THE DEVELOPMENT OF A VALID AND RELIABLE NUTRITION KNOWLEDGE QUESTIONNAIRE AND PERFORMANCE-RATING SCALE FOR URBAN SOUTH AFRICAN ADOLESCENTS PARTICIPATING IN THE 'BIRTH-TO-TWENTY' STUDY

by

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DECLARATION

I, the undersigned hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or impart submitted it at any University for a degree.

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SUMMARY

The Birth to Twenty (BTT) study involves the monitoring of the health status and related factors of urban-born children from birth until age twenty. When the cohort reached age 13 years in 2003, nutrition knowledge assessment was identified as an important new priority and a nutrition knowledge questionnaire was required for these purposes. Subsequently a valid and reliable nutrition knowledge questionnaire was developed for the BTT study. This process started with the development of a conceptual framework of nutrition-related issues facing urban South African adolescents and identification of related nutrition concepts. A pool of potential questionnaire items reflecting the concepts was subsequently developed. These items were evaluated by an expert panel to ensure content and face validity before being structured into a questionnaire. The resulting 88-item questionnaire was completed by adult and adolescent samples, each age group comprising subgroups of those likely to have good nutrition knowledge and those likely to have poor nutrition knowledge. The data obtained from the completion of the questionnaire by these groups was used to refine the questionnaire through the determination of difficulty and discriminatory indices of the items, and the deletion of items that did not meet the stated criteria. The construct validity of the remaining 63 items was assessed using the same data set. To assess the internal consistency reliability (ICR) of the 63-item questionnaire it was completed by an adolescent sample population considered to be representative of the BTT cohort, after which the questionnaire underwent further steps of refinement. The result was a 60-item questionnaire of which the ICR and construct validity was reassessed and found to be satisfactory. However, to ensure the accurate interpretation of scores obtained by testees, the development of a performance-rating scale was necessary.

A norm-referenced performance-rating scale (norms) was developed by administering the nutrition knowledge questionnaire to a sample population similar to the BTT cohort (norm group) and transforming their performance scores to z-scores. The z-scores ranges were then categorised into stanines, thereby resulting in a norm-referenced performance-rating scale that can be used to rate the performance of the BTT cohort. The validity of the norms was assessed by administering the nutrition knowledge questionnaire to three validation groups that comprised groups who were expected to obtain different performance-ratings on the questionnaire based on their varying levels of nutrition knowledge. The validation groups performed as expected, with significant differences in performance-rating profiles found among the three groups, indicating the validity of the norms.

The study was successful in developing a reliable and valid nutrition knowledge questionnaire for use on the urban adolescents who participate in the BTT study. A norm-referenced performance-rating scale for use with the questionnaire was also successfully developed. The questionnaire and norms will be useful in assessing nutrition knowledge as well as in comparing the changes in knowledge of the BTT cohort as they move from lower to higher school grades.

OPSOMMING

Die “Birth to Twenty” (BTT)-studie behels die monitering van die gesondheidstatus en verwante faktore van kinders wat in stedelike gebiede gebore is van geboorte tot twintigjarige ouderdom. Toe die kohort in 2003 dertienjarige ouderdom bereik het, is die evaluering van die voedingkennis van die kinders as ‘n belangrike nuwe prioriteit geïdentifiseer. ‘n Toepaslike voedingkennisvraelys is vir hierdie doeleindes benodig en gevolglik is ‘n geldige en betroubare vraelys vir gebruik in die BTT-studie ontwikkel. Hierdie proses is begin deur die ontwikkeling van ‘n konseptueleraamwerk oor voedingverwante vraagstukke wat stedelike Suid-Afrikaanse adolessente in die gesig staar, asook die identifisering van verwante voedingkonsepte. ‘n Poel van potensiële vraelysitems wat die konsepte reflekteer is daarna ontwikkel. Die items is eers deur ‘n paneel van kenners evalueer om inhoud- en gesigsgeldigheid te verseker alvorens dit in ‘n vraelys omskep is. Die produk was ‘n vraelys wat 88 items ingesluit het wat vervolgens deur volwasse en adolessente groepe voltooi is. Die groepe het subgroepe ingesluit van diegene met verwagte goeie voedingkennis en diegene met verwagte swak voedingkennis. Die data wat tydens hierdie stap gegenereer is, is gebruik om die vraelys verder te verfyn deur die bepaling van die moeilikheids- en diskriminatoriese-indekse van die items. Die items wat nie aan vooraf gestelde kriteria voldoen het nie, is weggelaat. Die konstrukgeldigheid van die oorblywende 63 items is bepaal deur dieselfde datastel te gebruik. Om die interne-konsekwensie-betroubaarheid (IKB) van die vraelys te bepaal, is dit deur ‘n steekproef van adolessente, wat verteenwoordigend van die BTT-kohort is, voltooi. Hierna is die vraelys verder verfyn. Die uitkoms was ‘n 60-item vraelys waarvan die IBR en konstrukgeldigheid weereens bepaal is. Dit is gevind dat dié twee indikatore van geldigheid en betroubaarheid bevredigend is. Om akkurate interpretasie van die punt wat deur ‘n respondent vir die toets behaal te verseker, is die ideal om ‘n skaal te ontwikkel wat gebruik kan word om dié punt te takseer.

‘n Norm-gebaseerde prestasietakseringskaal is ontwikkel deur die voedingkennisvraelys deur ‘n steekproef wat verteenwoordigend is van die BTT-kohort (normgroep), te laat voltooi. Die prestasiepunte is getransformer na z-tellings wat vervolgens getransformeer is na stanneges, wat ‘n norm-gebaseerde prestasietakseringskaal opgelewer het wat gebruik kan word om die prestasie van die BTT-kohort te takseer. Valideringsgroepe met verskillende vlakke van voedingkennis, wat dus na verwagting verskillend getakseer behoort te word indien die norme toegepas word, het die voedingkennisvraelys voltooi om die geldigheid van die norme te bepaal. Dié valideringsgroepe het

soos voorspel presteer, met betekenisvolle verskille in die prestasieprofiele van die verskillende groepe. Hierdie resultate dui daarop dat die norme geldig is.

Die ontwikkeling van ‘n geldige en betroubare voedingkennistoets vir gebruik in die BTT-studie is suksesvol in hierdie studie deurgevoer. ‘n Norm-gebaseerde prestasietakseringskaal vir gebruik saam met die vraelys is ook suksesvol ontwikkel. Die vraelys en norme sal van waarde wees vir die evaluering van die voedingkennis van die BTT-kohort. Dit sal ook met sukses gebruik kan word om die verandering in die voedingkennis van die kinders soos wat hulle ouer word, te bepaal.

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All glory belongs to God, whose grace made it possible

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CHAPTER 1

INTRODUCTION

1.1 PROBLEM IDENTIFICATION AND MOTIVATION FOR THE STUDY

The release of Nelson Mandela from prison in 1990 initiated South Africa's transformation from an oppressive government serving the interest of a minority to a democratically elected government serving the interests of all citizens. This and other related changes in the country's political situation had environmental, economical and social implications for the people of South Africa. For example, the formal abolishing of the apartheid laws in 1991 legalised and thereby increased the migration of people from urban to rural areas in their search for jobs, access to educational facilities and for better living conditions (Heribert & Moodley 1993). The Birth-to-Ten study was initiated in 1990 with the aim of investigating biological, environmental, economic and psychosocial factors that are associated with the survival and health of children born and living in such urban areas, particularly in South Africa's largest metropolis Johannesburg-Soweto, for a period of ten years. The researchers expected children growing up in urban South Africa during this period of transformation to be faced with health challenges relating to adverse sexual and reproductive outcomes, non-communicable diseases and micronutrient deficiencies. These problems were expected to arise because of various biological, social, psychosocial and lifestyle risk factors. Therefore, the researchers wanted to investigate the existence of such factors so as to recommend strategies to reduce or eliminate these risks. The information gathered from this study would enable researchers to understand the determinants of child health and development and thereby provide government and other stakeholders with information that they can use to address the important health-related challenges facing the country's children during this period of transformation (Richter *et al*. 2004).

