variety of foods to a larger number of people year round. Advances in food technology have also contributed to the consumption of diets, which are increasingly dependent on processed foods. Some technological changes on the supply of food may have a fairly direct effect on the demand for food. This is particularly true of changes in marketing processes and institutions, which can greatly influence consumer acceptance (Burk, 1961). The development of new products influences the demand for alternative products. Some

technological changes affect demand more directly by changing ways of living and eating.

The development of new non-food items may decrease the relative importance of food consumption to adolescents. Children from low-income families might be particularly susceptible to the promotion of these new products since they are more affordable than real foods (Burk, 1961).

3.4 Nutritional requirements for adolescents

Popular opinion is that nutrient requirements are high for this group because of the growth spurt, extra activity and decreased rest. Because adolescents' growth is considered in terms of their age as well as physical maturity, the recommended dietary allowances (RDA) are therefore stated for different age groups. The RDA's have been updated on a number of occasions and undoubtedly have served as useful guidelines for individuals, institutions, populations and population subgroups. Their original objective as stated by the Vitamin Information Center (1999) is to provide standards to serve as a goal for good nutrition. Below are the nutrient requirements during indolence.

3.4.1 Macronutrients

- ***Energy***

The recommended range of energy intakes for adolescents as shown in table 3.1 reflects the different needs of teenagers. As with other nutrients, the RDA for energy does not include a safety factor for increased energy needs (e.g. during periods of illness, trauma or stress). and thus are considered to be only average needs (Mahan & Escott-Stump, 2000). Growth rate as well as the level of exercise will always influence the needs of individuals. Because of the marked variation in energy expenditure for both boys and girls, recommendations must be individually adjusted.

➢ *Protein*

During adolescence, protein needs, like those of energy, correlate more closely with the growth pattern that with chronological age (Mahan & Escott-Stump, 2000). Current recommendations specify that protein intake should make up to 7 to 8% of the total energy consumed (Mahan & Arlin, 1992). The range of total protein intake for an adolescent is from 45 to 59 grams per day.

3.4.2 Micronutrients

Micro nutrients are defined by Olmedilla and Granado (2000) as a group of dietary constituents characterized by the low amounts in which they are found in the diet, but which nevertheless are the key to optimal macro-nutrient metabolism, and by the interdependent role of many of them in metabolic functions. Micronutrients are essential for growth and development, utilization of macronutrients, maintenance of adequate defenses against infectious diseases and for many other metabolic and physiological functions (WHO, 1996). The micronutrients classically considered as essential comprise just 13 vitamins and around 16 minerals, although our diet includes a multitude of other compounds, some of which most likely, but not definitely, are responsible for actions that are beneficial to the human body (Olmedilla & Granado, 2000). In this study the focus will be on the micronutrients in relation to the needs throughout adolescence, a period which is described by Lachance (1998) as involving growth and development that occur through a complex interaction of genetic instructions, hormones and environmental influence, most of them of dietary origin.

➢ *Vitamins*

There are less data on vitamin requirements for adolescents than on minerals. However, vitamins are essential nutrients that are needed in tiny amounts in the diet of both adolescents and adults to both prevent deficiency diseases and support optimal health (Whitney *et al,* 1998) The human body needs both water-soluble (vitamin B-complex and vitamin C) and fat-soluble vitamins (A, D, E and K).

The need for vitamins is increased during adolescence. Because of energy demands during this period, increased quantities of thiamine, riboflavin and niacin are required for the release of carbohydrates (Mahan & Escott-Stump: 2000). With tissue synthesis, there is increase demand for vitamin B_6, folic acid and vitamin B_{12}. There is also an increased requirement for vitamin D (for rapid skeletal growth) and vitamin A, C and E are needed for new cell growth (Mahan & Escott-Stump, 2000).

Lack or shortage of these vitamins in the body could cause certain diseases. Children with vitamin A deficiency are more prone to infection, especially gastrointestinal and respiratory infections (Whitney *et al*, 1998). Globally, an estimated 250 million children are at risk for vitamin A deficiency (Mahan & Escott-Stump, 2000) The earliest signs of vitamin A deficiency is night blindness, an impaired ability to see in dim light. Niacin deficiency in humans is first manifest as muscular weakness, anorexia, indigestion, and skin eruptions (Mahan & Escott-Stump, 2000), and lack of vitamin D can retard bone growth. Vitamin C not only prevents the deficiency disease scurvy, but also seems to protect against certain types of cancer (Whitney *et al*, 1998). The recommendations of some major vitamins for adolescents are shown in table 3.1.

➢ *Minerals*

There is a great amount of direct information on needs in adolescents for iron, calcium, zinc, copper and fluorine. Classical studies have shown calcium, iron and zinc to be essential micronutrients for growth and sexual maturity, and their retention by the body increases significantly during the growth spurt (Olmedilla & Granada, 2000).

Adolescents incorporate twice the amount of calcium, iron, zinc and magnesium into their bodies during the years of the growth spurt compared with the other years. The requirement for calcium in adolescence is based on needs for skeletal growth, 45% of which occurs during this period (Mahan & Arlin, 1992).

With respect to iron, concerns during adolescence are related to the need to increase the body stores during growth and to maintain the haemoglobin concentration. Both

With respect to iron, concerns during adolescence are related to the need to increase the body stores during growth and to maintain the haemoglobin concentration. Both boys and girls have high requirements for iron. In boys, the increase in their muscle mass is accompanied by the rapid increase in blood volume, and girls have increased iron needs due to menstrual losses. Zinc is known to be essential for growth; retention of zinc increases significantly during the growth spurt, leading to more efficient use of dietary sources. Zinc needs are higher at times of maximal rates of protein synthesis, so adolescents may be susceptible to zinc deficiency (Olmellida & Granado, 2000). The importance of other minerals such as magnesium, iodine, phosphorus, copper, chromium and cobalt during adolescence are also well recognized. The possibility of interactions among these nutrients cannot be overlooked. (Olmellida & Granado, 2000). Recommendations for the levels listed in table 3.1 are made on the basis of the best data presently available.

Table 3.1 Major nutrient recommendations for adolescents (Mahan & Escott-Stump, 2000).

Category	Age (yrs)	Weight (kg)	Weight (1b)	Height (cm)	Height (in)	Energy (kJ)	Protein (g)	Calcium(mg) & Phosphorus(mg)	Iron (mg)	Vitamin A(µg RE)	Vitamin D(µg)	Vitamin K(µg)	Vitamin E(mg)	Vitamin C(mg)	Zinc (mg)
BOYS	11-14	45	99	157	62	9 450	45	1 200	12	1 000	10	45	10	50	15
	15-18	66	145	176	69	12 600	59	1 200	12	1 000	10	65	10	60	15
GIRLS	11-14	46	101	157	62	9 240	46	1 200	15	800	10	45	8	50	15
	15-18	55	120	163	64	9 240	44	1 200	15	800	10	55	8	60	15

3.5 Dietary assessment

According to Robinson *et al.,* (1990) dietary assessment is an important part of nutritional assessment, but it cannot be used alone to make a diagnosis of nutritional health. It is an aid in the interpretation of anthropometric, clinical and laboratory findings and provides a foundation for dietary counseling. Measurement of dietary intake of individuals and groups is central to nutrition research (Nesheim, 1982; Medlin & Skinner, 1988). Measuring of an individual's dietary intake is usually conducted for one or more of the following purposes: - to compare average nutrient intake of different groups; to rank individuals within a group; or to assess an individual's usual intake (Nelson *et al.,*1989). Dietary and nutrient assessment can be divided into two based upon data collection methods: quantitative daily consumption and semi-quantitative frequency methods. The quantitative daily consumption method attempts to measure the nature and the quantity of individual food consumed in a defined period of time, in contrast to the semi-quantitative food frequency method, which attempts to measure patterns of food use and implied nutrient intake across longer and often less precisely defined periods of time (US Dept. of Health and Human Service, 1989).

Current methods of dietary assessment include the 24-hour recall, food diaries, weighed food intake, duplicate portion analysis, food frequency recall and semi-quantitative food-frequency recall (Dwyer, 1994). According to Medlin & Skinner (1988) none of the above mentioned methods is perfect, the objective of the specific study and the population being assessed (e.g. children compared with adults) determines which one of the methods is the most appropriate for a certain investigation. Although dietary assessment methods have been studied extensively, they remain in need of considerable refinement, and the exploration of creative approaches from other disciplines is necessary (Medlin & Skinner, 1988).

Dietary assessment of children is important because many diet-associated chronic diseases of adulthood originate in childhood (Newman *et al.,* 1986). More accurate assessment of children's diets could increase awareness of changes needed to help establish healthful eating habits in children that could decrease the risk of chronic

disease in adults. Some assessment methods that can be used in assessing a teenager's dietary intake are reviewed and critiqued in the following section.

3.5.1 24-hour recall

The 24-hour recall is based on foods and amounts actually consumed by an individual on one or more specific days (Buzzard, 1998). In this method, a trained interviewer or assessor asks the subject or client to recall or remember in detail the food and drinks consumed during a period in the recent past. In most instances, the time or period is the previous 24 hours. Thus, the method is best known as the 24-hour recall (Block, 1989). Below is an example of a how a 24-hour recall form looks like.

Table 3.2 An example of a 24-hour recall form

NAME_____ DATE_____

DATE OF THE WEEK OF RECALL_____

TIME	FOOD ITEM	TYPE & PREPARATION	AMOUNT	AMOUNT IN GRAMS	CODE

Additional questions

Was the intake unusual in any way YES_____ NO_____

If YES, Why (in what way) ?_____

Do you take a vitamin or mineral supplement YES_____NO_____

If yes, what kind (brand name)_____

See addendum no. 1 for the 24-hour recall used in this study.

In collecting the data, the interviewer or assessor asks the subject to recall what s/he has eaten, how much was eaten, how the food was prepared, and when it was eaten. Because respondents may have difficulty expressing amounts in standard units of weight or volume, various amount estimation tools may be used to estimate portion sizes from memory. Examples of amount estimation tools include: - common size mugs, glasses, bowls; standard measuring cups and spoons; a ruler; food models; photographs or drawings of food ***(See addendum no 2).*** The tools for estimating amounts should be representative of measures commonly used in the communities in which subjects reside (Willet, 1990).

The interviewer then records this information for later coding and analysis. To determine the amount of nutrients consumed, the assessor usually enters the data of food and their portion sizes into a computer using a diet analysis program. The calculations of nutrient content are done automatically. Alternatively, the step can be done manually by looking up each food item in the tables of food composition. Then the assessor compares the calculated nutrient intake with the recommended intake such as the Recommended Dietary Allowance (RDA).

Nowadays, dietary recalls may be obtained interactively, using computer software that prompts the interviewer to collect all of the necessary information about a food consumed by the subject. Several programs have been developed specifically for this purpose. When the food name is entered into the system, the computer guides the interviewer through a series of menus that capture descriptive information, such as the type or brand name of the food, method used in food preparation, specification on key ingredient in recipes, whether fat and/ or salt was added to the food, and whether food was prepared commercially or at home.

The use of such automated systems standardizes the data collection process and ensures that the appropriate level of details is obtained for every food consumed (Willet, 1990). In addition, it eliminates the need for manual coding, which has traditionally been the most labour intensive step in dietary data processing.

The 24-hour recall has several strengths. One of the principal advantages of the 24-hour recall is its speed and ease of administration (Nelson & Bingham, 1997). This has made its use very attractive in very large scale and national surveys. It has been used extensively in the United States (Thompson & Byers, 1994). Another major advantage of the 24- hour recall method is the fact that literacy of respondents is not required. The interviewer administers and fills in the responses, which only requires verbal answers from the recipient, which in turn allows this method to be used across a wide range of populations. The method is inexpensive and can provide detailed information of specific food, especially if brand names can be recalled (Block, 1989). The 24-recall requires only short-term memory and it is well accepted by respondent because they are not asked to keep records and their expenditure of time and effort is relatively low (Lee & Nieman, 1993). This method is considered by some to be more objective than the dietary history and its administration does not alter the usual diet (Dwyer, 1988).

By itself, the 24-hour recall is not a reliable indicator of food intake (Carter, 1981; Beaton *et al.,* 1983; Todd, 1983; Alford & Ekvall, 1984). The primary limitation of this method is that data on a single day's diet, no matter how accurate, is a very poor description of an individual's usual nutrient intake because of day-to-day or intra-individual variability (Todd *et al.,* 1983; Block *et al,* 1986). Another limitation of a 24-hour recall is that it relies on memory, which is subject to a variety of errors (Dwyer *et al.,* 1994). These errors, which are manifested in the self-reported diet as omission, "which is failure to report the actually eaten food items" and intrusion, "which is a report of food items not eaten at all" decrease the accuracy of dietary intake (Smith *et al.,* 1991).

3.5.2 Food frequency

The food frequency approach asks respondents to report their usual frequency of consumption of each food from a list of foods for a specific period (Willet, 1990; Zulkifli & Yu, 1992; Willet, 1994). Food frequencies are usually administered in the form of a food checklist (Simko *et al.,* 1984). The frequency list may include a few broad groupings of foods or more than a hundred foods common to the geographic region (Robinson *et al.,* 1990). The food frequency technique has been described by

Morgan *et al.,* (1978) as a more useful "clue seeking" tool that may help to identify people who may need more detailed dietary assessment.

The limitation of using this tool is that, if the list is very limited, it will not reflect the total intake. If it is too intensive, on the other hand, it may be tedious to complete and clients may mark items indiscriminately, with the quality of the data deteriorating throughout the checklist.

Table 3.3 An example of a food frequency checklist

Below is the list of food. Please indicate how many servings of these foods you eat each week, which food you seldom eat (less than 6 times per week) and which you never eat.

FOOD ITEM	**No. OF SERVINGS PER WEEK**	**SELDOM EAT**	**NEVER EAT**	**AMOUNTS**
1. Dark green leafy vegetable	----------	----------	----------	----------
Dark yellow vegetable	----------	----------	----------	----------
Other vegetable	----------	----------	----------	----------
2. Bread types	_____	_____	_____	_____
Cereals	_____	_____	_____	_____
Potatoes	_____	_____	_____	_____
3. Citrus fruit	_____	_____	_____	_____
4. Beef	_____	_____	_____	_____
Pork	_____	_____	_____	_____
Fish	_____	_____	_____	_____
Chicken	_____	_____	_____	_____

3.6 Summary

Nutrition evaluation, care and status of the adolescent are tied to the increased needs associated with the sudden growth spurt occurring just prior to and during puberty. During this stage adolescents undergo physiological, social and psychological changes, which affect food habits and therefore food intake. This in turn influences their nutritional well-being. Other factors that play a major role in determining what adolescents eat are cultural influence, technological changes and the socio-economic status of those adolescents.