The Birth-to-Ten study continued for 12 years, a period during which several indicators of health and development were assessed on approximately 2 700 of the original 3 723 cohort enrolments. The indicators were birth weight, socio-economic status, household composition, migration patterns, anthropometry, dietary intake, dental health, bone mineral density, lipid profiles, blood pressure, smoking habits and psychosocial stress. The Birth-to-Ten study was successful in achieving its aims during the 12-year period and produced several reports that were circulated to all relevant stakeholders. One of the highlights of the study was its influence in the passing of new legislation prohibiting children access to cigarettes. The results from the study proved to parliament that the legislation at that time was making it easy for children to start smoking and was thereby having a negative impact on the children's health (Richter *et al*. 2004). Because of the positive impacts the study was having, a decision was made to continue with the study from year 13 until this cohort reaches age 20 years. From that

point onwards the study was referred to as the Birth-to-Twenty (BTT) study.

Cigarette smoking is only one of the many lifestyle practices that presented a health challenge facing the country. Because of the increased migration from rural to urban areas, the diets of many South Africans was observed to be changing from the traditional high fibre and low fat diet to the western low fibre and high fat and sugar diet, a phenomenon referred to as the *nutrition transition.* This was also accompanied by an increase in alcohol intake and a decrease in physical activity (Bourne & Steyn 2000; Popkin 2001). This kind of lifestyle has been implicated in the increased prevalence of chronic diseases of lifestyle such as coronary heart disease, type 2 diabetes, hypertension and obesity in South Africa (Walker 2001).

In addition to the South African studies on risk factors and the presence of chronic diseases of lifestyle in adults, studies have also indicated that the risk for certain chronic diseases may appear during childhood and adolescence (Berenson *et al*. 1998; Selvan & Kurad 2004); Obesity is already a problem among South African adolescents (Puoane *et al.* 2002; SADHS 1998) and they are also at risk of developing other nutrition-related problems, e.g. eating disorders, and micronutrient deficiencies (Vorster 2002). The possibility of these health challenges presenting in the BTT group and the need for investigations into these potential problems tied in well with the aim and objectives of the study and was adequate motivation for the inclusion of an intensive nutritional assessment component in the BTT study from year 13.

The objectives of this nutritional assessment component in the BTT study were to determine the presence of nutrition–related factors and their association with the eating behaviour of the BTT cohort. The specific nutrition-related factors targeted for investigation included weight management practices, dietary intake, eating attitudes and nutrition knowledge (Richter *et al.* 1999). These factors can impact on nutrition behaviour and ultimately, individual growth and development. For example, the lack of nutrition knowledge regarding the nutritional value of many commonly consumed foods may lead adolescents to consume foods of poor nutritional value, which may result in nutrient deficiencies, obesity and other chronic diseases of lifestyle (Mahan & Escott-Stump 2004).

Nutrition knowledge assessment was therefore one of the new aspects introduced into the BTT study from age 13 of the cohort. The results will be used in determining whether nutrition knowledge is an independent risk factor and/or linked to other risk factors in the development of nutrition-related diseases in adolescents. For these purposes the BTT research group identified the need for a valid and

reliable nutrition knowledge questionnaire for urban South African adolescents. A literature search showed that such a questionnaire was not available for use on the BTT cohort, indicating the need for the development of an instrument of this nature.

When considering the development of a nutrition knowledge questionnaire for a target group, in this case, the BTT group, the target group needs to be considered. The following was relevant in this regard: the cohort included children residing in the greater Johannesburg metropolitan and surrounding areas whose racial composition included blacks (78%), those of mixed ancestry (12%), whites (6%) and Indians (4%) (Richter *et al.* 2004). This 'rainbow nation' encompassed a variety of languages, cultures, beliefs, attitudes and practices that could impact on nutrition knowledge assessment. A nutrition knowledge questionnaire that would be appropriate for use on the cohort would therefore have to cover all relevant nutrition topics, be in an acceptable and understandable language, be relatively easy to complete and finally, be valid and reliable. Furthermore, the questionnaire should be able to facilitate rating of knowledge levels as well as monitoring possible changes in nutrition knowledge levels (Hopman *et al.* 2000).

The first step in the development of a questionnaire is to define what level of nutrition knowledge is required from the target group**.** This is referred to as establishing the measurable attribute (construct) of an instrument (Hawkes & Novak 1998). To accurately define knowledge requires the formulation of a conceptual framework and thereafter identifying nutrition topics (concepts) relevant to the conceptual framework in consultation with an expert panel (Rosander & Sims 1981; Fanslow *et al.* 1981; Sullivan & Schwartz 1981; Byrd-Bredbenner 1981; Lackey *et al.* 1981; Stevens *et al.* 1999; Talip *et al.* 2003). Following the definition of the conceptual framework and the identification of relevant concepts, an item pool for potential inclusion in the questionnaire must be developed. The items should then be subjected to various evaluations to determine whether they should be included in the final test or not. These evaluations should include assessment by expert panels and pilot testing using a group representative of the target group to ensure content and face validity (Fanslow *et al.* 1981; Sapp & Jensen.1997; Hawkes & Novak.1998). For statistical assessments such as item analysis for the determination of item difficulty and discrimination, as well as Cronbach α to assess internal consistency (reliability), the questionnaire should be completed by different groups appropriate for such purposes (Parmenter & Wardle 1999). As an assessment of construct validity, the questionnaire should be able to distinguish between groups known to differ in terms of the knowledge being measured (Sapp & Jensen 1997; Hawkes & Nowak 1998).

An important step in ensuring appropriate nutrition knowledge assessment is to develop a performance-rating scale to determine the knowledge levels of a target group. The literature distinguishes between three types of performance-rating scales namely; norm-referenced, criterion referenced, and content-referenced performance-rating scales (Morganthau 1990; McCloskey 1990). A norm-referenced performance-rating scale rates a child's performance in relation to that of a set of scores (norms) that have been established using a standardisation group. The norms can be interpreted according to standard scores, T scores, percentile ranks or stanines. A criterion-referenced scale rates performance against a predetermined standard, which is usually the mastery level, thus comparing the children against each other. These are usually interpreted within an age/gender-related framework. Content-referenced performance-rating scales are based on a range of developmental objectives and are usually interpreted according to the number of objectives that have been accomplished (Morganthau 1990; McCloskey 1990; Taylor & Walton 2001). Finally, the validity of a performance-rating scale should ideally, also be assessed.

It is clear that the development of a valid and reliable nutrition knowledge questionnaire and associated norms should occur through following a suitable well-defined process to ensure that the result are tools that are effective and efficient. Such were the processes that were followed for this study

1.2 AIMS

1.2.1 The primary aim of this study was to develop a valid and reliable nutrition knowledge questionnaire for urban adolescents to be used on participants of the BTT study.

1.2.2. The secondary aim was to develop a performance-rating scale to appropriately and accurately rate the nutrition knowledge of the BTT cohort.

1.3. OBJECTIVES

The following objectives were formulated to realise these aims:

1.3.1 To formulate a conceptual framework for the nutrition knowledge questionnaire and thereby identify the relevant nutrition knowledge concepts.

1.3.2 To develop a pool of potential questions based on the identified nutrition knowledge concepts.

1.3.3 To develop a preliminary questionnaire from the item pool.

1.3.4 To further refine the preliminary questionnaire until acceptable validity and reliability is ensured.

1.3.5 To develop a performance-rating scale to rate nutrition knowledge.

1.3.6 To assess the validity of the developed norms

1.4. DESCRIPTION OF KEY CONCEPTS

1.4.1. **Adolescence** is a period in a person's growth and development aimed at ensuring that by the end of that period, he/she has attained the ability to reproduce. This period usually occurs between the ages of 10 and 19 years and involves physical, cognitive and psychosocial growth and development (Dacey & Kenny 1997; United Nations 1997 & Coon 2001).

1.4.2. **Nutrition knowledge** for urban South African adolescents is defined as knowledge about nutrition that is required for good health as well as for the prevention and management of nutrition–related diseases and conditions, based on current South African recommendations for healthy eating behaviour (see section 3.3).

1.5. OUTLINE OF THE THESIS

After this introduction, the thesis follows the format of four additional chapters. In the literature review (Chapter 2) the different issues that needed to be considered in the development of the questionnaire are discussed in detail. Chapter 3 describes the actual development process that resulted in a 60-item nutrition knowledge questionnaire. This chapter has resulted in the publication of an article in the January 2005 edition of the journal, '*Nutrition'* (Whati *et al.* 2005). The second article that is yet to be published is presented in Chapter 4 and describes the process followed to develop a performance-rating scale to rate the nutrition knowledge of testees. In Chapter 5 a summary is provide of the whole process as well as final recommendations regarding the use of the questionnaire and its norms. Lists of tables and figures as well as addenda relevant to the chapters are included in the content pages.

Since the first article has already been published in the journal *Nutrition*, the referencing system applied throughout this thesis will follow the author's guidelines of *Nutrition*. However, the references in the text are not indicated by numbers as prescribed by the journal, but as specified by the Harvard system. Authors are listed in alphabetical order in the reference list.

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CHAPTER 2

LITERATURE REVIEW

When a nutrition knowledge questionnaire is developed for a particular target group, the nutrition-related characteristics of the target group, general principles and guidelines for good nutrition and the theory for questionnaire development need to be considered. As the questionnaire in this study is aimed at adolescents, the adolescence developmental phase is firstly discussed. This is followed by a discussion on the role of nutrition during adolescence which focuses on the actual nutrient needs of adolescents, their eating behaviour and factors influencing these eating behaviours. The potential health consequences of these behaviours are also discussed. As nutrition knowledge is one of the factors influencing the nutritional behaviour of adolescents and since it is the focus of this study, the third discussion looks at this concept in further detail. Since recommendations for healthy eating behaviour emerged as key concepts in nutrition education and knowledge assessment, these concepts are discussed in more depth. Finally, the theory of nutrition knowledge questionnaire development as well as the development of performance-rating scales is discussed.

1. THE ADOLESCENCE DEVELOPMENTAL STAGE

1.1 Overview

Adolescence is a period during which a child acquires the physical growth and maturity, intellectual/cognitive ability, as well as social knowledge and skills required to live and function as an adult. There are two phases of physical development in the adolescent stage, pubescence and puberty. Pubescence is a stage of physiological growth where primary sex organs mature and various processes that promote reproductive function start to occur. Puberty is the stage during which the processes leading to adult maturity in terms of sexual, emotional, intellectual and physical growth and development begin (Steinberg 1995; Dacey & Kenny 1997; Coon 2001).

1.2 Physical development

Physical development during puberty occurs with the main purpose being for the individual to become capable of reproduction (Rolfes *et al*. 1998; Coon 2001). In girls, the increased secretion of luitenising hormone (LH) and follicle-stimulating hormone (FSH) by the body's endocrine system leads to the appearance of secondary sexual characteristics such as breasts and body hair as well as the beginning of menstruation (menarche) which in fertile individuals involves the production and release of ova (ovulation). In boys, the hormone released is testosterone and it promotes the growth of genitalia, appearance of facial and body hair, deepening of the voice, as well as initiation of spermatogenesis

(Dacey & Kenny 1997; Kaplan 2000). During puberty, there is also a rapid increase in height and weight accompanied by changes in regional distribution of body fat resulting in the typical android and gynoid distribution found in older males and females, which is referred to as the 'growth spurt' (Dacey & Kenny 1997; Rogol *et al.* 2002).

There are gender and/or individual differences concerning the onset of puberty, timing of the first menstruation (menarche) in girls, as well as the rate and extent of pubertal growth. Genetics and nutrition have been implicated as the cause of these differences. Genetics has led to the generally earlier onset of puberty in girls of 10-11 years compared to 12-13 years in boys (Dacey & Kenny 1997; Coon 2001). Physically this has no negative consequences since the later onset of puberty in boys implies that they have a longer period of childhood growth and maturity and will ultimately be taller and heavier than girls by the end of puberty (Dacey & Kenny 1997; Rogol *et al*. 2002). However, the common differences in the onset of puberty between adolescents of the same gender may have a negative or positive impact on the adolescent. The so-called early-maturing or late-maturing adolescents develop at a slower or faster rate than the average adolescent. These non-average adolescents' body image as well as the society norms (of peers, family, community, etc.) that he/she is exposed to, will determine the type of impact the timing of maturity will have on him/her. For example, boys may react positively to early maturation as it may give them an advantage in the performance of sporting activities while girls may not appreciate looking bigger than their peers if they are treated differently by friends, family and the community or feel awkward for being bigger (Dacey & Kenny 1997; Kaplan 2000; Coon 2001).

Nutrition has an impact on some aspects of pubertal development, specifically in relation to body fat composition in girls. Dietary intake has been implicated in the decrease in onset of menarche from ~17 years of age to the current 12.5 years that was observed in the 20th century. This is because the onset of menarche physically enables girls to produce and release ova thereby allowing the ability to conceive. Since menarche and conception can only occur if there are adequate body fat stores, a diet that promotes early fat storage will lead to an early onset of menarche. Conversely, the typical eating habits of females that characterise anorexia nervosa, which is a common disorder in adolescents, leads to low fat stores which may delay the onset of menarche in such affected girls (Dacey & Kenny 1997; Kaplan 2000).

For the reason that differences are observed in adolescents of the same age and similar gender, the physical growth stage of an adolescent can be characterised by applying the sexual maturity rating

(SMR), referred to as Tanner Ratings. This scale is based on the presence of specific secondary sex characteristics. The ratings range from stage 1 to 5, with 1 indicating the presence of pubescence stage characteristics and 5 indicating the presence of adult characteristics (Dacey & Kenny 1997; Mahan & Escott-Stump 2004).

1.3 Cognitive development

The second aspect of adolescent development involves cognitive development, which relates to the acquisition of skills and abilities that will culminate in the adolescent displaying patterns of thinking that are more advanced, more efficient and more complex than those of younger children thereby reflecting mental maturity (Steinberg 1995; Dacey & Kenny 1997; Kaplan 2000). Cognitive development starts from birth where mental function has not yet become possible and becomes increasingly advanced during early and late childhood. Adolescence is the next developmental stage where cognitive development advances further in that a person learns to formulate their own arguments regarding issues that they previously would respond to by regurgitating the thoughts and opinions of others. This improvement in the manner of thinking is applied in the following four ways: in formulating an individual opinion about how to relate to other people (social cognition); in taking in available information, processing and storing the information in an effective manner (information processing); in logically assessing situations and subsequently making good judgements (critical thinking); as well as in using individual knowledge, skills and imagination to formulate original ideas referred to as creative thinking (Dacey & Kenny, 1997).

In addition to development related to the intellectual functioning of a person, the development of morals is another important aspect of cognitive development. The development of morals refers to the development of the ability to think and reason in a way that leads to behaviour that is acceptable to the individual based on their values and beliefs, as well as to society. The development of morals occurs in three stages. Firstly, thinking is guided by concerns regarding the negative or positive consequences of behaviour (pre-conventional level). Secondly, reasoning is based on following accepted rules and values in wanting to please society (conventional). Finally, self-accepted moral principles that have been carefully conceptualised are followed (post-conventional). Although moral development occurs during adolescents, as part of cognitive development, morals may not have developed to the last stage during adolescence and in fact, continued development or change in morality may occur during adulthood or a person may never reach the conventional or post-conventional stages (Dacey & Kenny 1997; Coon 2001).

1.4 Social development

The third aspect of adolescent development involves social development, which refers to the ways adolescents view themselves as individuals as well as in their interactions and relationships with others. Social development is initiated by the physical and cognitive development that occurs throughout adolescence which leads to adolescents questioning their self as well as their role in society. Self-questioning ultimately leads to a search for identity as well as seeking behavioural and emotional independence (Dacey & Kenny 1997; Kaplan 2000; Coon 2001).