During this stage adolescents' needs increase, particularly for calories, protein, but also for vitamins and minerals. Dietary assessment during this stage is very important because it could increase awareness of changes needed to help establish healthful eating habits in children that could decrease the risk of chronic disease in adulthood. Dietary assessment could be done by using 24-hour recall, food frequency recall and food diaries.

4
EMPIRICAL STUDY: METHODS

4.1 Introduction

This research formed part of the THUSABANA study. THUSA is a Setswana word, which means "help". It is also an acronym for "Transition and Health during urbanization of South Africans". BANA is also a Setswana word, which means "children". So, in short, THUSABANA means "Help the children". THUSABANA is a follow-of the THUSA project, which was done in 1996-1998 in the North West Province of South Africa. THUSA is already part of focus area 9.1 of the Potchefstroom University for Christian Higher Education, which is "Preventive and Therapeutic Intervention".

The THUSABANA study is a multi-disciplinary project in which various departments of the Potchefstroom University for Christian Higher Education (PU for CHE) are participating, this includes the department of Nutrition (to which the author of this dissertation belongs), the departments of Physiology, Human Movement Science, Physiology and Social Work. Each department that is involved in this project provides researchers who are responsible for gathering health-related data in their specific

fields of expertise. Although vast amounts of data were gathered, the author of this study was only responsible for gathering the dietary intake data. The THUSABANA project is a long-term study, in which it is intended to obtain data from a large number of subjects, and follow-up with appropriate intervention. The data collected in 2000 were from 725 subjects and the results were analyzed and reported.

4.2 DESIGN

This part of the THUSABANA project was designed to compare the dietary intake of the children aged 10 to 15 years in the North West Province of South Africa with the South African food based dietary guidelines.

The study sample was a group of randomly selected children aged between 10 to 15 years in the North West Province of South Africa. The data were collected from the children during school hours in their respective schools as shown in table 4.1. A period of seven months was used to collect the data. (May 2000 to November 2000).

4.3 SUBJECTS

The North West Province consists of a number of heterogeneous subgroups or strata, which differ in characteristics. For this reason, a stratified random sampling method was used for sample selection so that each subgroup in the population was well represented in the sample. Major regions in the province were identified, and the numbers of schools in those regions were also identified. This provided a sample frame. Each school was given a distinct identification number. The sample was selected by employing a table of random numbers (***See addendum no. 3***) to select the school identification number to be included in the sample. The purpose of randomness was to permit blind chance to determine the outcomes of the selection process to as great a degree as possible. Class lists in each selected school were used to randomly select the children or subjects included in the sample. No exclusion criteria were applied.

The sample included scholars from public, farm and private schools, of both sexes and from high, middle and low socio-economic status (SES). The sample was drawn from both primary and high schools. The selection of the sample was done well in advance, prior the data collection period. Not all the selected subjects were available during the data collection days. All the selected subjects who were not available were automatically excluded from the sample, no replacement were made. This reduced the initial targeted sample size of 848 to 725.

The demographic data of the subjects were collected using demographic questionnaires (***See addendum No. 4***).

4.3.1 Age ranges

The subjects (n=725) ranged from the ages of 10-15 years, which is the beginning of the adolescent stage, a crucial time for developing healthful attitude and behaviour patterns related to food choices and physical activities. Hence, this period is of peak concern.

4.3.2 Stratification

The subjects were stratified according to the schools they are attending. They were stratified as follows: -

Stratum I : Black schools

These are public schools with subjects mostly from townships, rural areas and some from informal settlements.

Stratum II : Predominantly White schools

These are schools in predominantly white areas, where mostly Afrikaans speaking white people live.

Stratum III : Predominantly Indian schools

These are the schools in predominantly Indian living areas.

Stratum IV : Predominantly Coloured schools

These are schools in predominantly Coloured living areas. High school children from the coloured group were also recruited from Afrikaans medium high schools.The following table depicts the design of the THUSA cross-sectional study, including the study population, stratification as well as various data collected by people from different departments.

Table 4.1 Design of the THUSABANA cross-sectional study

STUDY POPULATION
North West Province Representative sample (n=725)
STRATIFICATION
Gender: girls/ boys Age range: 10-15 years Strata : Black schools Predominantly white schools Predominantly Indian schools Predominantly Coloured schools
DATA
Demography Blood pressure Anthropometry Psychological questionnaires Dietary intake Motor development Eating habits Family circumstances and HIV transmission Physical activity

Table 4.2 below provides information about the number of schools that were involved in the study, their towns of location as well as the region in which they belong.

Table 4.2 Location of recruitment for THUSABANA study in alphabetic order

REGION	TOWN	NUMBER OF SCHOOLS
5	Brits	2
1	Delareyville	1
2	Dinokana	1
5	Garankuwa	1
3	Ikageng	2
3	Klerksdorp	1
5	Lethlabile	2
2	Lichtenburg	1
2	Ottosdal	1
3	Potchefstroom	1
4	Rustenburg	4
2	Sannieshof	1
2	Schweizer-Reneke	2
1	Stella	1
3	Ventersdorp (Tshing)	1
3	Promosa	1
1	Vryburg	2
2	Zeerust	2
TOTAL		**27**

4.4 Ethical consideration

Within certain disciplines including medical science, behavioural science, education and similar areas of study, the use of human subjects in research is common. The ethics involved in the use of human subjects in research projects should not go without careful scrutiny. Many disciplines have their own codes of ethical standards with respect to involving human subjects. According to Leedy (1997) the principles of ethical propriety at a base of guidelines, resolve into simple consideration of fairness, openness of intent, disclosure of methods, the ends for which the research is executed, and respect for the integrity of the individual, the obligation of the researcher to guarantee unequivocally individual privacy, and an informed willingness on the part of the subject to participate voluntary in research activity (Leedy, 1997). Certainly, no person should be asked to cooperate in any research that may result in a sense of self-denigration, embarrassment, or a violation of ethical or moral standards or principles.

This research study is no exception at all, it was therefore approved by the Ethics Committee of the PU for CHE, project number 00M 10. Since the subjects were still minors, the parents or guardians were required to sign an informed consent form ***(See addendum no. 5)*** for giving permission for the children's participation in the study.

4.5 Organisational procedure

Permission to do the study was granted by the Deputy Director General of the Department of Education in the North West Province ***(See addendum 6).*** Letters were sent to all selected schools. Two research assistants made introductory visits to the selected schools to explain the procedures to the principals, to draw the random sample and to obtain the informed consent from the learners and the parents.

Prior to the commencement of the study, a group of field workers were recruited to assist with the gathering of data. These field workers were thoroughly trained on how

to use the tools for data collection and how to go about collecting the data. On the morning of each field visit, the study was explained in detail to the subjects. Each subject received a green card ***(See addendum no. 6)*** on which the subject number and the station numbers of all the collected data were entered. The subject then proceeded to each of the stations where relevant data were gathered, and the researcher who collected the data in each station attached his/her signature on the space provided on the green card to help control if the subject has undergone all the stations.

4.6 Measuring procedures and tools

For this study, a 24-hour recall ***(See addendum no. 1)*** was designed and the standard procedures for the 24-hour recall interview were used to collect data. A skilled interviewer asked the subject questions in a manner designed to put them at ease and to facilitate their ability to recall their previous day's intake. The interviews were conducted at the subjects' respective schools. The length of the interviews varied, they dependent on the number of food items the subjects had for that day. The interviewer provided a relaxed and unhurried atmosphere to give the subject a chance to carefully reflect on what s/he ate the previous day. Collecting a brief history of the previous day's activities prior to the beginning to ask questions about the intake facilitated the subject's memory ***(See addendum no. 7)***.

The interviewer had to begin with the first food item that the subject ate or drank on the previous day and then proceeded forward to cover 24 hours. To improve the reliability of the 24-hour recall, a semi-quantitative approach was used, where subjects were required to indicate the weight, volumes and cooking methods of the food eaten. To help the subject to report the amount of food or drinks accurately, tools such as photograph books and food models ***(See addendum no.2)*** were used. This was extremely helpful in enhancing the accuracy of the 24-hour recall in this study. All the foods mentioned by the subject were then coded by using the MRC food composition tables (Langenhove *et al*, 1991) and the NRIND food quantity manual (MRC, 1986). The questionnaires were then analysed by using the Foodfinder program®.

4.7 Quality control

Quality control is a very important aspect in research. In this study the following quality measures were applied. The 24-hour recall questionnaire was pre-tested in a pilot run to determine its ease of administration and repeatability. This pre-test helped to determine the effectiveness of the questionnaire.

A major source of error in collecting dietary data using a 24-hour recall method is its reliance on the subject's memory. Using well-trained field workers who are skilled in the art of asking questions that helped the subjects remember what they ate minimized this limitation. To improve the reliability of the 24-hour recall, the semi-quantitative approach was used as indicated in section 4.5 paragraph 2, where subjects were required to indicate the weight, volume and cooking methods of food with the help of the photo books and food models.

The researcher, with the help of her study supervisor, monitored the collection of data by the field workers; all the questionnaires were double-checked in order to pick up errors, if any. The coding of the data was also double-checked by the researcher and her study supervisor.

For the purpose of this study, only the first 289 subjects were administering it on two separate occasions in order test the reproducibility of the 24 -hour recall. The same fieldworkers visited subject numbers 1 to 289 on different days. The data were tested for any significant difference between the two 24-hour recalls. The data were analysed by a qualified statistician using a specialised statistical program (SAS, 1988). With computer, once the data and commands are correctly entered according to the prescribed instructions, the possibility of error is vastly reduced (Vockel & Asher, 1995: 398). The data were analysed and documented by the researcher and then double-checked by the study supervisor for any errors that may have occurred during the analysis and documentation.

4.8 Summary

The Thusabana study was conducted in 725 children aged 10-15 years who were randomly sampled in the North West province. The sample comprised of 53.4% black children, 26.3% whites, and 10.8% Indians and 9.5% coloureds. Well-trained field workers using a 24-hour recall collected data from the subjects. The quality was controlled by double-checking all the questionnaires and coding and by using a specialized statistical program for data analysis.

5

RESULTS, DISCUSSION AND RECOMMENDATIONS

5.1 Introduction

This chapter describes the findings that emerged from this research; this includes the results on demographic data, reproducibility of the 24-hour recall method, quantitative analysis of food intake and nutrient intake. Discussion and recommendations also form part of this chapter.

5.2 Demographic data

Seven hundred and twenty five (725) children from 27 schools represented the sample for this study. The sample study consisted of 387 (53.4%) blacks, 191 (26.3 %) whites, 78 (10.8 %) Indians and 69 (9.5%) of coloureds. The distribution of the subjects according to their groups is shown in figure 5.1. Girls of all ages (10-15) were 366, which made 50.5% of the population and the remaining 49.5% were boys.

When reviewing the demographic analysis, it became clear that more than half of the children (68.7%) came from high-income families, 20% from middle income families and only 11.3 % from high income families.

Below here is a figure that indicates the distribution of subjects according to their ethnic groups.

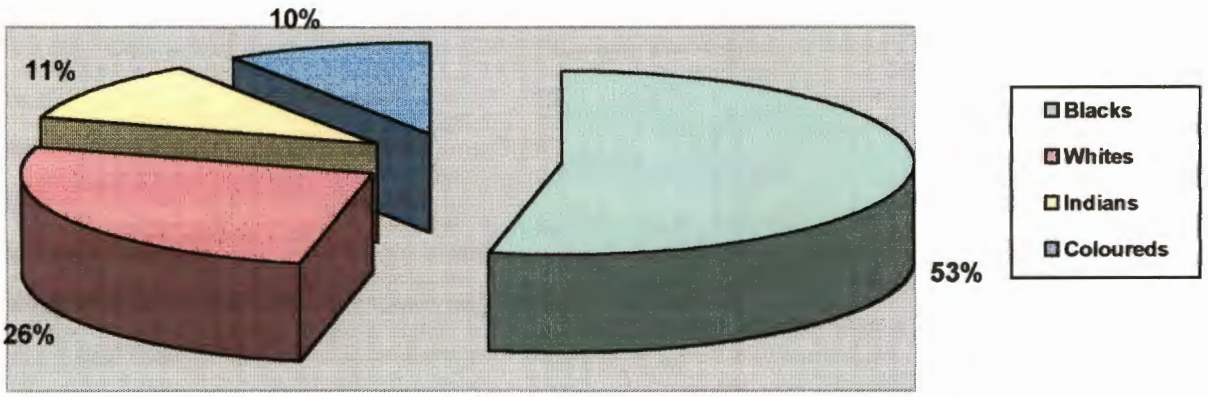


Figure 5.1 Distribution of subjects by ethnic groups

5.3 Reproducibility of the 24-hour recall method

Reproducibility (also referred to as reliability, repeatability or precision) is the extent to which one is able to obtain the same results when the method is repeated under the same conditions (Buzzard, 1998a). Reproducibility of the24-hour recall method was tested on the first 289 subjects, which represent 40% of the entire study population. Statistically significant correlations were found between the mean nutrient intake (16 nutrients) of the subjects in both occasions, except for vitamin B12 ($r=0.016$, $p=0.79$) and folate ($r=0.0617$, $p=0.06$). The findings indicate that the data obtained was reproducible and reflected fairly well the mean nutrient intakes of the 289 subjects of the survey population (Table 5.1).

Table 5.1 ***Reproducibilityy of the 24-hour recall dietary intakes of the subjects (n = 289)*** **Key** **r** = correlation between two measurements

p = Level of significance of correlation

Nutrient	**Initial 24 h-recall (date 1) Mean**	**Second 24-h recall (date 2) Mean**	**Correlation between two measurements (r)**	**Level of significance of correlation (p)**
Energy (kJ)	8739	8728	0.306	< 0.0001
Protein (g)	68.1	68.7	0.202	0.0006
Fat	66.9	67.0	0.281	< 0.0001
Carbohydrate (g)	306.4	305.8	0.374	< 0.0001
Fibre	16.4	16.0	0.227	< 0.0001
Sugar	58.7	57.5	0.512	< 0.0001
Calcium	481.8	447.7	0.475	< 0.0001
Vitamin B12	3.230	3.059	0.016	0.7865(NS)
Iron	10.06	9.34	0.360	< 0.0001
Magnesium	237.6	229.0	0.344	< 0.0001
Zinc	8.598	8.693	0.170	0.0038
Vitamin A	553.8	363.6	0.118	0.0454
Thiamin	1.073	1.031	0.305	< 0.0001
Riboflavin	1.874	1.634	0.134	0.0223
Nicotinic acid	14.217	13.794	0.314	< 0.0001
Folic acid	189.4	170.3	0.110	0.0617 (NS)
Vitamin C	51.804	51.05	0.269	< 0.0001
Vitamin E	10.92	10.34	0.173	0.0031

5.4 Quantitative analysis of food intake results

The findings of the survey as shown in table 5.2.indicated that white sugar was by far the most commonly (81.2%) consumed food, while 71.4% of the respondents used milk (whole, skim or 2% fat). Maize meal, enriched or unenriched was consumed by 53.5% of the respondents; white bread was consumed by 52% whereas brown bread was consumed by only 35%. Of the 725 respondents, 42% indicated that they drank cold drink or sweetened drinks whereas 18% drank fruit juice, 42% drank tea whereas 39% drank coffee. Chicken was consumed by 40% whereas 39% ate beef. The most commonly consumed snack foods were savoury (potato crisp or maize fried snacks by 24% of the respondents, 11.2% ate toffees and 11.0% ate apples. Other than the food mentioned above there were many other food consumed by the subjects but in very little quantities.