In their search for identity, adolescents seek to develop their own personal ideology regarding values, beliefs, spirituality, relationships and vocational choice. The search occurs through adolescents questioning their current status and later committing themselves to following a specific plan of action. In seeking behavioural and emotional autonomy, adolescents go through a process where they become less reliant on their parents, form relationships with peers and members of the opposite sex and become increasingly dependent on themselves (Steinberg 1995; Dacey & Kenny 1997; Kaplan 2000; Coon 2001).

However, these processes do not go by smoothly and are usually loaded with confusion and conflict. For example, during the search for identity adolescents tend to rely on each other for support through the process of self-discovery. The increasing reliance on peers can extend to a need for their acceptance resulting in poor self-esteem, succumbing to peer pressures, as well as conflict with parents as a result of unacceptable behaviours (Steinberg 1995; Dacey & Kenny 1997; Kaplan 2000; Coon 2001).

1.5 Implications for nutrition knowledge questionnaire development

Nutrition knowledge of the BTT adolescents will be assessed from when the adolescents are at 'Tanner stage 1' up to 'Tanner stage 5'. This means that these adolescents will be at various times and to varying extents, going through the physical changes described above. The changes in physical development will be accompanied by cognitive and social development. Consequently, adolescents will possess various levels of thinking and reasoning abilities throughout the nutrition knowledge assessment period. Their nutrition knowledge and eating behaviours will also be affected by the stage of physical, cognitive and social development. The questionnaire will need to accommodate all these aspects in terms of item formulation and level of presentation in that the items should be formulated in a manner that appeals to the adolescent way of thinking; the form of questioning used should be

acceptable; and the lowest to the highest possible levels of adolescent intellectual abilities should be accommodated.

2. ADOLESCENCE AND NUTRITION

2.1 Nutritional needs of adolescents

The importance of nutrition throughout the lifecycle is undisputable and this is especially true for the adolescent because of the growth spurt experienced during this phase. A general increase in the requirements of all nutrients is experienced during this phase.

Energy needs are based on individual growth rate and level of activity and protein needs are linked to growth patterns (Mahan & Escott-Stump 2004). Adolescents incorporate more calcium, zinc, iron and magnesium into their bodies than at any other stage of the lifecycle. The increase in calcium requirements is linked to accelerated muscular, skeletal, and endocrine development. The build-up of muscle mass and associated greater blood volume in males as well as blood loss associated with the onset of menses in females increases iron requirements for both genders. Zinc is required for growth and development, which is noticeably increased in adolescents. Lastly, magnesium is also increasingly needed for bone growth and the proper functioning of nerves and muscles (National Diary Council, http://www.nationaldairycouncil.org 2001 accessed August 22, 2002; Mahan & Escott-Stump 2004).

The physical growth experienced during adolescence also influences their vitamin requirements. The increased demands for energy lead to increased requirements for thiamine, riboflavin and niacin. Tissue synthesis and cell growth increases vitamins A, C, E, B6, B12 and folic acid needs, while rapid skeletal growth increases vitamin D requirements. The specific role of other micronutrients such as iodine, phosphorus, copper, cobalt, chromium and fluoride in the adolescence phase has not been as extensively studied but it is a matter of course that they also play an important role (Mahan & Escott-Stump 2004).

2.2 Eating and associated behaviours of adolescents

For the purpose of this review the concept ‘eating behaviour’ refers to aspects such as actual eating patterns; food, drink and nutrient intake; as well as factors influencing such patterns and intakes.

Adolescents have been reported to generally display poor eating behaviour which could contribute to the development of nutrition-related diseases and conditions (Story & Resnick 1986; Story *et al*. 1998).

Firstly, adolescents have been observed to consume less than the recommended amounts of certain essential nutrients, including energy, protein, iron, calcium, fiber, vitamin A, vitamin C, and riboflavin. These deficiencies reflect an inadequate intake of food sources of these nutrients such as fruits, vegetables and milk as well as a diet lacking in variety (Ahmed *et al.* 1998; Cavadini *et al.* 2000; Rolland-Cachera *et al*. 2000; Chapman 2003). In the United States (US), a survey of US adolescent food intake trends from 1965 to 1996 showed that a lack of variety of fiber-rich foods was the cause of inadequate fiber intake in this group (Cavadini *et al.* 2000). Studies conducted among South African children and adolescents also reported inadequate intakes of energy, calcium, zinc, iron, potassium, riboflavin, iodine, fiber, vitamins B6, B12 as well as folate (Steyn *et al.* 1990; Walker 1994; Vorster *et al.* 1997). Black South African adolescents have specifically been found to follow a diet where refined cereals are the staple food and the main type of starch consumed. The lack of whole grain cereals, legumes, and vegetables in their diet was implicated in the poor fiber intake reported in the group (Steyn *et al.* 1990; Walker 1994).

In contrast to inadequate intake of certain foods or nutrients, over-consumption has also been observed among adolescents. They tend to consume excessive amounts of high fat foods such as hamburgers, fried foods and pastries, resulting in excessive intakes of saturated fat and cholesterol (Sargent *et al.* 1994; Cavadini *et al.* 2000). In a South African study by Steyn *et al.* (1990) a high intake of meat products which resulted in high saturated fat and cholesterol intake levels was reported for white 10-12 year old adolescents in the Western Cape. Lipids and their various components are not the only nutrients taken in excessive amounts. Refined sugar intake in the form of carbonated drinks, confectionary and table sugar (Lytle *et al.* 2000; Alexy *et al.* 2002) is also on the on the increase. A high intake of sugars, sweets, cakes and puddings was also reported in the South African adolescents of the Western Cape (Steyn *et al.* 1990).

Unhealthy weight management practises such as the use of diet pills, vomiting, fasting, and laxatives have been observed in several adolescent groups, with the prevalence of such practices as high as 43% (n=15 349), 57% (n=869) and 57% (n=599) reported in three separate studies in the United States (Grigg *et al.* 1996; Thombs *et al.* 1998 & Lowry *et al.* 2000). Among black first year female university students in South Africa (20 ± 4 years old, n=180) the prevalence of weight management practices was also found to be high with 42% having partaken in these practices in the five years preceding the study. The specific methods used were similar to those observed in the above-mentioned studies but also

included following unhealthy diets obtained from magazines and the skipping of meals (Senekal *et al*. 2001).

Alcohol use is highly prevalent among adolescents and was observed to start as early as school grades eleven or age 15 in South African adolescents (Myers & Perry 2002; Madu & Matla 2003). Of major concern is the use of alcohol during pregnancy, as was discovered among adolescents in the US (Kokataili *et al.* 1994). Of the 117 pregnant adolescents recruited for this particular study, 9% were using alcohol. The nutritional implications of alcohol use are discussed in more detail in Section 3.

2.3 Factors influencing adolescent eating behaviour

To understand factors that influence adolescent eating behaviour, Story (2002) identified four levels of influence, namely individual, social environmental, physical environmental and the macrosystem levels.

2.3.1 Individual factors

Individual factors that influence eating behaviour are psychosocial, biological and lifestyle-related (Neumark-Sztainer *et al.* 1999). The psychosocial factors influencing eating behaviour include the appeal and taste of food, attitude and beliefs, self-efficacy and level of nutrition knowledge. The taste and appeal of food have been identified by Neumark-Sztainer *et al.* (1999) as the two most common criteria used by adolescents in making food choices indicating that they would consume healthy foods more often if those foods tasted and looked better. Self-efficacy is a person's belief that they are capable of adopting a specific behaviour (Mounir *et al.* 1998) and the lack thereof has been described by Crayton (1994) and Neumark-Sztainer *et al.* (1999) as the reason behind adolescents choosing unhealthy over healthy behaviour. The common attitudes and beliefs of American adolescents regarding food have led to the adolescents' general categorization of foods as either 'junk' or 'healthy' foods (Story & Resnick 1986), concepts which have filtered across to other westernised countries. According to American adolescents junk foods are essential for enjoyment, pleasure and socializing, and the consumption of such foods is considered normal and appropriate for their age group and in line with their expression of independence. On the other hand, consuming healthy food was considered to be "abnormal" and only acceptable when such foods are eaten at home as part of a family meal or as part of a weight control diet (Chapman 1993; Neumark-Sztainer *et al.* 1999). Nutrition knowledge has also been described as one of the psychosocial risk factors for poor nutritional status in adolescence. For example, Walker and Walker (1993) evaluated the nutrition knowledge pertaining to food

composition of White, those of mixed ancestry, and Indian adolescents in South Africa and the results indicated an unsatisfactory level of knowledge among adolescents in all three groups studied. These authors implicated lack of knowledge as the reason for poor eating habits which contributes to the development of degenerative diseases later in the lives of the population groups studied.

Gender and hunger are the biological factors that influence individual eating behaviour (Neumark-Sztainer *et al.* 1999). Males have been described as more likely to increase intake of certain foods or nutrients as well as regular exercising so as to increase their muscle size, while their female counterparts are more likely to attempt to restrict intake with the aim of loosing weight (Field 2001; McCabe 2002). Gender was also associated with a higher fat and sugar intake in boys compared to girls in the study conducted by Lien *et al.* (2002) on fifteen year old (n=613) adolescents. On the subject of hunger, the feeling was mentioned and discussed frequently and extensively in the focus group discussions with US adolescents conducted by Neumark-Sztainer *et al.* (1999) as an important influential factor.

Lifestyle factors influencing adolescent dietary behaviour include perceived barriers to healthy eating such as time constraints, meal patterns, convenience, weight control and cost (Neumark-Sztainer *et al.* 1999). Adolescents tend to want to sleep longer in the morning thereby often skipping breakfast. Due to very busy schedules skipping meals throughout the day is also very common. When the adolescent eventually takes time to eat, the meals are often not healthy. It can therefore be said that regular meal patterns and perceived time constraints are issues for such adolescents. To complement their busy lifestyles, adolescents tend to consume foods that require minimum preparation at home or outside the home, with the latter's selection limited to ready-to–eat foods found in convenience stores, fast food restaurants as well as vending machines. In such instances, convenience is an influencing factor on the eating behaviour of adolescents (Neumark-Sztainer *et al.* 1999; Story 2002).

Attempting to prevent weight gain or attempting to loose weight influences eating behaviour in that adolescents will decide how and what to eat based on the effect it will have on their weight. Weight control behaviours range from the moderate to the extreme. Those practicing moderate levels of weight control tend to practice healthy behaviour such as a high fruit and vegetable intake or limiting saturated fat intake (Story *et al.* 1998; Neumark-Sztainer *et al.* 1999). Those who practice extreme weight loss behaviour on the other hand tend to skip meals, induce vomiting and take laxatives and such adolescents were found to consume less fruits and were more likely to consume high fat foods (Story *et al.* 1998).

With regard to cost, studies have shown that adolescents will buy foods that they can afford. For instance, consumption of fruits and vegetables by adolescents in high schools increased in cafeterias after they had cut the prices by 50%. However, due to their generally lower prices compared to a healthy meal at a restaurant, fast foods are the regular choice of foods consumed by adolescents (Neumark-Sztainer *et al.* 1999).

2.3.2 Social environment

The social environment for adolescents refers to the family, peers, and society (Story 2002). Although adolescence is a stage in which adolescents seek independence from parents, the family remains a major influence on adolescent eating behaviour through providing access to food and having an effect on an adolescent's food attitudes, preferences and values (Dacey & Kenny 1997; Kaplan 2000; Story 2002). Family members may also directly or indirectly educate children and each other about healthy or appropriate eating behaviour (Ivanovic *et al.* 1997) and this knowledge can on its own influence the adolescent's eating behaviour.

Society can be described as an organised group of individuals who practice certain characteristic behaviours. Although individuals are born and develop further in their capabilities for independent thought, feeling, and action, all these will be influenced by their interaction with society. In addition, society dictates which behaviours are appropriate or acceptable. For instance, society may determine the consumption of certain foods to be taboo while at the same time promoting the consumption of certain foods. All interactions and experiences associated with society that adolescents experience will have an influence on their dietary behaviour (Gifft *et al.* 1972; Dacey & Kenny. 1997; Kaplan 2000).

Peers are such major influences in adolescent behaviour that the issue of peer pressure and adolescent conformity to such pressure is often considered to be a significant part of adolescence (Dacey & Kenny 1997). Adolescents spend most of their time with their peers and rely on their peer group for emotional support and advice. Seeking peer approval regarding eating behaviour is one of adolescents' common behaviours (Dacey & Kenny. 1997; Kaplan 2000; Neumark-Sztainer *et al.* 1999). For example, adolescents may practice certain behaviours such as consumption of 'junk food' (Neumark-Sztainer *et al.* 1999) based on acceptability of such behaviours within their peer group. They may also practice other behaviours unbeknown to their peers such as purging, so as to conform to peer pressures to achieve thinness (Dacey & Kenny 1997; Rolfes *et al.* 1998).

2.3.3 Physical environment

The physical environment refers to all places other than the home, where food for consumption is available to adolescents. It includes schools, fast-food restaurants, vending machines, and workplaces. All these are places where adolescents consume foods depending on their availability and accessibility as food sources, as well as their preference for the types of food available in such places (Neumark-Sztainer *et al.* 1999).

Schools sometimes provide specific foods as per government nutrition programs such as the Integrated Nutrition Program in South Africa (Department of Health, unpublished document) or in cafeterias in the United States (Wills *et al.* 2004). South African school pupils from age 6-19 years were also found to purchase foods from street vendors selling their goods at schools (Cress-Williams 2001). All these present sources of food or meals that adolescents have access to and thereby form part of their eating environment.

Fast–food outlets hold a great appeal to adolescents due to their accessibility, acceptability, convenience, foods sold and food prices (Story 2002). Fast food outlets provided 32% of meals away from home for adolescents in the US, with increased consumption during weekends. Vending machines have also increased in visibility and popularity, conveniently located to cater for the snacking trend observed in the general population. Convenience stores represent 28% of non-home and non-school eating occasions for US adolescents. US adolescents are also part of the labour force as they take on part-time/weekend jobs (Story 2002). Fast-food outlets and convenience stores are the main suppliers of jobs for adolescents and the workplace can influence the food choice of adolescents due to the types of discounted and sometimes free foods available to them (Nielsen *et al.* 2002; Story 2002). Although there is inadequate scientific data on South Africa's physical environment and how it affects the country's adolescents, one can assume that urbanisation and westernisation is having a similar impact on our adolescents as has been observed in the US.

2.3.4 Macrosystem

According to Story (2002) components of the macrosystem that influence individual eating behaviour include food production, food distribution systems and the media.

With technological, political and economic changes food production has changed in the past few decades from the hunter-gatherer way of life where the focus was on daily survival to an era where

there are large quantities and varieties of food (Walker unpublished document). In the family, the caregiver is the main decision maker regarding how food is distributed amongst members of the household. On a larger scale food producers distribute their products through various channels and government policy has an impact on which, where and how foods are distributed. Government policies may also promote or restrict the import from and export to other counties. This can ultimately be traced to the economic and political situation within a country and relationships with other countries (Gifft *et al.* 1972). These factors will all have an impact on the availability and accessibility of foods for adolescents (Story 2002).

The mass media refers to means of communication that reach large numbers of people at a time. The main ones are print and audio-visual. Print media include newspapers, magazines and books while audiovisual media include radio, television, the internet and films (Story 2002). Adolescents thus live in a media- saturated environment. Coon et al (2001) summarized the results of international peer reviewed studies conducted on children to determine the relationship between their food intake and television viewing. The authors reported that children exposed to advertising choose advertised food products at a higher rate than those who were not exposed. The same applied to requests for food purchases. Unfortunately a similar in-depth study has not been carried out for adolescents. However, television viewing has been implicated in the onset of obesity in US adolescents through the negative impact time spent watching TV and playing computer games has on physical activity (Gortmaker *et al.* 1990; NDC 2001).