Table 5.2 Food most frequently eaten by the Thusabana subjects, position on Frequency table and percentage (n=725).

KEY 1; 589 (81.2%)

1 stands for ranking of food item eaten by most children, **589** stands for the total number of children who consumed a particular food item.

(81.2%) stands for the percentage of the children who consumed particular food item.

Kind of food	**Total sample (n= 725)**	**Boys (n=359)**	**Girls (n=366)**	**Younger children, 10-12 years (n=382)**	**Older Children, 13-15 years (n=343)**
Sugar, white	1; 589 (81.2%)	1; 303 (84.4%)	1; 286 (78.1%)	1; 314 (82.2%)	1; 275 (80.2%)
Milk, whole, skim or 2% fat	2; 518 (71.4%)	2; 256 (71.3%)	2; 262 (71.6%)	2; 260 (68.1%)	2; 258 (75.2%)
Maize meal, enriched and unenriched	3; 388 (53.5%)	4; 188 (52.4%)	4; 200 (54.6%)	3; 208 (54.4%)	3; 180 (52.5%)
Bread, white	4; 376 (51.9%)	3;198 (55.1%)	3;198 (55.1%)	4;198 (51.8%)	4; 178 (51.9%)
Margarine, all brands	5; 345 (47.6%)	5; 164 (45.7%)	5; 164 945.7%)	5; 194 (50.8%)	5;170 (49.6%)
Cold drink, sweetened	6; 308 (42.5%)	6; 162 (45.1%)	6; 162 (45.1%)	8;160 (41.9%)	6;148 (34.1%)
Tea	7; 301 (41.5%)	7; 161 (44.1%)	7; 161 (44.8%)	7; 168 (44.0%)	7; 133 (38.8%)

Table 5.2 continues

Kind of food	Total sample (n= 725)	Boys (n=359)	Girls (n=366)	Younger children, 10-12 years (n=382)	Older Children, 13-15 years (n=343)
Chicken (cooked)	8; 290 (40.0%)	8 147 (40.8%)	8 147 (40.9%)	6 175 (45.8%)	11 115 (33.5%)
Beef (cooked)	9; 274 (37.8%)	9 144 (40.1%)	10 130 (35.5%)	9 147 (38.5%)	8; 127 (37.0%)
Bread, brown	10; 257 (35.4%)	10; 127 (35.4%)	9; 132 (36.1%)	10; 145 (38.0%)	10; 116 (33.8%)
Rice, white	11; 245 (33.8%)	11; 126 (35.1%)	11; 119 (32.5%)	11; 130 (34.0%)	12; 115 (33.5%)
Coffee	12; 223 (30.8%)	12; 114 (31.8%)	12; 109 (29.8%)	12;105 (27.5%)	9; 118 (34.4%)
Potato, baked, boiled, mashed	13; 181 (25.0%)	13; 96 (26.7%)	14; 85 (23.2%)	14; 96 (25.1%)	13; 84 (24.5%)
Savoury snack (potato crisps and maize fried snacks)	14; 174 (24.0%)	14; 81 (22.6%)	13; 93 (25.4%)	13; 97 (25.4%)	14; 77 (22.4%)
Breakfast cereals	15; 150 (20.7%)	15; 76 (20.7%)	15; 74 (20.2%)	15; 92 (24.1%)	18; 58 (16.9%)
Fruit juice	16; 132 (18.2%)	16; 69 (19.2%)	18; 63 (17.2%)	17; 67 (17.5%)	15; 64 (18.6%)
Polony	17;126 (17.4%)	17; 60 (16.7%)	17; 66 (18.0%)	16; 76 (19.9%)	21; 50 (14.6%)

Table 5.2 continues

Kind of food	Total sample (n= 725)	Boys (n=359)	Girls (n=366)	Younger children, 10-12 years (n=382)	Older Children, 13-15 years (n=343)
Cheese	18; 107 (14.8%)	20; 51 (14.2%)	16; 66 (18.0%)	20; 50 (13.1%)	16; 61 (17.8%)
Eggs	19; 102 (14.1%)	18; 58 (16.2%)	21; 44 (12.0%)	23; 43 (11.2%)	17; 59 (17.2%)
French fried potato chips	20; 101 (13.9%)	19; 55 (15.3%)	19; 46 (12.6%)	21; 46 (12.0%)	19; 55 (16.0%)
Tomato and onion stew	21; 90 (12.4%)	22; 44 (12.2%)	20; 46 (12.6%)	24; 38 (9.9%)	20; 52 (15.2%)
Toffees	22; 81 (11.2%)	24 37 (10.3%)	22; 44 (12.0%)	19; 51 (13.4%)	23; 30 (8.7%)
Apple	23; 80 (11.0%)	23 37 (10.3%)	23; 43 (11.7%)	22; 44 (11.5%)	22; 36 (10.5%)
Peanut butter	24; 77 (10.6%)	21 50 (13.9%)	26; 27 (7.4%)	18; 53 (13.9%)	27; 24 (7.0%)
Atchaar	25; 6 (8.8%)	26; 30 (8.4%)	24; 34 (9.3%)	25; 37 (9.7%)	25; 27 (7.9%)
Fat cakes	26; 53 (7.3%)	27; 24 (6.7%)	25; 29 (7.9%)	26; 26 (6.8%)	24; 27 (7.9%)

The mean daily amount of foods consumed most frequently by the subjects is indicated in table 5.3

Table 5.3 Mean daily amount of foods (standard deviation) eaten most frequently by Thusabana subjects

Kind of food	**Total sample (n=725)**	**Boys (n=359)**	**Girls (n=366)**
Sugar, white (g)	25.2 (18.2)	26.5 (18.2)	23.9 (18.0)
Milk, whole, skim or 2% fat (g)	194 (167.4)	194.3 (168.7)	195.1 (166.4)
Maize meal, enriched and unenriched (g dry meal)	611 (104.9)	682 (114.8)	538.3 (88.7)
Bread, brown (g)	154.9 (111.7)	150.3 (100.3)	145.5 (109.4)
Margarine, all brand (g)	15.6 (12.6)	161 (95.1)	15.3 (12.6)
Cold drinks, squash, sweetened, and carbonated drinks (g)	380.9 (226.9)	416 (249.1)	335.1 (186.4)
Tea, black and rooibos (g)	321.5 (557.3)	98.5 (69.0)	345.9 (793.0)
Chicken, fried, roast, stew (g)	70.6 (34.3)	51.4 (42.5)	60.9 (30.4)
Beef, stew, roast, grilled (g)	85.0 (61.5)	57.1 (34.3)	83.2 (36.2)
Bread, brown (g)	138.8 (85.4)	273 (113.4)	127.7 (66.4)
Rice (g)	158 (98.4)	161 (95.1)	155 (101.7)
Coffee (g)	304.9 (211.5)	311 (239.4)	298.4 (178.6)
Potato, baked, boiled, mashed (g)	106.4 (64.9)	98.5 (69.0)	114.2 (60.2)
Snack savoury (potato crisp and maize fried) (g)	44.6 (33.8)	51.4 (42.5)	38.5 (22.2)
Breakfast cereal, all brands (g)	52.4 (26.4)	57.1 (34.3)	48.0 (14.1)
Fruit juice (g)	272.6 (121.2)	273 (113.4)	272.3 (128.6)
Polony (g)	33 (25.3)	37.2 (27.3)	29.2 (22.8)
Cheese (g)	36.6 (22.8)	39.7 (23.2)	34.2 (22.4)
Egg (g)	102.7 (69.9)	109.7 (82.5)	93.4 (48.5)

Table 5.3 continues

Kind of food	Total sample (n=725)	Boys (n=359)	Girls (n=366)
French fried potato chips (g)	127.4 (81.8)	147.1 (99.0)	103.9 (45.4)
Tomato and onion stew (g)	36.5 (19.4)	36.8 (18.8)	36.6 (20.20
Toffees (g)	25.7 (21.6)	29.5 (22.9)	22.5 (20.1)
Apple (g)	169.3 (61.8)	179.5 (73.6)	160.5 (48.7)
Peanut butter (g)	16.6 (15.1)	17.8 (15.6)	14.3 (14.0)
Atchaar (g)	3.2 (27.3)	66.5 (33.4)	60.3 (20.6)
Fat cakes (g)	237.6 (153.8)	220.4 (110.3)	251.9 (183.0)

5.5 Quantitative analysis of nutrient intake results

5.5.1 Energy and Macronutrients

The table below portrays the energy and macronutrient intake in boys and girls.

Table 5.4 Energy and macronutrient intake of the subjects (n=725).

Age	10yrs	11yrs	12yrs	13yrs	14yrs	15yrs
Boys						
N	**59**	**66**	**69**	**53**	**57**	**76**
Energy(kJ)	7786 ± 2728	8029 ± 2749	8343 ± 2959	8872 ± 2667	9389± 3273	8560± 3262
Total Protein (g/d)	55.6 ± 22.1	65.1 ± 22.9	64.6 ± 23.6	34.1 ± 16.4	73.1 ± 28.3	72.3 ± 37.6
Total Fat (g/d)	55.6 ± 33.5	57.9 ± 27.3	61.0 ± 34.9	63.3 ± 34.6	75.0 ± 45.0	57.5 ± 41.4
Total CHO* (g/d)	285.0 ± 97.8	288.7±117.2	301.0± 08.1	319.4± 21.3	322.9±112.8	314.4±117.7
Fibre (g/d)	14.2 ± 7.6	16.1 ± 9.2	15.9 ± 7.8	18.9 ± 12.4	16.5 ± 8.9	16.5 ± 9.4
Added Sugar (g/d)	50.7 ± 38.8	48.3 ± 47.2	45.1 ± 32.8	61.6 ± 45.9	70.3 ± 67.0	56.0 ± 54.4

Table 5.4 continued

Age	10yrs	11yrs	12yrs	13yrs	14yrs	15yrs
Girls	10yrs	11yrs	12yrs	13yrs	14yrs	15yrs
N	64	52	67	50	52	60
Energy (kJ)	7260 ± 2373	7450 ± 3556	7448 ± 2902	8567 ± 3650	7048 ± 2872	7460 ± 3095
Tot Protein (g/d)	59.0 ± 21.8	57.8 ± 30.1	59.2 ± 23.9	65.0 ± 22.3	57.7 ± 27.4	58.3 ± 25.3
Total Fat (g)	53.2 ± 29.8	58.9 ± 43.5	56.0 ± 33.3	69.0 ± 42.1	53.0 ± 33.9	55.0 ± 40.2
TotalCHO* (g)	257.8 ± 84.3	258.1±106.4	263.2±102.0	297.1±135.7	248.4±103.2	266.2±104.5
Fibre (g)	13.4 ± 6.3	13.5 ± 7.4	14.4 ± 9.1	15.5 ± 8.4	13.1 ± 8.0	14.7 ± 7.6
Added Sugar (g)	42.2 ± 38.9	41.4 ± 35.7	53.0 ± 42.0	43.5 ± 38.0	48.2 ± 38.1	51.0 ± 40.8

* CHO = Carbohydrate

Mean ± SD#.

Energy: On the basis of the 24-hour recall analyzed, the total energy intakes were generally higher than the RDA, with only 37% of the children consuming below the RDA for their age. The highest mean intake (9389 kJ) was recorded in boys aged 14 years and the lowest mean intake (7048 kJ) recorded in girls aged 14 years.

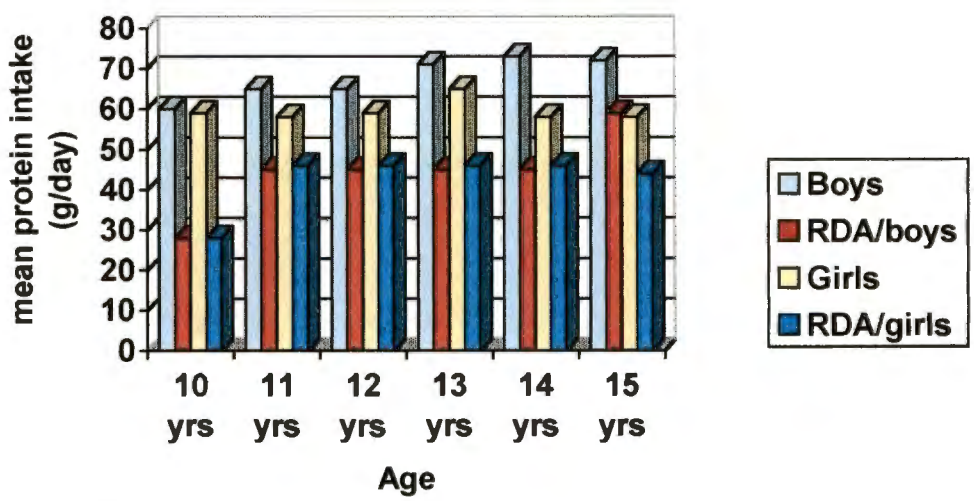


Figure 5.2 Mean protein intakes of the subjects (n=725)

Protein: The total mean protein intakes for most of the children were higher than the recommendations and mostly of animal origin, only 7% had protein intakes less than 67% of the RDA for gender and age. The highest mean protein intake (73g) was found in boys aged 14 and 15 years and the lowest mean (58g) found in girls aged 11, 14, 15 years (figure 5.2.).

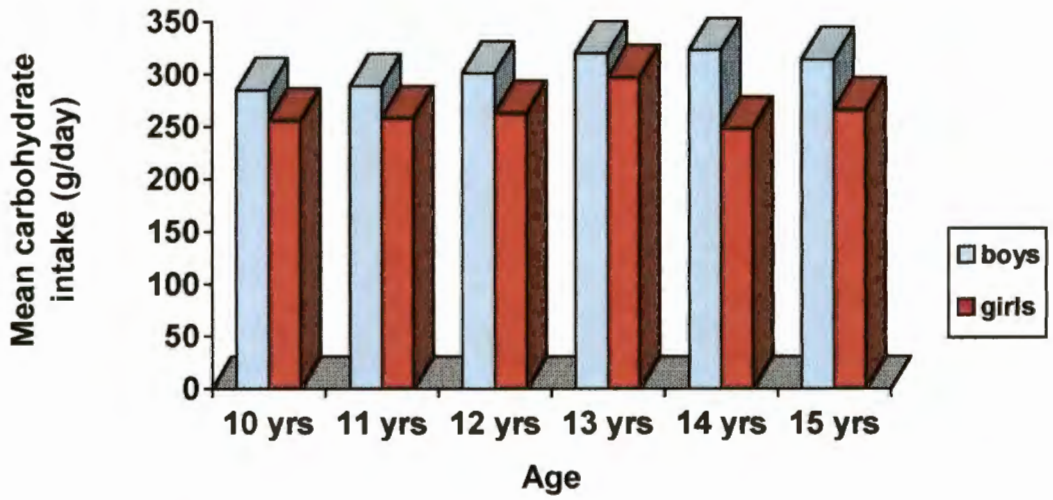


Figure 5.3 Mean carbohydrate intake of the subjects (n=725)

Carbohydrates: The mean carbohydrate intake (Figure 5.3) was highest (323g) in the boys aged 14 years and lowest (248g) in girls aged 14 years.