2.4 Nutrition-related health problems experienced by adolescents

2.4.1 Undernutrition

Deficiencies of certain essential micronutrients are common in developing counties and the most common deficiencies that present in adolescents are those of iron, vitamin A, iodine, calcium, and zinc (Korode 1990; Serra-Majem *et al.* 2001; Venkaiah *et al.* 2002; Delisle *et al.* unpublished document). However, less prominent deficiencies of riboflavin, vitamin B6, E and folate (Korode 1990; Serra-Majem *et al.* 2001) have also been reported. In the South African population there is a general lack of studies conducted in adolescent groups and most available data is on younger children. The latter has revealed the prevalence of vitamin A, vitamin C, iron, riboflavin and niacin deficiencies among young children in urban, peri-urban and rural areas of South Africa (Coutsoudis *et al.* 1993; MacKeown *et al.*

1998; Faber *et al.* 2001). It can be speculated that these deficiencies may also be prevalent among adolescents

In addition to nutrient deficiencies the effects of insufficient food intake has also been observed in South African children. The national food consumption survey of 1999 has reported stunting in 1 out of every 5 children and underweight in 1 out of 10 South African children aged 1-9 years (Labadarios *et al.* 2000). Other smaller studies have revealed a 20% and 31% prevalence of stunting among black children aged 2-5 years and black and coloured children aged 3-9 years (Popkin *et al.* 1996; Faber *et al.* 2001). In the adolescent population, a 19.5% prevalence of stunting was observed in South African adolescents (n=860) aged 10-14 years (Rampele *et al.* 1995).

2.4.2 Chronic diseases of lifestyle

Chronic diseases of lifestyle include conditions such as cardiovascular diseases, cancer, osteoporosis, overweight and obesity as well as Type 2 diabetes that occur in adolescence or later in life (Lytle 2002). Generally, these conditions develop due to a combination of genetic factors and lifestyle patterns such as poor dietary intake, inactivity and cigarette smoking. Therefore one would not expect a high prevalence of such conditions in adolescents. However, overweight and obesity, type 2 diabetes, bone fractures and weight-related eating disorders have already been reported in adolescent populations globally (Lytle & Kubik 2003). Wang *et al.* (2002) compared the adolescents' overweight trends in four countries, namely Brazil, Russia, China and the US, spanning three decades (1975- 1998). The prevalence of overweight was found to have increased in three of the four countries studied, namely Brazil (tripled), United States (doubled), and China (increased by one fifth). According to Schneider (2000), this is just an example of the ever increasing prevalence of obesity worldwide.

In South Africa a nationwide study (South African Demographic and Health Survey-SADHS) found 19.2% of South Africans aged 15 and older to be obese (SADHS 1998). A study conducted on 231 first year university students also found 8% of them to be overweight and 6.5% obese (Steyn *et al.* 2000). Hypertension prevalence increases with age (Health Systems Trust 2000) and the SADHS study revealed that 16% of adult women and 13% of adult men were hypertensive (SADHS 1998). One can thus postulate that the elevated blood pressure reported in the younger populations can develop into hypertension with increasing age.

2.4.3 Other nutrition-related conditions

Eating disorders occur commonly in adolescence and include anorexia nervosa, bulimia nervosa, binge-eating disorders, and anorexic/bulimic behaviours (Rolfes *et al.* 1998; Lytle & Kubik 2003). In South Africa, one study conducted on first year university students revealed a high prevalence of eating disorders in females, ranging from a 6% prevalence of bulimia/binge-eating to 16% responding in a manner suggesting disturbed eating habits (Sheward 1995). A study which showed a high prevalence of abnormal eating attitudes among white (33%), mixed race (26%) and black (20%) South African adolescents also suggest the presence of eating disorders amongst the group (Caradas *et al.* 2001). These conditions are psychological disorders that require specialised treatment (Lytle & Kubik 2003) by a team that includes doctors, nurses, psychiatrists and dieticians. Regardless of the aetiology of eating disorders, poor eating habits such as self-starvation, binge eating and purging characterise these conditions (Lytle & Kubik 2003) and they can also lead to the development of chronic illness amongst adolescent girls (Fischer *et al.* 1995).

HIV/AIDS is a world-wide phenomenon that has reached epidemic proportions in South Africa, with a prevalence of HIV infection of 15.6% reported for South Africans aged 15-49 years of age in 2002 (SAHR 2000). Various opportunistic infections in HIV/AIDS result in disease conditions that are characterised by a decrease in appetite; poor food intake; inefficient metabolism and malabsorption of nutrients; excessive loss of nutrients; and negative drug-nutrient interactions. As a result, a person with HIV/AIDS is at risk of weight loss and wasting; as well as deficiencies of vitamins A, B1, B2, B6, B12, C, E, folate, selenium, zinc and magnesium (Piwoz & Preble 2000; Whitney *et al.* 2002) and these are all problems that may occur among adolescents with HIV/ AIDS

As was mentioned in section 2.3, alcohol use and abuse is a problem since excessive intake is known to have a negative impact on health status. Alcohol increases the risk for protein–energy malnutrition; cancers of the oral cavity, pharynx, liver, oesophagus and female breast cancer; and anaemia. Nutritional deficiencies occur as a consequence of decreased appetite and thus inadequate intake, as well as changed absorption, metabolism and excretion of essential nutrients. These include protein, calcium, vitamins A, C, B6, thiamine and riboflavin; as well as malabsorption of thiamine, folate, calcium, phosphorus, zinc and vitamin D deficiencies (Williams 1994; Whitney *et al.* 2002). The risk of iron overload has also been found to increase with the consumption of more than two units of alcoholic drinks per day (Ioannou *et al.* 2004) and excessive consumption may even lead to diarrhoea as the alcohol inhibits sodium and water absorption (Bode & Bode 2003). Although the presence of

such health conditions as a direct consequence of alcohol intake have not been researched in South African adolescents, the use of and abuse of alcohol by South African adolescents as reported by Myers and Parry (2002) places them at risk of developing such conditions.

Another important issue for South Africans is food and water safety. In certain urban and rural areas of the country there is a lack of access to safe clean water. People are also at risk of consuming unhygienic foods due to the poor hygiene standards observed at some purchase points such as shops and street vendors. For example South African school pupils from age 6-19 years were found to purchase foods from street vendors selling their goods at schools and taxi ranks (Cress-Williams 2001) Poor personal hygiene practices may also lead to the preparation, storage and consumption of unsafe food and water. As a consequence of such practices, adolescents are at risk of developing food and water-borne illnesses such as diarrhoea and botulism which may sometimes prove to be fatal (Whitney *et al.* 2002).

The high prevalence of adolescent pregnancy is a worldwide problem with 25% of woman having a child before age 20 (Senderowitz 1995). The rates are higher for South Africa as the SADHS revealed a 35% prevalence of adolescent pregnancy (SADHS 1998). South African adolescents are also at greater risk of early pregnancy as sexual maturation occurs at an early age (13 years) among some adolescent populations (Buga *et al.* 1996). Pregnancy is associated with nutrition-related consequences which although not directly related to age, are worsened by existing nutritional issues that feature prominently during adolescence. Adolescents who become pregnant while their own nutritional status is poor, including low nutrient stores, are at increased risk for the development of anaemia caused by vitamin B12, folate and iron deficiencies. They are generally at risk of developing vitamin A, vitamin C, calcium and zinc deficiencies. (Gadowsky *et al*. 1995; Pena *et al*. 2003; Delisle *et al.* unpublished document). Pregnant adolescents have also been found to be at risk of being overweight and developing obesity and other chronic diseases later in life (Mahan & Escott- Stump 2004; Delisle *et al.* unpublished document). In addition, alcohol use in pregnancy could result in foetal alcohol syndrome (Williams 1994). The high prevalence of pregnancy during this stage makes it an important nutrition-related health issue with nutritional implications for female adolescents that needs to be borne in mind.

2.5 Implications for nutrition knowledge questionnaire development

Growth and development occur at a very rapid rate during adolescence and nutrition during this period takes on a special significance. Gender and individual differences occur in the timing, intensity and

extent to which growth and development takes place thus cause variations in the nutritional requirements of each adolescent. In addition to the inter-individual differences in nutritional needs, adolescents practice a wide range of eating behaviours. These factors should be taken into consideration when formulating the questions and answer options for items to be included as questions in a nutrition knowledge questionnaire. The items should firstly be phrased in such a way that a wide range of possible correct answers can be accommodated and secondly, should include all possible eating behaviours. Another aspect that requires consideration in item formulation is the different factors that influence eating behaviours that are being practised. Some of these individual, physical and social environmental as well as macrosystem-related factors represent the context within which adolescents practice various eating behaviours, e.g. food choices when eating with friends is a typical situation that adolescents are faced with. These context-related factors should be considered when formulating items to make them relevant for adolescents.

The lack of adequate scientific information on nutrition-related health problems among South African adolescents makes it difficult to identify relevant issues for questionnaire development. Considering how important it is in questionnaire development to formulate items based on appropriate topics, this poses a potential problem. However, it has long been understood that issues facing adolescents from both developed and developing countries as well as problems experienced by younger children in South Africa could be relevant for adolescents in this country. It follows that the above-mentioned issues will be considered in the development of a nutrition knowledge questionnaire for urban South African adolescents.

3. NUTRITION KNOWLEDGE AND ADOLESCENCE

3.1 Nutrition education for adolescents

Several factors were shown to influence the eating behaviour of adolescents and nutrition knowledge was identified as one of these factors. Because of the link between nutrition knowledge and eating behaviour as well as other risk factors in the development of nutrition-related diseases and conditions, nutrition education has been suggested as one of the strategies to address nutrition-related issues for adolescents (Delisle *et al.* unpublished document) with school-based programmes recommended as the most effective route of action (Jacoby *et al.* 1998; Simeon 1998).

A nutrition component in formal education has proven effective in improving the knowledge of adolescents in the US. After 7th grade children were enrolled in a 5-week course that involved nutrition

education based on the food guide pyramid, knowledge was found to have increased after the group was tested with a 34-item nutrition knowledge questionnaire (Reinhardt & Brevard 2002). Another example is of a study conducted with high school students aged 14-18 years where the curriculum for 'comprehensive family and consumer sciences' was the basis for a 4-week nutrition education programme. A 57-item nutrition knowledge questionnaire showed significantly higher knowledge levels among those who participated than those who did not go through the education program (Stanberry *et al.* 2001).

In South Africa, nutrition education was previously included in the secondary level education curriculum only as part of the 'Home Economics' (now referred to as Consumer Science) school subject (Department of Education 2002). Despite recommendations made by Walker and Walker (1993) after their assessment of white, coloured and Indian adolescents' nutrition knowledge to intensify nutrition education at schools, amongst other places, no significant move was made until recently. The implementation of the new national curriculum, 'Life Orientation', a school subject compulsory to all secondary school pupils, was a move in the right direction. The curriculum contains a wide range of nutrition information that is meant to be implemented from primary school onwards (Department of Education 2002).

3.2 South African recommendations for nutrition education

Over the decades many countries have generated various recommendations to be used in advising the public on healthy eating behaviour. These recommendations are generated through consultations among the nutrition fraternity and government policy makers to be disseminated from a national down to an individual level by using them as basis for nutrition education programs. These recommendations are often accompanied by practical guides, both in written and graphic format and are changed as new information arises and eating patterns change. It is therefore no wonder that studies mentioned in Section 3.1 all used nutrition recommendations as a basis for nutrition education and assessing nutrition knowledge. There are several ways in which nutritional recommendations are formulated and the main ones are summarised on Table 1.

Table 1: Types of recommendations for healthy eating behaviours

Type of recommendation	Principle	Application
Dietary Reference Intakes[1]	Four nutrient-based reference values for the maintenance of health, improving quality of life, and reduction of risk for chronic diseases in individuals.	Used as bases for advising individual regarding adequate daily food and nutrient intake.
Dietary Goals	Quantitative recommendations for food and nutrient intake for optimal nutrition.	Used at a national level for the planning of food and nutrition policies, designing food products and evaluating dietary habits of a large group of healthy people.
Dietary targets	Specific desirable points to be achieved along the path towards meeting national eating goals in an overall health policy context.	Identifiable and quantifiable objectives for the monitoring and evaluation of implemented objectives.
Dietary guidelines	A set of qualitative advisory statements that express dietary goals in terms of food that gives advice on following optimal eating habits.	Form the basis of nutrition policies and programmes and can be used by health workers for nutrition education and promotion purposes.

(Institute of Medicine 2000; WHO 1998; Delisle *et al.* unpublished document)

Before 1988, South Africa's nutrition community had been using recommendations and tools adapted from the US and the United Kingdom which included the 3, 4, 5 and 7 food groups (Love 2002). The 3-food groups were targeted at poor people with little education, the 4 and 5-food groups for wealthier and more educated people, and the 7-food groups were used to compile exchange lists for therapeutic diets. In 1988 a decision was made to use only the 3-food groups and 5-food groups in South Africa in order to provide an understanding of the importance of a balanced and varied diet for all the different socio-economic groups (Love 2002).

The Food and Agriculture (FAO)/World Health Organisation (WHO) International Conference on Nutrition held in December 1992 adopted the World Declaration and Plan of Action for Nutrition of which South Africa was one of the signatories. One of the strategies for the plan of action involved the development and dissemination of qualitative and/or quantitative food-based dietary guidelines

[1] Recommended Dietary Allowance (RDA), Estimated Average Requirement (EAR), Adequate Intakes (AI) and Tolerable Upper Intake Level (UL)

(FBDGs) appropriate for different age groups, lifestyles and populations of different countries. It was assumed that such guidelines would serve to "promote healthy diets and lifestyles" that would improve nutritional well-being and food consumption throughout the world (WHO 1998). In 1994 the Development Bank of Southern Africa recommended the development of appropriate nutrition messages and materials and the integration thereof into primary health care services. This was strongly supported by the Department of Health's Nutrition Directorate, with additional emphasis placed on the integration of the messages and materials into the Integrated Nutrition Program (INP). However, no policy decision had been made at that point in time (Love 2002).

The WHO and FAO convened in March 1995 to formulate the scientific principals for the development and use of FBDGs (WHO 1998). The consultation resulted in the publication of a technical report that, together with the lack of suitable guidelines for South Africa, promoted the initiation of a process by the Nutrition Society of South Africa (NSSA) to formulate FBDGs for South Africa (Vorster *et al.* 2001). To set off the process of developing the guidelines the NSSA formed a Working Group (WG) comprising of volunteer delegates from the South African National Department of Health, academia, Association for Dietetics in South Africa (ADSA), NSSA, Medical Research Council (MRC), the agriculture and food industries, United Nations Children's Fund (UNICEF) and the FAO. All these delegates had been invited via a South African scientific journal to become members of the working group (WG), a request to which only a few volunteers responded. However, after the WG's first workshop held in Pretoria, many attendees became volunteer members thereof. (NSSA 2001; Vorster *et al.* 2001). The WG followed the process recommended by the WHO/FAO (WHO 1998) in developing the guidelines, with adaptations where necessary.