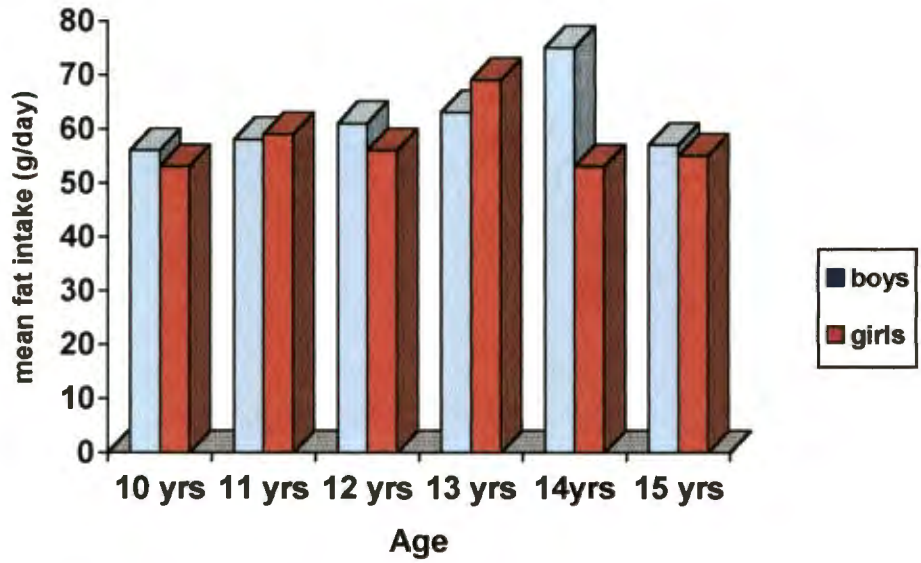


Figure 5.4 Mean fat intakes of the subjects (n=725)

Fat: The highest mean intake for fat (75g) was recorded in the boys aged 14 and the lowest mean fat intake (53g) in girls aged 10 and 14 (figure 5.4)

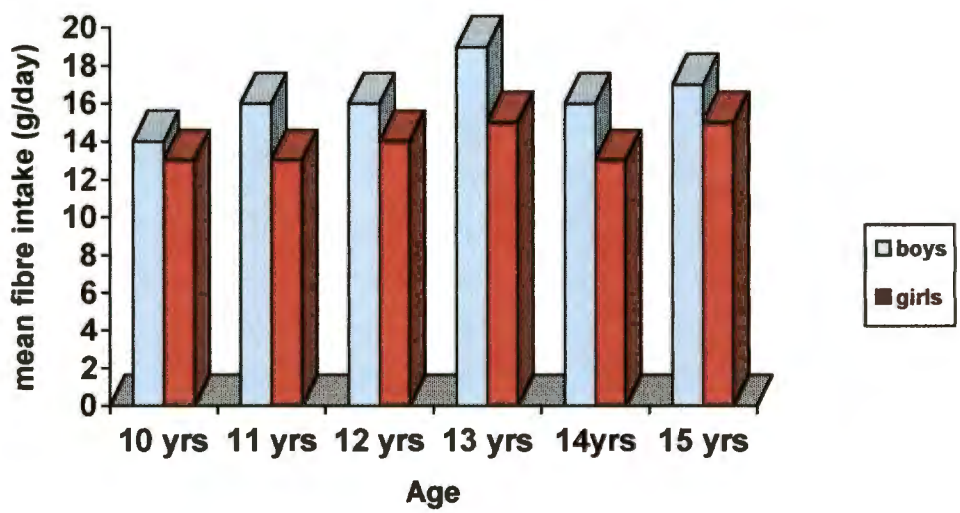


Figure 5.5 Mean fibre intakes of the subjects (n=725)

Fibre: The fibre intake of 90% of the children was above the 67% of recommendation of age + 5g/day. The highest mean fibre intake (19g) was found on boys aged 12 years and the girls aged 10, 11 and 14 years recorded the lowest (13g) mean fibre intake (figure 5.5).

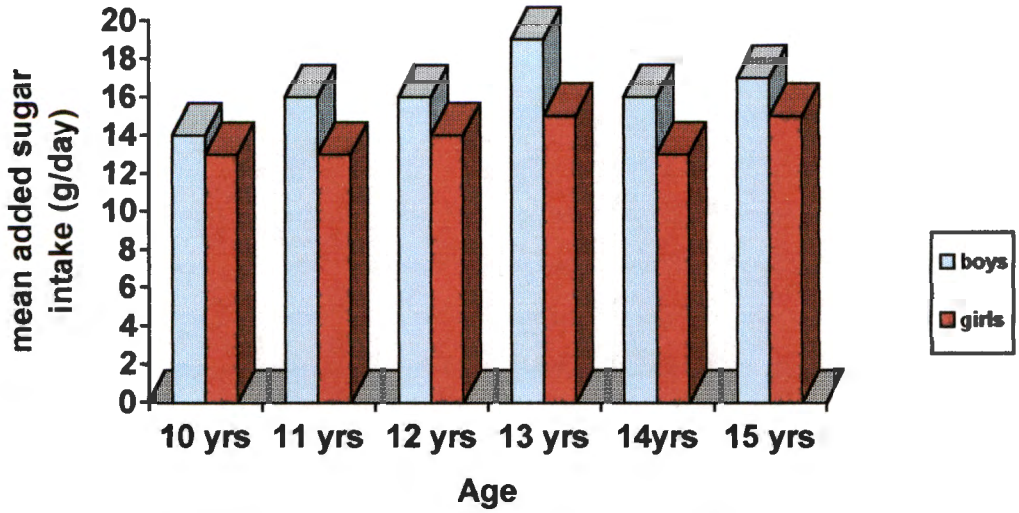


Figure 5.6 Mean added sugar intakes of the subjects (n=725)

Sugar: The highest mean added sugar intake (70g) was found in boys aged 14 years and the lowest (41g) mean intake was found in girls aged 11 years (figure 5.6).

This concludes the analysis of energy and macronutrients. The dietary intakes of micronutrients will now be presented.

5.5.2 Micronutrients

The table below (Table 5.5) indicates the micronutrient intake of the subjects.

Table 5.5 Micronutrient intake of the subjects (n=725).

Mean ± SD#

Age	10yrs	11yrs	12yrs	13yrs	14yrs	15yrs
Boys						
N	**59**	**66**	**69**	**53**	**57**	**76**
Calcium (mg)	440.8 ± 290.5	415.0 ± 311.5	420.0 ± 272.9	469.0 ± 326.4	553.1 ± 421.3	470.0 ± 344.0
Iron (mg)	8.7 ± 5.3	9.0 ± 5.0	10.0 ±7.3	10.6 ± 6.0	10.0 ± 5.0	9.2 ± 5.8
Magnesium (mg)	215.7 ± 85.0	235.2 ± 103.6	230.0 ± 84.4	261.6 ± 108.6	254.0 ± 116.0	236.2 ± 102.6
Phosphorus (mg)	836.7 ± 339.5	865.4 ± 355.2	865.0 ± 318.3	977.0 ± 376.7	1035.0± 462.0	965.5 ± 462.1
Zinc (mg)	7.1 ± 3.6	8.5 ±4.2	8.1 ± 4.0	8.9 ± 4.1	10.0 ± 5.2	9.5 ± 7.6
Copper (mg)	1.0 ± 0.5	1.0 ± 0.5	1.0 ± 0.5	1.1 ± 0.6	1.2 ± 1.0	1.0 ± 1.0
Vitamin A(µg RE)	519.4 ± 935.0	351.4 ± 469.7	427.3 ±497.4	402.9 ± 593.0	468.0 ± 496.0	399.3 ± 735.7
Vitamin D(µg)	2.3 ± 2.8	2.0 ± 3.3	3.3 ± 5.4	3.0 ± 3.6	3.7 ± 4.0	2.8 ± 5.3
Vitamin E (mg α-TE)	7.6 ± 8.9	7.1 ± 6.4	9.2 ± 11.0	8.9 ± 7.8	11.4 ± 8.3	7.5 ± 8.5
Vitamin B6(mg)	1.2 ± 0.8	1.2 ± 0.7	1.2 ± 1.0	1.3 ± .08	1.3± 1.0	1.1 ± 1.0
Vitamin B12(µg)	2.3 ± 2.1	2.6 ± 2.0	3.0 ± 2.5	3.2 ± 2.7	3.2 ± 2.5	3.7 ± 4.1
Vitamin C (mg)	28.1 ± 42.3	34.2 ± 59.8	27.0 ± 48.0	71.1 ± 136.3	66.1 ± 120.0	29.2 ± 54.6
Thiamin (mg)	1.0 ± 0.4	1.0 ± 0.5	1.1 ± 0.5	1.1 ± 0.5	1.2 ± 1.0	1.0 ± 0.5
Riboflavin (mg)	1.8 ± 2.4	1.6 ± 1.9	1.7 ± 1.7	1.8 ± 2.0	1.8 ± 1.8	1.2 ± 1.1
Nicotinic Acid (mg)	13.0 ± 7.5	12.8 ± 7.7	13.3 ± 7.3	15.7 ± 9.0	14.6 7.5	12.8 ± 9.0
Folic Acid (µg)	161.6 ± 85.4	158.3 ± 111.6	178.5 ± 111.0	195.1 ±144.2	186.9 ± 112.4	172.6 ± 129.3
Pantothenic Acid (mg)	3.1 ±1.6	3.0 ± 1.3	3.1 ± 1.6	3.5 ±1.7	3.7 ± 1.8	3.5± 2.0
Biotin(µg	13.5 ± 7.7	13.8 ± 11.0	17.1 ± 17.1	16.2 ± 10.3	18.0 ±10.2	20.1 ± 22.1

Table 5.5 continues

Girls

Age	10yrs	11yrs	12yrs	13yrs	14yrs	15yrs
N	64	52	67	50	52	60
Calcium (mg)	452.0 ± 288.6	414.2 ± 306.6	447.2 ± 284.0	545.8 ± 358.3	457.7 ± 317.8	456.9 ± 419.0
Iron (mg)	8.7 ± 5.0	8.1 ± 6.2	8.4 ± 5.0	8.6 ± 4.0	7.6 ± 4.7	8.4 ± 4.6
Magnesium (mg)	213.1 ± 77.5	208.6 ± 99.6	215.6 ± 94.7	229.1 ± 86.6	202.4 ± 93.2	210.3 ± 81.4
Phosphorus (mg)	833.4 ± 316.5	814.6 ± 426.2	841.0 ± 324.3	929.8 ± 344.2	814.0 ± 395.0	834.4 ± 395.3
Zinc (mg)	7.4 ± 3.8	7.4 ± 4.7	8.0 ± 4.2	7.9 ± 3.0	7.4 ± 4.4	7.1 ± 3.7
Copper (mg)	0.9 ± 0.4	0.8 ± 0.6	1.0 ± 0.6	1.0 ± 0.5	0.9 ± 0.4	1.0 ± 0.4
Vitamin A(µg RE)	355.7 ± 366.7	647.3± 2291.1	447.0 ± 967.1	389.0 ± 421.6	595.6 ± 907.6	327.2 ± 388.1
Vitamin D (µg)	2.0 ± 3.0	2.3 ± 3.1	2.0 ± 2.4	2.8 ± 4.0	2.6 ± 4.7	3.5 ± 5.4
Vitamin E (mg α-TE)	6.4 ± 5.8	10.7 ± 13.0	7.0± 6.8	11.9 ± 13.3	7.6 ± 7.4	10.5 ± 14.3
Vitamin B6 (mg)	1.2 ± 0.7	1.1 ± 1.1	1.1 ± 0.6	1.2 ± 0.8	1.0 ± 0.6	1.0 ± 1.0
Vitamin B12 (µg)	2.6 ± 2.3	3.9 ± 9.2	3.0 ± 3.3	3.0 ± 2.3	3.1 ± 3.8	2.9 ± 2.5
Vitamin C (mg)	42.8 ± 59.2	37.0 ± 58.4	56.4 ± 102.7	46.4 ± 57.7	37.0 ± 70.7	84.1 ± 152.4
Thiamin (mg)	1.0 ± 0.5	1.0 ± 0.6	1.0 ± 0.4	1.1 ± 0.5	0.8 ± 0.4	1.0 ± 0.5
Riboflavin (mg)	1.6 ± 1.3	1.9 ± 1.5	1.5 ± 1.1	2.1 ± 2.8	1.4 ± 1.4	1.4 ± 1.3
Nicotinic Acid (mg)	12.6 ± 7.3	12.0 ± 8.3	12.4 ± 6.1	12.1 ± 5.3	11.4 ± .4	12.4 ± 6.8
Folic Acid(µg	147.1 ± 91.4	190.6 ± 366.2	166.4 ± 162.4	164.1± 78.7	157.4 ± 129.7	146.3 ± 79.8
Pantothenic Acid (mg)	3.0 ± 1.3	3.2 ± 2.8	2.9 ± 1.6	3.4 ± 1.6	2.7 ± 1.4	3.0 ± 1.6
Biotin (µg)	13.7 ± 8.5	24.5 ± 11.9	16.2 ± 24.0	16.8 ± 12.0	16.2 ± 21.8	15.9 ± 12.0

5.5.2.1 Vitamins

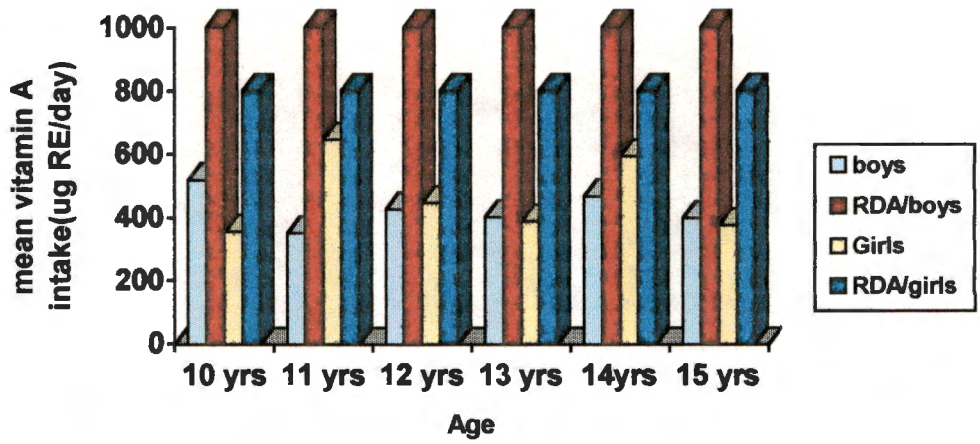


Figure 5.7 Mean vitamin A intakes of the subjects (n=725)

Vitamin A (Retinol): The vitamin A consumption was overall considerably poor, with 89% of the children having an intake less than 67% of the RDA for their age groups. The girls aged 11 years recorded the highest mean vitamin A intake (647µg RE) whereas the girls aged 15 years recorded the lowest mean (327µg RE) (Figure 5.7).

Vitamin D (Calciferol): The mean vitamin D intakes of all the subjects were below the dietary reference intake (DRI) for their age. Although the mean intake of vitamin D was far below the DRI for their age and gender, these findings do not imply deficiency, because of the endogenous synthesis of vitamin D in the skin upon exposure to sunlight.

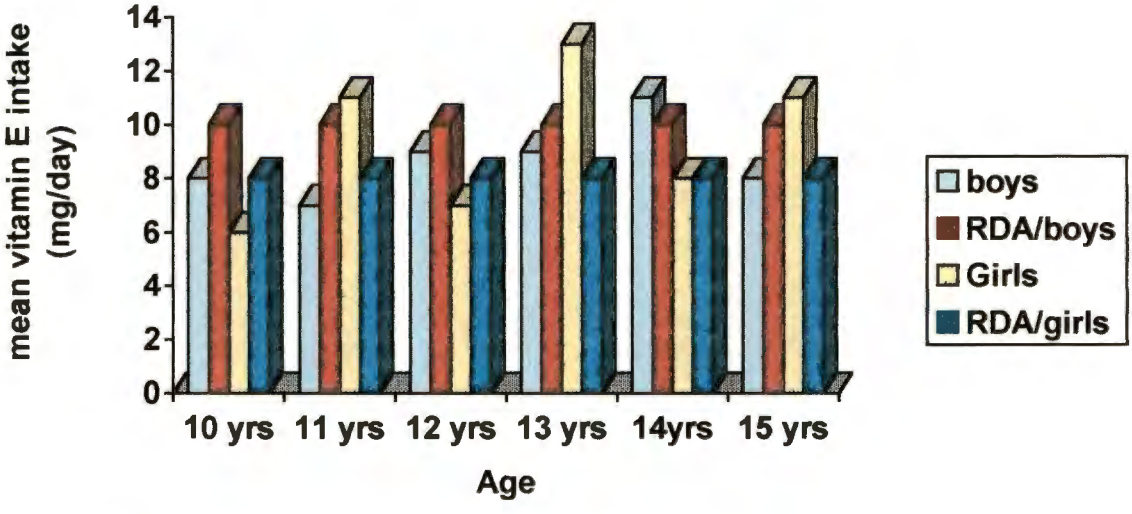


Figure 5.8 Mean vitamin E intakes of the subjects (n=725)

Vitamin E (Tocopherol): Only 40% of the respondents recorded the mean vitamin E intakes that are higher than the 67% of the RDA for their age group. The highest mean intake (12mg) was found in girls aged 13 and the lowest (6.4mg) in girls aged 10 (Figure 5.8).

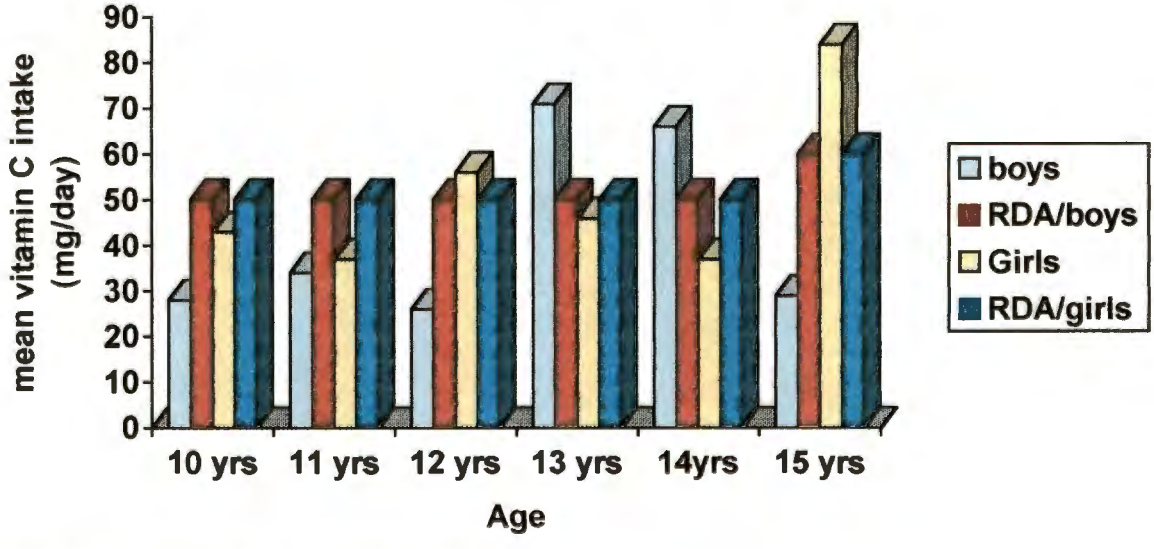


Figure 5.9 Mean vitamin C intakes of the subjects (n=725)

Vitamin C (Ascorbic acid): Only 27% of the entire sample had vitamin C intakes that were above 67% of the RDA for their age, the other 73% had their intake below this cut-off point. The highest mean intake (84mg) was found in 15 year old girls and a very low mean intake (27mg) was found in boys aged 12 years (Figure 5.9).

Thiamin: The general intake of thiamin was satisfactory with 77% above the recommendation (67%) of the RDA for gender and age. The mean intake was almost the same for all the age and genders groups (Table 5.5).

Riboflavin: Most (71%) of the respondents recorded a riboflavin intake that is well above the recommendation (67%) of the DRI for age and gender (Table 5.5).

Niacin: The mean intake of niacin was the highest relative to the recommendation of all the nutrients analyzed with 93% of the children's intake being above the 67% of the DRI for age and gender.

Vitamin B6: Two thirds (67%) of the children's vitamin B6 intakes were higher than the RDA for their age or gender. The recording for the mean intake was almost the same for all the age groups and gender (Table 5.5).

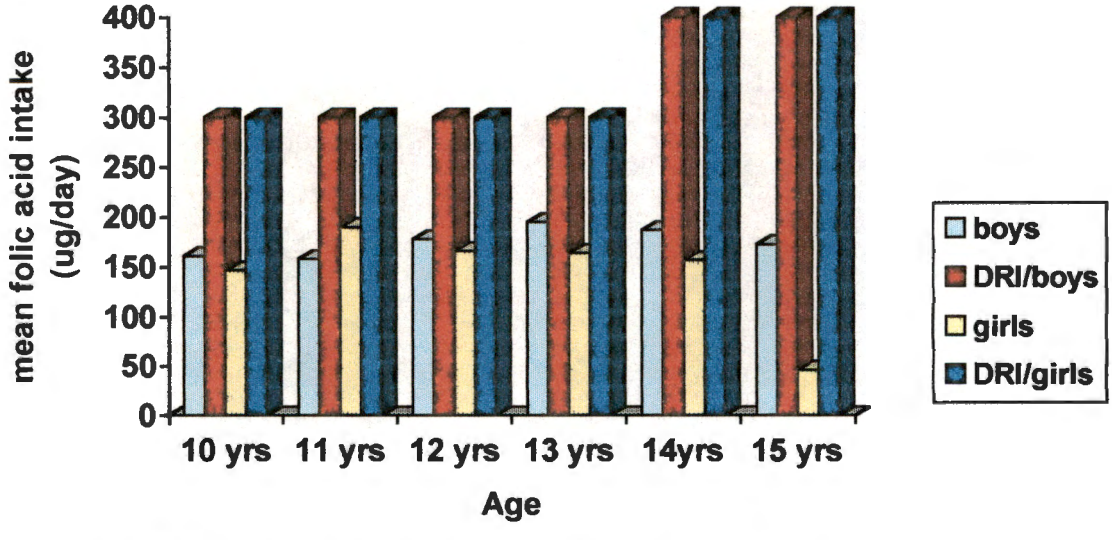


Figure 5.10 The mean folic acid intakes of the subjects (n=725)

Folic acid (Folate): The folic acid intakes of most of the subjects were far below their DRI for their age and gender, with the highest mean intake (195μg) recorded in boys aged 13 and the lowest mean intake (146μg) recorded in girls aged 15 (Figure 5.10).

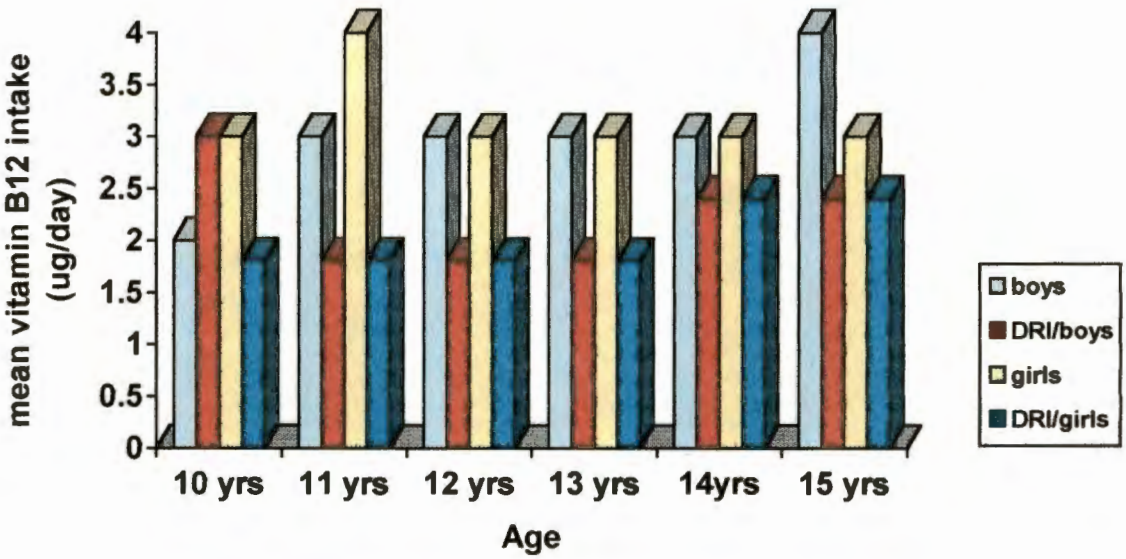


Figure 5.11 The mean Vitamin B12 intake of the subjects (n=725)

Vitamin B12 (Cobalamin): The intake of vitamin B12 had 69% of the children above the DRI for their age, with the highest mean intake recorded in boys aged 11 and 15 years and the lowest mean intake found in boys aged 10 years (Figure 5.11).

Biotin: The mean biotin intake was consistently and markedly lower than the RDA in all age groups and genders, with the highest mean intake (25μg) found in girls aged 11 and the lowest mean intake (13μg) found in boys aged 10 years (Table 6.5).

Pantothenic acid: The mean pantothenic acid intake was generally lower than the RDA in all age groups except in boys aged 13 & 14 who recorded the highest mean intake. The lowest mean intake was found in girls aged 14 years (Table 5.5).

5.5.2.2 Minerals and trace elements

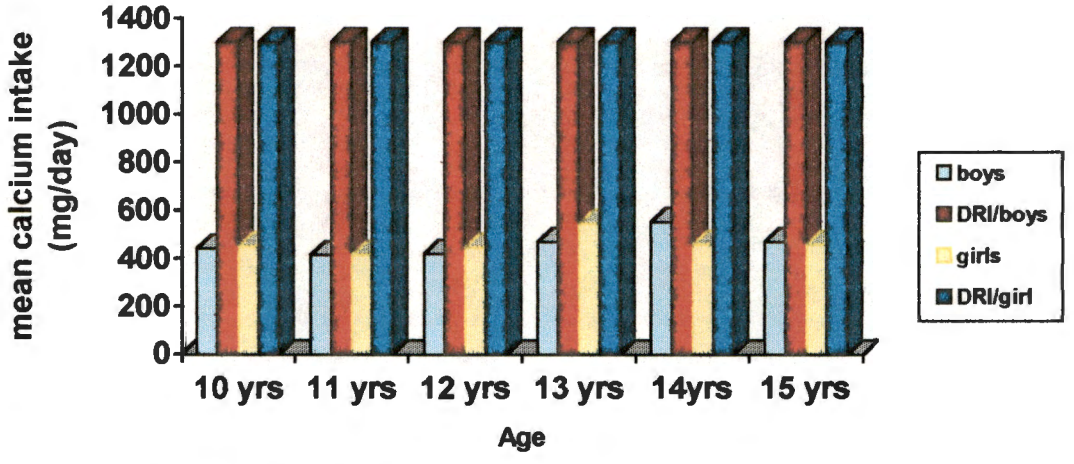


Figure 5.12 The mean calcium intake of the subjects (n=725)

Calcium: A great majority of children consumed a diet deficient in calcium to meet the requirements. Most (89%) had calcium intakes that were below the DRI for their age and gender. The highest mean intake (553mg) found in boys aged 14 was far below the DRI for their age and the lowest mean intake (414mg) found in girls aged 11 years (figure 5.12).

Phosphorus: The mean phosphorus intake of all the gender and age groups were below the recommended level (DRI) with the highest mean intake (1035mg) recorded in boys aged 14 and the lowest mean intake (814mg) in girls aged 14 years (Table 5.5).

Iron: Mean iron intakes were consistently lower than the RDA in all age groups and genders with the highest mean intake (10mg) recorded in boys aged 12, 13, and 14 and the lowest mean intake found (7mg) in girls aged 14 years (Table 5.5).

Zinc: Of the respondents 61% had zinc intakes that were less than 67% the RDA for age. Similar to iron, the mean zinc intake was inadequate in all groups and genders,

with the highest recording (10mg) found in boys aged 14 and the lowest recording found in boys aged 10,and girls of all groups (Table 5.5).

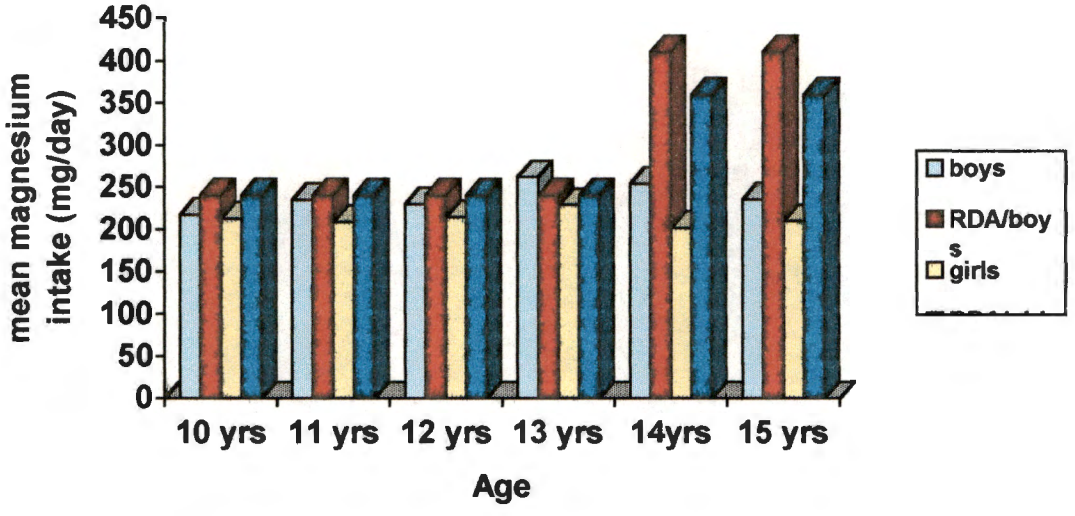


Figure 5.13 The mean magnesium intake

Magnesium: The findings on magnesium intake indicated that the intake was adequate in the majority of the younger children with 61% of their intakes being above the RDA for age. The analysis indicated the highest mean magnesium intake (262mg) in boys, aged 13 and the lowest intake (202mg) in girls aged 14 years.

5.6 COMPARISON OF THE FOOD INTAKES OF THE SUBJECTS WITH THE SAFBDGs

The findings of the present study indicate poor compliance with the South African food based dietary guidelines.

"Enjoy a variety of food"

The top 10 foods most frequently consumed by the subjects included only starchy foods, sugar, margarine, cold drink, milk, chicken and beef. The majority of the subjects did not consume fruits and vegetables (see table 5.2). As indicated in chapter 2, the major limitation to the implementation of this guideline is severe financial constraints. It is therefore assumed that only a small percentage that is from high and middle income families complied with this guideline. The subjects from low income families, which constitute the highest percent (68.7%) as indicted in section 5.1, were limited to staple meals of porridge with sauce/stew or milk.

"Be active"

In entire multi-disciplinary this study, the children's activity patterns were investigated, but the final data were not available at the time of preparation of this report. This study was mainly focused on the dietary intakes and comparison with physical activity data were not done.

"Make starchy food the basis of most meals"

The participants consumed a variety of starchy foods in the form of maize-meal, white rice, white and brown bread, potatoes and fat cakes (see table 5.2). The staple starchy food of preference was maize-meal porridge in various forms. This was rated the third most frequently eaten food item and was consumed by 54% of the children and the mean daily intake was 611.3g. About 34% of the children consumed white rice as

their staple starchy food (See table 5.2). Most children (60%) preferred white bread to brown bread (35%). White bread was rated the fourth most frequently consumed food item consumed, whereas brown bread was rated number 10 on the list of foods most frequently eaten.

Potatoes (baked, boiled or mashed) were consumed by 25% of the children and was rated number 13 on the list of most frequently eaten food items, whereas 14% consumed french fried potato chips which was rated number 20 on the list of foods most frequently eaten. Of the respondents, 7% ate fat cakes, which were rated number 26 on the list.

From the above analysis, it is clear that most subjects make starchy food the basis of most meals.

"Eat plenty of fruit and vegetable everyday"

The children's consumption of fruits and vegetables was very limited. Only 18% consumed fruit in the form of fruit juice and it was rated number 16 on the list of foods most frequently eaten (see table 5.2). Tomato and onion stew was rated number 21 on the list and was consumed by 12% of the children. Apples were consumed by only 11% of the children. The possibility of the percentages overlapping makes the percentage of the children who did not eat any fruit or vegetable even higher. This indicates that the children did not eat plenty of fruit and vegetable as the guideline suggests.

"Eat dry beans, peas, lentils and Soya often"

About 11% of the children consumed peanut butter, which was rated number 24 on the list of the foods most frequently eaten (Table 5.2). Only 14 boys and 20 girls (total 34, 4.7%) ate legumes on the day prior to the study. This strongly suggests that the children did not comply with this guideline.

"Food from animals can be eaten every day"

A large number of participants (71%) consumed milk (whole, skim, or 2% fat), and it was rated second on the list of foods most frequently eaten (Table 5.2). This high consumption of milk comes as no surprise because of the importance attached to milk in the Tswana eating pattern. The Tswana children comprise the majority (53.4%) of the children in this study. Chicken was rated number 8 on the list of foods most frequently eaten, and was consumed by 40% of the children. The consumption of chicken was high among boys (88.3g/day) as compared to girls (60.9g/day). About 39% of the children ate beef, which was rated number 9 on the list. Like chicken, the beef consumption was high among boys (110.4g/d) and girls consumed a mean of 83.2g per day. Polony was consumed by 17% of the children, cheese consumed by 15% and eggs consumed by 14% of the children (see table 5.2). Even in this case, the possibility of percentages overlapping cannot be overlooked.

"Use fat sparingly"

Of the children, 48% consumed margarine (all brands), which, was rated number 5 on the list of the foods most frequently eaten. Other than the margarine consumed by the children, fats were also found in other food cooked with addition of cooking oil, cooking fat or other forms of fat. These foods include chicken, beef, French fried potato chips, tomato and onion stew and fat cakes. The addition of fat during food preparation is of great concern. Although only 7.3 % of the children ate fat cakes, the amount of the fat cakes reported to be eaten on the day of the recall was fairly high (237.6g). The mean amount eaten by girls was more than that eaten by boys (251.9g/d compared to 220.4g/d). The mean fat intake of the boys ranged from 55.6 to 75g per day, while the mean intake for girls ranged from 53 to 60g per day (Table 5.4). These fat intakes represent 27.1% to 30.3% of the mean energy intakes for the boys and 29% to 30% for the girls. This indicates that about 48% of the children did not consume fat sparingly, with the boys slightly higher than the cut-off point, which is 30% of energy.

"Use salt sparingly"

Although salt was used in cooking to enhance the flavour of food, it was not measured as a food item. A low percentage (24%) of the children consumed savoury snacks, which contained salt. This shows a low preference of salty snacks by the children.

"If you drink alcohol, drink sparingly"

None of the children reported drinking alcohol.

"Eat healthier snacks"

Low percentage (24%) of the children consumed savoury snacks (potato crisp and maize fried snacks), which, were rated number 14 on the list of foods most frequently eaten. In most instances, children who purchased snacks, also bought toffees, which were consumed by 11.2% of the children and were rated number 22 on the list (see table 5.2). This increases the possibility of percentage overlapping. Atchaar was consumed by 9% of the children. The most nutritious snack consumed were apples consumed by only 11.0% of the children. The children who ate snacks did not consume healthier snacks as recommended by this guideline.

The statistical analysis of reproducibility of this method tested in the 289 subjects, which comprises 40% of the study population, detected no significance difference between mean nutrients intakes of the subject on both occasions (See table 5.1). The findings indicate that the children do not comply with the SAFBDGs.

5.7 DISCUSSION

The majority of children consumed diets with adequate energy, but the diets were of poor nutrient density to meet their nutrient requirement. The mean intakes of the following nutrients were less than the recommended level.

- Calcium
- Iron
- Phosphorus
- Magnesium (For 14 and 15 years old children only)
- Zinc
- Copper
- Folic acid
- Vitamin A
- Ascorbic acid
- Pantothenic acid
- Biotin
- Vitamin D
- Vitamin E

Although the mean intakes of all of the above mentioned nutrients were below the recommended level, mean intakes of calcium and vitamin A were far lower, approximately less than half the recommended level. For instance, the highest mean calcium intake recorded was 553mg whereas the recommended level is 1300mg for all the age groups and genders, and the highest mean vitamin A intake recorded was 647RE when the recommended level for girls of all age groups is 800RE, and 1000RE for boys of all age groups. This situation is similar in most other countries. In the Czech Republic, there was a recent reduction of the intakes of calcium, vitamin A and persisting low intakes of vitamin C among adolescents (Parizkova, 2000). Although intakes of most micronutrients in European girls and boys appear adequate as compared to recommendations, calcium and iron intakes were low in varying

proportions of males and females (Belton *et al.*, 1997). According to French recommendations (15 mg/d in boys and 18mg/d in girls) intakes of iron were below recommendations in 50% of boys and 80% of girls (Dupin *et al.*, 1992).

All the children in the present study had mean protein intakes that were well above the recommended dietary allowance. About 92% of the children had more than 50% of mean protein intakes from animal products. This really boosts the quality of protein the children consumed. This is similar to the Western European adolescents' consumption, which was high, both in absolute value and percentage of the daily energy (Rolland-Cachera *et al.*, 2000). A survey of 193 Swiss adolescents (9-19y old) carried out to investigate the effect of puberty on dietary habits and findings indicated that the protein intake was higher than recommendations and mostly from animal origin (Clavien *et al.*, 1996). In the present study, about 60% of the children also had mean riboflavin intakes that are above the recommended level. The mean intakes of thiamin and niacin of all the children were just at the cut-off point of the RDA for their age and gender.

Out of all the nutrients analyzed, the girls aged 14 years were found to have the highest percentage (58%) of the lowest mean intakes whereas the boys aged 14 years were found to have the highest percentage (42%) of the highest mean intakes. The 14 and 15 years old girls' low intake of iron is of great concern since they loose iron with the blood during their monthly menstrual period. If not replaced, the iron deficiency may manifest itself ultimately by the development of anemia (hypochromic microcytic anemia), which is corrected by giving diets rich in absorbable iron and by providing supplements in the form of ferrous sulfate or ferrous gluconate (Marlin & Arlin, 1992). Iron deficiency can also be aggravated by diets that are poorly balanced, containing insufficient iron, protein, folate, and vitamin C, which is evident in the children of this study. The low intakes of some important nutrients such as calcium, iron, phosphorus, folic acid, vitamin A, C and D as indicated earlier in this discussion, put the children not only at risk for iron deficiency, but also for other nutrition related problems, since these nutrients are mostly needed during these years of growth spurt.

On the comparison of food intake and the SAFBDGs, when analyzing the starchy food consumed by the children, one should not overlook the fact that overlapping of these percentages is a great possibility. Some children could have consumed more than one of the starchy foods mentioned above. Some children could have eaten both porridge and rice on the day of the recall. Others could have eaten both white and brown bread as well as the fat cakes. There is also a possibility of some children having consumed all of the above mentioned starchy food, since there is a small percentage of the children who come from high income families who could afford to have all the food on their table. Based on this discussion, one can conclude by saying the participants complied with this guideline.

The fact that food of animal origin are relatively expensive, lead to an assumption that food like chicken, beef and cheese could have been consumed by a very small percentage of the children from high income families. Based on the possibility of overlapping of percentages and the assumption made above, one can conclude that only a small portion of the subjects complied with this guideline.

Based on the findings, one can conclude by saying that the findings partially support the hypothesis that was formulated in chapter 1 which says "The dietary intake of the children aged 10-15 years in the North West Province does not comply with the South African food based dietary guidelines".

5.8 RECOMMENDATIONS

The findings indicate clearly that most children had intakes of some of the important nutrients below the recommended level, for example, vitamin A, vitamin C, calcium and iron. Therefore, one would recommend the following: -

- Nutrition information should be provided to the school children through nutrition education programmes. This learning should be made formal by being included in the school curriculum. This will help to promote positive attitudes about nutritious foods. These programs should highlight certain aspects such as the importance of

brown bread over white bread, and encouraging the change of the current prevailing consumption pattern including the improvement of the nutrient density of the children's diet and increased consumption of fruits and vegetables. Parental involvement in nutrition education projects can also produce positive outcomes, with subsequent carryover into the home.

- Tuck-shops at schools should be monitored regularly in order to ensure that healthy and nutritious snacks are sold to those children who bring money to school. Instead of selling sweets, different fruits can be sold. This will help increase the vitamin intakes of the children.
- If the schools are involved in school nutrition programmes, the current menus of the these should be reviewed with a view to improving dietary variety and the quality of the foods used. These food should preferably be selected from the food groups in which the children in this study had low intakes, this include fruits and vegetables.
- Primary school nutrition programmes should be introduced to the schools that presently do not have one. This will help to improve the dietary intake of the children from low income families who might sometimes go to school without any meal at all.
- Families should be encouraged, when appropriate to grow their own vegetable gardens. This will ensure that the children would have their vitamin sources readily available.
- The key findings of this study need to be widely disseminated to the public and health care workers in order to increase awareness of the level and the nature of food and nutrient insecurity together with its effect on the health and the well being of the children in the North West province of South Africa.

ADDENDUM 1
24-HOUR RECALL USED IN THIS STUDY

24-HOUR RECALL

Subject number: _____ Interviewer: _____

School: _____ Date: ____/ _____/ 200___

Tick what the day was yesterday:

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday

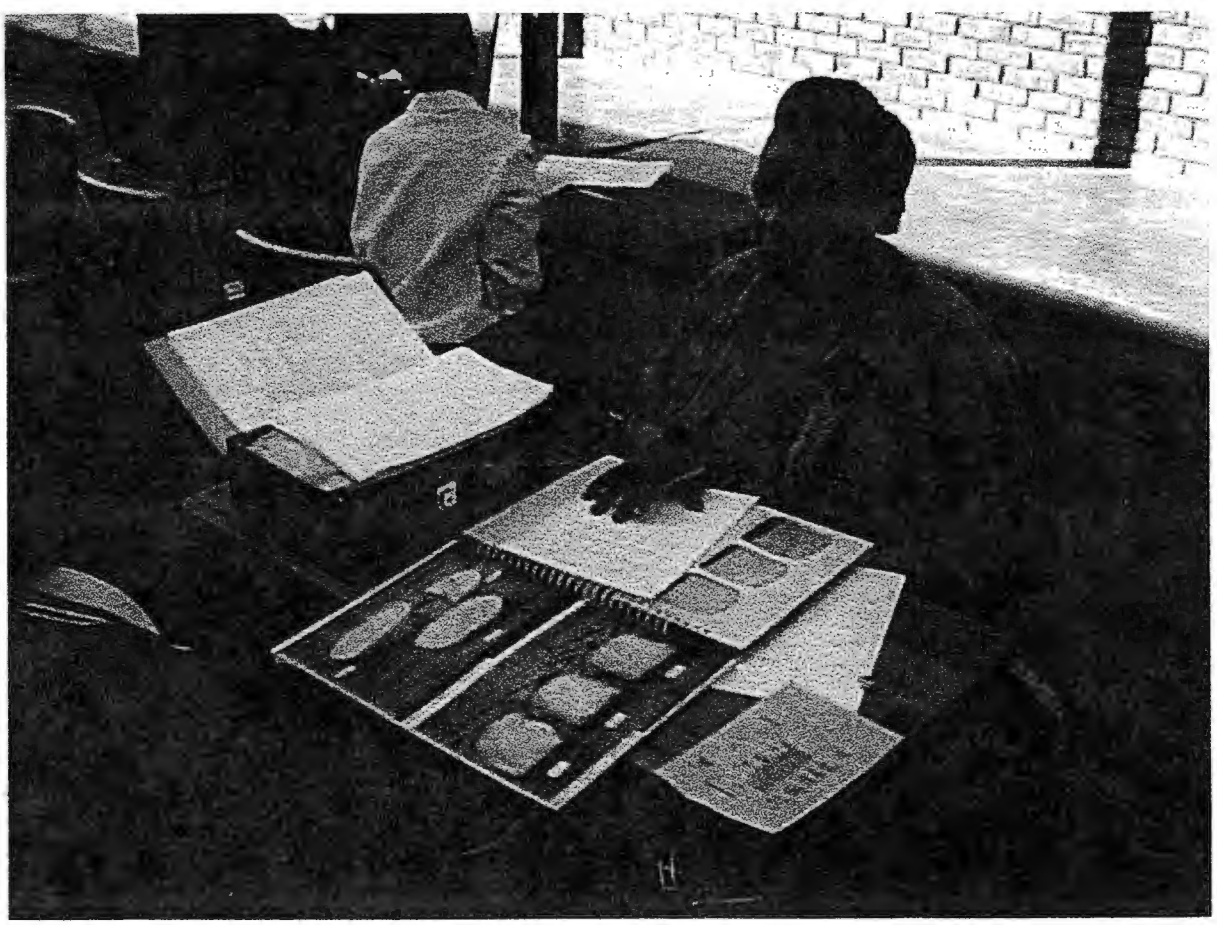
Would you describe the food that you ate yesterday as typical of your habitual food intake?

Yes	1	No	2

I want to find out about everything you ate or drank yesterday, including water or food you pick from the veld. Please tell me everything you ate from the time you woke up to the time you went to sleep. I will also ask you where you ate the food and how much you ate.

Time (approximately)	Place (Home, school, etc)	Description of food and preparation method	Amount	Amount in g (office use only)	Code (office use only)
From waking up to going to school, or starting day's activities					
During the morning at school or at home					

ADDENDUM 2
SAMPLE OF FOOD MODELS



ADDENDUM 3
TABLE OF RANDOM NUMBERS USED IN THIS STUDY

RANDOM DIGITS

Row:	Column: 00–04	05–09	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49
00	66241	82072	36359	39074	87266	69303	41915	01524	67981	65300
01	89698	56630	50968	15842	03105	29841	66060	71815	80036	87387
02	41171	97682	14803	55187	71756	91954	34525	07612	41893	80773
03	40176	13043	64270	50830	25412	97076	31168	12737	26371	59680
04	40571	88714	03292	43736	83688	70206	62150	82523	85794	20849
05	20280	63877	62646	52520	01133	14998	92336	49006	20273	08940
06	18455	55505	59379	34457	17262	03321	99419	79223	93174	35294
07	61405	03948	64197	59215	24548	78490	09085	21420	35437	49093
08	54626	79858	28969	21101	52871	98072	60724	22094	66835	52009
09	81920	09365	98038	67302	54966	66641	22678	46146	48437	08524
10	62227	48454	20160	31572	92899	29415	47061	90457	85569	55041
11	50493	38619	32006	83696	40539	52844	14081	81046	33283	76354
12	49321	13575	62920	00724	47506	76257	86150	38377	12813	44205
13	51969	20117	81999	99650	48595	90711	75341	68328	50249	18249
14	36265	72249	99395	16146	47821	85596	07550	84611	52167	66654
15	68544	58538	51869	60137	65762	95560	13288	88262	23843	66834
16	98383	37635	36917	87140	89040	29255	97680	67444	66562	15537
17	41629	03786	72397	83593	69053	41031	56953	15564	30093	43957
18	94950	69846	61311	60965	25132	15485	99556	56381	37345	14746
19	76617	72242	44643	72978	21086	53483	53499	49884	20687	87290
20	50983	31993	51727	19832	18131	13060	92861	90454	80823	60732
21	67326	51593	78372	15690	16293	84459	09572	32434	52536	78997
22	84500	47405	93996	02934	09298	32418	93706	60181	96057	63120
23	69629	99616	86192	16918	82236	47813	43181	10789	50217	95972
24	45427	80621	64015	29877	59415	68889	43650	54068	45753	23874
25	04842	90686	62968	46564	77938	09747	42773	12460	44836	41988
26	60190	79290	32945	16872	49694	77467	62193	36652	71053	47972
27	92765	63512	46656	20048	63788	03192	97083	33615	04619	41765
28	47846	49625	57112	38574	32053	99708	65959	17295	62462	47261
29	81743	74308	29061	57561	26611	21209	46261	52710	76915	91415
30	39681	47404	92230	17205	61655	68488	27471	98319	61241	35487
31	68961	70218	13715	66055	40865	33533	20766	58662	05230	75106
32	67542	75202	99468	95321	547 5	32184	26215	84287	01726	51551
33	14374	09879	46825	84353	55861	13739	92348	14640	67591	24536
34	10460	90185	78344	15784	55746	55190	79116	16788	86504	49337
35	51282	87415	26064	05053	27906	09222	61320	98879	30825	50336
36	92403	68804	41198	69180	33027	42593	94438	80818	18903	72468
37	78291	15522	21300	40335	66128	63255	73629	69505	50344	41748
38	87215	72404	89599	15740	93907	15762	19878	37928	51665	67020
39	56470	50673	52912	66642	76092	38924	99427	73752	02765	34847
40	59469	37946	11912	32161	63864	41449	54738	01341	22549	38560
41	26484	66134	02903	12776	78687	00772	53585	87227	37004	41541
42	41903	75207	41897	34759	43284	85048	10112	13539	81625	06108
43	67053	89786	98020	76790	14015	58528	95742	15673	54205	63646
44	56835	79433	05468	80283	37499	29077	13072	78999	17146	34010
45	34299	20208	26358	12247	27316	71490	20933	05274	23962	64363
46	82451	23318	14230	71095	77512	71961	90958	23518	73872	69008
47	98044	52950	29316	62935	40153	34663	55002	21750	38889	99000
48	87059	14336	24469	44760	16470	28620	13192	35191	79835	16505
49	40267	19837	18161	40046	08280	51801	11155	17281	59255	71071

ADDENDUM 4
DEMOGRAPHIC QUESTIONNAIRE USED IN THIS STUDY

Potchefstroomse Universiteit
vir Christelike Hoër Onderwys

1 Subject number				
2 Date	D	M	Y	
3 Place and region				
Interviewer				

Home address _____

4 Stratum of urbanisation:	Rural *	1
	Informal town	2
(Classify stratum of urbanisation)	Urban	3

*Rural = tribal land, farm schools; informal town = corrugated iron house; urban = formal town/city

5 Gender	Male	1
	Female	2

6 Age				
Date of birth (for control purposes, do not code)	D	M	Y	

7 First Language	Setswana	1
	Afrikaans	2
	English	3
	Xhosa	4
	Zulu	5
	Other:	6

8 Second Language	Setswana	1
	Afrikaans	2
	English	3
	Xhosa	4
	Zulu	5
	Other:	6

9 Do you receive treatment for any chronic disease?	Yes	1
	No	2

10 If yes - what disease?		
11 Girls only: Have you started menstruating (seeing periods) yet?	Yes 1	No 2
If yes, at what age (year)?		

12 Do you take snuff?	Yes	1
	No	2
13 Do you smoke?	Yes	1
	No	2
14 If no – have you smoked regularly before?	Yes	1
	No	2

15 If yes – what do you smoke?	Cigarettes	1
	Tobacco/pipe	2
	Other:	3

If other – describe

16 How much do you smoke?	per day	
	per week	
17 For how long have you been smoking (years)		
18 Calculate pack years		

19 In which grade are you this year?	Grade 1-3	1
	Grade 4	2
	Grade 5	3
	Grade 6	4
	Grade 7	5
	Grade 8	6
	Grade 9	7

20 Does any member of your household have the Right to use any property (house/flat/room) as his/her own?	Yes	1
	No	2

21 What type of property?	

22 Please name the members of your household

Member	Age	Education (grade passed)	Present job

23 Who is the breadwinner in your home?	

24 Does he/she have a job at the moment?	Yes	1
	No	2

25 If yes – what kind of job?	Doctor/nurse/teacher/professional	1
	Business/taxi/self employed formal	2
	Typist/assistant/office work	3
	Domestic worker/garden/contract	4
	Hawker/car washer/informal sector	5

26 On which days of the week does he/she work?	Irregular (piece work)	1
	Part time (1-4 days/week)	2
	Full time (5-6 days/week)	3

27 Does someone in your household receive any additional pensions?	Yes	1
	No	2

28 What type of house do you live in?	Traditional hut	1
	Mokuku	2
	Brick house	3
	Other	4
Specify other		

29 Do you share a toilet with other households?	Yes	1
	No	2

30 What type of toilet do you have?	None	1
	Communal	2
	Bucket system	3
	Outside pit toilet	4
	Outside chemical	5
	Outside water flush	6
	Inside water flush	7

31 Where do you get your drinking water from?	Fountain, river	1
	Communal tap	2
	Tap on premises	3
	Tap in house	4
	Other	5
If other specify		

33 What type of stove do you have?	None	1
	Coal/wood	2
	Gas or parrafin	3
	Electric	4

34 What type of fridge do you have?	None	1
	Parraffin	2
	Gas	3
	Electric	4

35 Do you watch television every week?	Yes	1
	No	2

36 Do you listen to the radio every week?	Yes	1
	No	2

37 Do you have a computer in your home?	Yes	1
	No	2
38 If yes, do you play/work on the computer on most days?	Yes	1
	No	2
39 If yes, how many hours do you play/work on the computer on most days?	.....hour	

40 Does your school week include a physical activity/training period ?	Yes	1
	No	2

ADDENDUM 5
INFORMED CONSENT FORM

THUSA BANA PROJECT: INFORMATION ON THE STUDY

THE PRPOJECT HAS BEEN APPROVED BY THE ETHICS COMMITTEE OF THE PU FOR CHE. ETHICS COMMITTEE NUMBER (OOM-10)

I CONFIRM THAT:

It has been explained to me, that:

1. The purpose of the research study is to collect information on the problem of overweight and obesity among schoolchildren aged 10-15 years in the North West Province of South Africa.
2. I have been told that the researchers will obtain anthropometric variables of a random sample of children aged 10-15 years
3. The participant will be weighed and his/her height as well as circumferences and skinfolds of his/her arm will be measured without causing any pain to the child. For those measurements boys and girls in separate groups will be asked to undress in privacy of a class-room, because some measurements must be taken with the children dressed in underwear only. The different age groups will be measured separately. The researchers and fieldworkers will work in a professional way, not to embarrass the children.
4. Appropriate methodology to classify overweight and obesity in these age groups will be developed
5. The prevalence of obesity in children in the North West Province will be determined
6. The anthropometry of the different ethnic groups will be compared
7. The relationship between body mass index and adiposity in stunted children (low-height-for-age) will be determined
8. The role of dietary practices in the development of overweight and obesity will be determined
9. The role of physical activity levels and patterns in the development of obesity
10. Influences of ethnicity and urbanisation on the causative factors of overweight and obesity will be determined
11. Knowledge regarding overweight and obesity in these age groups will be measured
12. The general health status of obese children with controls, regarding absence from school due to illness will be compared
13. Guidelines for appropriate, culture sensitive, practical and sustainable intervention programmes for these age groups will be developed
14. I have also been told that this research is being done for the benefit of the children, and that 1200 children will take part in this study
15. It was also explained to me that the information I will give shall be kept confidential, but that it will be used anonymously for making known the findings to other scientist
16. It was also clearly explained to me that I can refuse to participate in this research study or I can stop answering the questions at any time during the interview

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, OR it was translated to me by_____(Name of translator) in my language_____. I was also given the opportunity to ask questions on things I did not understand clearly.

I the participant (child) hereby agree voluntarily to take part in this research survey.

Signed/confirmed at_____on_____2000

Witness_____

Participant's/representative of participant (parent)_____

ADDENDUM 6

A LETTER FROM THE DEPARTMENT OF EDUCATION TO GRANT PERMISSION TO CONDUCT THE STUDY

DEPARTMENT OF EDUCATION

NORTH WEST PROVINCE

PRIVATE BAG X2044, MMABATHO, 2735 - DR JAMES MOROKA DRIVE,
GARONA BUILDING, PHONE (0140) 873428 FAX (0140) 873775

ENQUIRIES: M J VAN ZYL
TEL. NO.: 018 2998151
FAX NO.: 018 2932160

Dr H.S. Kruger
Potchefstroom University
Private Bag X6001
POTCHEFSTROOM
2520

13 January 2000

Dear Dr. Kruger,

PERMISSION FOR RESEARCH PROJECT

1. Your letter, dated 24 November 1999, on the above matter, refers.

2. This is to inform you that the North West Education Department supports the Thusabana Study Project and that you have permission to enter schools in the North West Provence included in your random sample for the purposes of the above research project.

3. 'Please allow me to remind you that learners can only participate on a voluntary basis with the consent of the parents / Guardians of the child and that the North West Education Department cannot be held liable for any legal action which is the direct result of this research project.

I wish you the very best with the Thusabana Study Project and are looking forward to feedback on the results / outcome of your research.

Yours sincerely,

DEPUTY DIRECTOR GENERAL : NWED

DOK334

ADDENDUM 7
GREEN CARD

THUSA BANA PROJECT

Subject name:_____No:_____Gender:_____

STATION	ACTIVITY	CHECK CONTROL
STATION 1	RECRUITMENT, DEMOGRAPHIC QUESTRIONNAIRE	
STATION 2	BLOOD PRESSURE	
STATION 3	ANTHROPOMETRY	
STATION 4	ANTHROPOMETRY: CLOTHING	
STATION 5	PSYCHOLOGICAL QUESTIONNAIRE A	
STATION 6	DIETARY QUESTIONNAIRE	
STATION 7	MOTOR DEVELOPMENT A	
STATION 8	PSYCHOLOGICAL QUESTIONNAIRE B	
STATION 9	EATING HABITS	
STATION 10	FAMILY CIRCUMSTANCES + HIV TRANSMISSION	
STATION 11	PHYSICAL ACTIVITY	
STATION 12	MOTOR DEVELOPMENT B	SIGNATURE
BACK TO STATION 1		

ADDENDUM 8

A SKILLED INTERVIEWER ASKING THE SUBJECT QUESTIONS ABOUT DIETARY INTAKE USING 24-RECALL QUESTIONNAIRE AND PHOTO BOOK

BIBLIOGRAPHY

1. ALFORD, H. & EKVALL, S. 1984. Variability of disease assessment values among nutrition students. *Journal of the American Dietetic Association,* 84: 71-74

2. ANDERSON,J.W.,SMITH,B.M. & WASHNOCK, C.S. 1991. Cardiovascular and renal benefit of dry bean and soybean. *American journal of clinical nutrition*. 70, Suppl: 464S-474S.

3. APPEL, L., MOORE, T. & OBARZANEK, E. 1997. A clinical trial of the effects of dietary patterns on blood pressure. *New England journal of medicine*, 336: 1042-1044.

4. BEATON, G.H., MILNER, J., McGUINE, V., FEATHER, T.E. & LITTLE, J.A. 1983. Sources of variance in 24-hour dietary recall data: Implications for nutrition study design and interpretation, carbohydrate sources, vitamins and minerals. *American journal of clinical nutrition,* 37: 986- 995.

5. BLOCK, G. 1989. Human dietary assessment: methods and issues *Preventative medicine,* 18: 653- 660.

6. BLOCK, G., HARTMAN, A.M., DRESSER, C.M., CARROLL, M.D., GANNON, J. & GARDER, L. 1986. A data based approach to diet questionnaire design and testing. *American journal of epidemiology*, 124: 453-469.

7. BOULTON, T.J.C. 1985. Patterns of food intake in childhood and adolescent and risk of later diseases, or the awful food kids eat nowadays must be bad for them. *Australian and New Zealand journal of medicine*, 15: 478- 488.

8. BRAY, G.A & POPKIN, B.M. 1998. Dietary fat intake does affect obesity. *American journal of clinical nutrition,* 68:1157-1173.

9. BURK, M.C. 1961. Influence of economic and social factors on US food consumption. U.S.A: Burgess Publishing Company.

10. BUZZARD, I.M. 1998. 24-hour recall and food record methods. In WILLET, W. Nutritional Epidemiology. 2nd ed. New York Oxford University Press..

11. CARTER, R.T.,SHARBUGH, C.O. & STAPELL, C.A. 1981. Reliability and validity of the 24-hour recall. *Journal of the American Dietetics Association,* 79: 542-547.

12. CHARLTON, K.E. & JOOSTE, P.L.2001. Eat salt sparingly-implications for health and disease. *South African journal of clinical nutrition*, 14, Suppl: S55-S64.

13. CHENAULT, A. 1984. Nutrition and Health. Texas: Holt, Rinehart and Winston Inc.

14. CLAVIEN, H., THEINTZ, G., RIZZOLI,R. & BONJOUR, J.P. 1996. Does puberty alter dietary habits in adolescents living in a Western society? *Journal of adolescent health*, 19: 68-75.

15. COX, D., ANDERSON, A., McKELLAR, S., REYNOLDS, J., LEAN, M. & MELA, D. 1996. Vegetables and fruit: barriers and opportunities for greater consumption. *Nutrition and Food Science*; (5): 44-47.

16. CRISP, A.H. & McGUINES, B. 1975. Jolly fat relations between obesity and psychoneurosis in general population. *British medical journal*, 1: 7-9.

17. DEPARTMENT OF HEALTH. 1999. Demographic and health survey. Preliminary findings. Pretoria. Government printers. S.A.

18. DUPIN, H., ABRAHIM, J. & GIACHETTI, I. 1992. Apports nutritionnels conseillès pour la population françatse. CNRS-CNERNA. Lavoisier. Paris.

19. DWYER, T.J. 1988. Assessment of dietary intake. In: Shils, M.E.& Young, V.R, eds. Modern nutrition in health and disease, 7th ed. Philadelphia: Lea and Febiger.

20. DWYER, T.J. 1994. Dietary assessment. In: Shils, M.E., Olson, J.A., Shikes, M. eds. Modern nutrition in health and disease. 8th ed. Philadelphia: Lea and Febiger.

21. DWYER, T.J., KRALL, E.A. & COLEMAN, K.A. 1987. The problem of memory in the nutritional epidemiology research. *Journal of the American Dietetics Association,* 87: 1509-1512.

22. ELDERS, M.J. & HUI, J. 1993. Making a difference in adolescent health. *Journal of the American Medical Association,* 269: 1425-1426.

23. FOA/WHO Consultation. 1996. Preparation and use of food-based dietary guidelines. *Nutrition programme* WHO/NUT 96.6 Geneva. 1-9.

24. FOA/WHO Consultation. 1997. Carbohydrates in Human Nutrition. Report of a joint FAO/WHO. Rome. 1-140.

25. GANJI, V., BETTS, N. & WHITEHEAD, D. 1995. Nutrient intake of 1-3, 4-6, and 7-10 year age group children: Analysis of diets reported in 1987-88 National food consumption survey. *Nutrition research,* 15 (5): 623-631.

26. GEIL, P.B., & ANDERSON, J.W. 1994. Nutrition and health implications of dry beans, A review. *Journal of American College of Nutrition*; 13: 549-558.

27. GIBNEY, M & VORSTER, H.H. 2001. Editorial. *South African journal of clinical nutrition,* 14: 1-6.

28. JENKINS, D.J.A., WOLEVER, T.M.S., & TAYLOR, R.H. 1991. Glycemic index of foods: a physiological basis for carbohydrate exchange. *American Journal for Clinical Nutrition*; 34: 362-366.

29. KRUGER, H.S., VENTER, C.S., VORSTER, H.H., GREER, C.A., MACINTYRE, U.E., & MATSHEGO, L.R. 1999. Physical activity is an important contributing factor to obesity in Black women in the North West. *South African medical journal*, 86 (4): 463. (abstract)

30. LACHANCE, P.A. 1998. Overview of key nutrients: Micronutrient aspects. *Nutrition reviews*, 56: 534-549.

31. LAMBERT, E.V., BOHLMANN, I & KOLBE-ALEXANDER, T. 2001. 'Be active' Activity for health in South Africa. *South African journal for clinical nutrition,* 14, Suppl: S12-S16.

32. LANGENHOVEN, M., KRUGER, M., GOUS, E. & FABER, M. 1991. MRC food composition tables, 3rd ed. PAROW. South African Medical Research Council. South Africa.

33. LAW, M.R., FROST, C.D. & WALD, N.J. 1991. By how much does the dietary salt reduction lower blood pressure? *British medical journal,* 302: 819-824.

34. LEE, R.D. & NIEMAN, D.C. 1993. Nutritional assessment. U.S.A. WM.C Brown Communication Inc.

35. LEEDY, P.D. 1997. Practical research: planning and design 6th ed. USA. Prentice Hall, Inc.

36. LEWIS, C.J. & YETLEY, E.A. 1999. Health claims and observational human data: relation between dietary fat and cancer. *American journal of clinical nutrition*, 69, Suppl: 1357S-1364S.

37. LOVE, P. & SAYED, N. 2001. Eat plenty of vegetables and fruits. *South African journal for clinical nutrition;* 14, Suppl: S24-S31.

38. LOVE, P. MAUNDER, E., GREEN, M., ROSS, F., SMALE-LOVELY, J., & CHARLTON, K. 2001. South African food-based dietary guidelines: testing of the preliminary guidelines among women in KwaZulu-Natal and the Western Cape. *South African journal of clinical nutrition;* 14(1): S9-S19.

39. MAHAN, L.K. & ARLIN. 1992. Krause's food, nutrition and diet therapy. Philadelphia W.B Saunders' company. USA.

40. MAHAN, K.L., & ESCOTT-STUMP, S. 2000. Krause's food, nutrition and diet therapy. Philadelphia. W.B Saunders' company. USA.

41. MAUNDER, E.M.W., MATJI, J., & HLATSWAYO-MOLEA, T.2001. Enjoy variety of foods-difficult but necessary in developing countries. *South African journal of clinical nutrion.*14, Suppl: S7-S11.

42. MEDLIN, C. & SKINNER, J.D. 1988. Individual dietary intake methodology: a 50 years review of progress. *Journal of the American Dietetic Association,* 88: 1250-1257.

43. MORGAN, R.N., JAIN.M., MILLER. A.B., CHOI. N.W., MATTHEWS. V., MUNAN. L., BURCH. J.D., FEATHER. J., HOWE. G.R. & KELLY. A. 1978. A comparison of dietary methods in epidemiological studies. *American journal of epidemiology,* 107: 488-498.

44. NELSON, M. & BINGHAM, S.A. 1997. Assessment of food consumption and nutrient intake. In: Margetts, B.M., Nelson, M.eds. Design concepts in nutritional epidemiology. Oxford: Oxford University Press.

45. NEWMAN, W.P., FREEDMAN, D.S., & VOORS, A.W. 1986. Relation of serum lipoprotein levels and systolic blood pressure to early arteriosclerosis: the Bogalusa heart study. *New England journal of medicine,* 314: 134-144.

46. NESHEIM, R.O. 1982. Measurement of food consumption- past, present and future. *American Journal of Clinical Nutrition,* 32: 1292-1296.

47. OLIVEIRA, A.S., ELISON, C.R., MORE, L.L., GILLMAN, W.M., GARRAHIE, J.E., & SINGER, R.M. 1992. Parent-child relationship in nutrient intake: the Framingham children's study. *American journal of clinical nutrition,* 56: 593-598.

48. OLMEDILLA, B., & GRANADO, F. 2000. Growth and micronutrient needs of adolescents. *European journal of clinical nutrition,* 1: S11- S15

49. PLUTCHIK, R. 1976. Emotions and attitudes related to overweight. *Journal of clinical psychology,* 32: 21-24.

50. ROBINSON, C.H., LAWLER, M.R., CHENOWETH, W.L., & GARWIRK, A.E. 1990. Therapeutic nutrition, 17th ed. New York. MacMillan publishing company.

51. ROLLAND-CACHERA, M.F., BELLISLE, F., & DEHEEGER, M. 2000. Nutritional status and food intake in adolescents living in Western Europe. *European journal of clinical nutrition,* 54: S41-S46.

52. ROMA-GIANNIKOU, E., ADAMIDIS, D., GIANNIOU, M., NIKOLARA, R., & MATSANIOTIS, N. 1997. Nutritional survey in Greek children: nutrient intake. *European journal of clinical nutrition,* 51: 273-285.

53. SALMERON, J., MANSON, J.E., & STAMPFER, M.J. 1997. Dietary fiber, glycemic load, and risk on non-insulin dependent diabetes mellitus in women. *Journal of the American Medical Association,* 277: 472-477.

54. SAS/STAT, 1988. User's guide. Release 6.03 edition. Cary, NC: SAS Institute. Inc.

55. SAVACG (South African Vitamin A Consultative Group). 1995. Children Aged 6-71 Months in South Africa: their Anthropometric, Vitamin A, Iron and Immunisation Coverage status. Isando. SAVACG.

56. SCHOLTZ, S.C., VORSTER, H.H (jun)., MATSHEGO, L. & VORSTER, H.H. 2001.*South African journal of clinical nutrition,* 14: Suppl: S39-S47.

57. SIMKO, M.D., COWELL, C. & GILBRIDE, J.A., 1984. Nutrition assessment. U.S.A. Aspen System Corporation.

58. SMALE-LOVELY, J., CHARLTON, K.E. & LOVE, P. 2000. Food-based dietary guidelines: one size fits all. *South African journal of clinical nutrition,* 13: 100

59. SMITH, A.F., JOBE, J.B. & MINGAY, D.J., 1991. Retrieval from memory of dietary information. *Applied cognitive psychology,* 5: 269-296.

60. SPEAR, B.A. 1996. Adolescent growth and development. In: Ricket VI (ed.). Adolescent Nutrition: Assessment and Management. New York: Chapman and Hall.

61. SUB COMMITTEE OF NUTRITIONAL SURVEILLANCE. 1989. Committee on medical aspects of food policy. The diet of British school children. *Reports on health and social subjects,* 36: 1- 293

62. THOMPSON, F.E., & BYERS, T. 1994. Dietary assessment resource manual. *The journal of nutrition,* 124: 2245S-2246S.

63. TODD, K.S., HUDES, M., & CALLOWAY, D.H. 1983. Food intake measurement: problem and approaches. *Journal of the American Dietetic Association,* 84: 429-432.

64. US DEPARTMENT OF HEALTH AND HUMAN SERVICES. 1989. Nutrition monitoring in the United States: an update report on nutrition monitoring. Washington D.C: U.S government printing office.

65. VITAMIN INFORMATION CENTER. 1999. Dietary reference intake (DRIs): A step in the right direction.

66. VENTER, C.S. & van EYSSEN, E. 2001. More legumes for better overall health. *South African journal of clinical nutrition,* 14, Suppl: S32-S38.

67. VOCKEL, E.L., & ASHER, J.W. 1995. Educational research 2nd ed. New Jersey: Merrill/ Prentice hall.

68. VORSTER, H.H., BOURNE, L.T., VENTER, C.S. & OOSTHUIZEN, W. 1999. Contribution of nutrition to health transition in developing countries: a framework for research and intervention. *Nutrition reviews,* 57: 341-349.

69. VORSTER, H.H., LOVE, P. & BROWNE, C. 2001. Development of food-based dietary guidelines for South Africa. -the process. *South African journal of clinical nutrition,* 14, Suppl: S3-S6.

70. VORSTER, H.H. & NELL, T.A. 2001. Make starchy food the basis of most meals. *South African journal of clinical nutrition,* 14, Suppl: S17-S24.

71. WANG, Y., POPKIN, B. & ZHAI, F. 1998. The nutritional status and dietary pattern of Chinese adolescents, 1991 and 1993. *European journal of clinical nutrition,* 52: 908-916.

72. WHITNEY, E.M., CATALDO, C.B. & ROLFES, S.R. 1998. Understanding Normal and Clinical Nutrition. 5th ed. Johannesburg: West/Wadsworth..

73. WHO/ FAO. 1996. Preparation and use of Food-based dietary guidelines: Report of a joint consultation in Nicosia, Cyprus. Geneva. WHO.

74. WILLET, W.C. 1990. Nutritional epidemiology. 2nd ed. New York: Oxford University Press.

75. WILLET, W.C. 1994. Future directions in the development of food-frequency questionnaires. *American journal of clinical nutrition,* 92: 681-685.

76. WOLMARANS, P., & OOSTHUIZEN, W. 2001. Eat fats sparingly-implications for health and disease. *South African journal of clinical nutrition,* 14, Suppl: S48-S54.

77. WORLD HEALTH ORGANIZATION. 1997. Preventing and managing the global epidemic on obesity: report of WHO consultation on obesity. Geneva. WHO, 98: 7-14.

78. YOUNG, V.R. 1991. Soy Protein in relation to human protein and amino acid nutrition. *Journal of the American Dietetic Association.* 91: 828-835.

79. ZULKIFLI, S.N. & YU, S.M. 1992. The food frequency method for dietary assessment. *Journal of the American Dietetic Association,* 92: 681-685.