The first step undertaken was to conduct a workshop in which diet-related public health problems, nutrient intakes of different groups, vulnerable groups and relevant public health policies were addressed. Thereafter, a document was compiled that highlighted relevant nutrition issues, after which preliminary guidelines were formulated. Volunteer attendees of a nutrition conference participated in a workshop during which the document as well as other relevant papers that had been circulated before the workshop were addressed. The WG later met to discuss the outcome of the workshop and a second set of guidelines was formulated. At this meeting it was also decided to test the guidelines and a protocol was formulated for these purposes. Based on the results of the testing of the guidelines in Kwazulu-Natal and the Western Cape Province, the guidelines were edited and technical support papers were written for each guideline. Further discussions were conducted with the nutrition

community during a FBDG workshop at a nutrition conference and appropriate changes to the guidelines were made. The third set of guidelines was submitted to the Department of Health (DOH) for endorsement. During this meeting with the DOH's health management committee the Dental directorate requested that the issue of dental caries also be addressed in the guidelines. This concern was addressed and further recommendations were made during a workshop that included nutritionists from each of the nine provinces, representatives from NSSA, ADSA, South African Society for Parenteral and Enteral Nutrition (SASPEN), as well as members of the original WG. The recommendations were referred back to the WG for further discussions. The proposed final guidelines that were ultimately approved by the South African National Department of Health are summarised in Table 2 (NSSA 2001; Vorster *et al.* 2001)

Table 2: Summary of the eleven South African food-based dietary guidelines

Guideline	Conceptual Meaning	Public health problems addressed by the guideline	Potential constraints and problems
Enjoy a variety of foods (Maunder *et al.* 2001)	The incorporation of different foods from all the different food groups as well as the use of different cooking methods on a regular basis.	Low energy and micronutrient intakes, over consumption and chronic diseases of lifestyle, taste preferences of families and individuals accommodated.	Food insecurity, misinterpretation of the guideline leading to increased consumption of processed foods poor in micronutrients and phytochemicals, increased energy intake, obesity and associated problems.
Be active (Lambert *et al.* 2001)	An accumulation of 30 minutes or more of moderate-intensity physical activity on most days of the week is advised; Lifestyle or habitual physical activity structured around household and gardening activities, transport, and leisure time is ideal.	Low physical activity a risk of all-cause mortality, as well as mortality and morbidity associated with many chronic diseases of lifestyle.	Age and gender, socio-economic status, education, certain negative health behaviours, self-efficacy, perceived lack of time, coastal effect, family participation, social support, lack of infrastructure and facilities in communities and risk to personal safety in violent areas.
Make starchy foods the basis of most meals (Vorster & Nell 2001)	Optimum intakes of cereals, grains, and other carbohydrate containing foods, preferably fortified, unrefined or minimally processed forms are advised. The starchy foods should be the largest portion of food with the rest of the meal planned around the starchy food.	Chronic diseases of lifestyle such as obesity, type 2 diabetes, cardiovascular disease, certain cancers; gastrointestinal diseases and dental caries.	Misinterpretation of the guideline resulting in very high intakes which can contribute to an increase in triglyceride levels that can lead to chronic diseases of lifestyle.
Eat plenty of fruits and vegetables everyday (Love & Sayed 2001)	At least 5 portions (400g) of vegetables and fruits are recommended per day.	Certain cancers, cardiovascular diseases, infections and cataracts can be influenced positively by a high intake of fruits and vegetables.	Affordability, availability and taste preferences.
Eat dry beans, peas, lentils, and soya regularly (Venter & Van Eyssen 2001)	100-200g of cooked pulses, and 25g soy protein a day are recommended at least 3 times per week or everyday if one never eats chicken, fish, meat, eggs or milk.	Type 2 diabetes and its complications; cardiovascular diseases including hypertension; certain cancers; protein deficiency; gastrointestinal function; menopausal symptoms and osteoporosis.	Inconvenience involved in changing shopping habits and eating patterns. The long cooking time and expenses associated with sources of fuel for cooking such as wood and electricity.

Table 2 (continued)

Guideline	Conceptual Meaning	Public health problems addressed by the guideline	Potential constraints and problems
Chicken, fish, meat, milk or eggs can be eaten daily (Scholtz *et al.* 2001)	An intake of 400-500ml of milk or its equivalent daily; 2-3 servings of fish per week; 4 eggs per week; and not more than 560g of meat /week is recommended. Low fat products should be chosen and fat should be used minimally in preparation, cooking and serving.	Undernutrition of calcium, iron, zinc, and essential omega-3 fatty acids	Misinterpretation of the guideline resulting in over consumption leading to increased risk of chronic diseases, and economic status.
Eat fats sparingly (Wolmarans & Oosthuizen 2001)	A moderate fat diet with fat providing less than 30% of total energy is advised. The selection of low fat options for animal products, lean meat and chicken, unsaturated tub margarines and oils instead of hydrogenated fats from animals, and avoidance of non-dairy creamers is recommended. Little fat should be used in food preparation and when using spreads on bread	Cardiovascular diseases, obesity, certain cancers and type 2 diabetes.	Increased intake of carbohydrates; lower absorption of fat-soluble vitamins; decreased palatability of diet.
Use salt sparingly (Charlton & Jooste 2001)	Use a minimum of 5g per day of iodised salt. Minimal use of salt at the table and in the preparation of meals is advised. The intake of processed foods high in salt should be limited.	Hypertension, iodine deficiency.	Taste preference of individuals
Drink lots of clean, safe water (Bourne & Seager 2001)	Two litres of clean water is recommended for each person in a day	Infectious intestinal diseases	Unavailability of adequate clean water sources
If you drink alcohol, drink sensibly (Van Heerden & Parry 2001)	People who do not drink alcohol are not advised to start drinking. The following people are advised to abstain from alcohol use: children, individuals of any age that cannot restrict their drinking to moderate levels, pregnant women, people operating machinery, people on prescribed medication, and people with a genetic tendency to become addicted to alcohol. Responsible drinking is limited to 0- 2 drinks/ day for females and 0-4 drinks/ day for men	Multiple organ system dysfunction, teratogenic effects, negative social effects	Individual behaviour, psychosocial influences
Eat food and drinks containing sugar sparingly and not in-between meals. (Steyn *et al.* 2002)	An amount of <40g sugar/day in areas where water is not fluoridated and $\leq$ 55g sugar/day where water is fluoridated. Equivalent to 6-10% of total energy intake. Consume smaller amounts of sugar, consume sugar containing foods less frequently during the day, and consume such foods preferably only during mealtimes and not close to bedtime	Chronic disease risk of dental caries, obesity and related chronic diseases, micronutrient dilution when large percentage of energy consumed is from sugar	Sugar used to prevent energy deficiencies; media promoting sugar consumption through advertising products with high sugar content, poor knowledge of foods with high sugar content.

The guidelines are short, simple, clear, user-friendly, culturally appropriate, practical and positive messages that are now used to educate all South Africans, adolescents included, about healthy eating behaviours.

3.3 Implications for nutrition knowledge questionnaire development

Nutrition knowledge education for assessment among South African adolescents has not received much attention, as is shown by the paucity of research information on the subject. Nutrition knowledge for the BTT study group must be defined through a process that will take into account any formal nutrition education that the group has or should have been exposed to. The South African FBDGs are aimed at all South Africans over the age of seven years to ensure healthy eating behaviour and should thus form the basis of the country's nutrition education programs and consequently serve as basis for defining nutrition knowledge for the development of the nutrition knowledge questionnaire for adolescents.

4. THE THEORY OF NUTRITION KNOWLEDGE QUESTIONNAIRE DEVELOPMENT

The most important and challenging aspect of using questionnaires in research methodology lies in ensuring that the questionnaires used are developed in such a manner that the validity and reliability thereof is established (Saw & Ng 2001). Few researchers have been doing this, as is suggested by JØrn Olsen and the European Questionnaire Group of the International Epidemiological Association (IEA) and as is highlighted by the scarcity of published papers on questionnaire quality (Wilcox 1999).

A literature search by the author resulted in the identification of a special edition of the Journal of Nutrition Education (1981, 13; 3) which contained eleven comprehensive articles on developing a valid and reliable nutrition knowledge questionnaire for various study groups. The groups ranged from pre-school children to nutrition educators and other academics. Since then, papers on questionnaire development were published by Sapp and Jensen (1997); Hawkes and Novak (1998), Stevens *et al.* (1999) Parmenter and Wardle (1999); Anderson *et al*. (2002); Hoelscher *et al.* (2003); Talip *et al.* 2003. The discussion that follows relates to steps that were generally followed in the above-mentioned papers on developing nutrition knowledge questionnaires.

4.1 Development of a conceptual framework and identification of nutrition concepts

An essential first step in questionnaire development involves developing a conceptual framework for the questionnaire, which is the foundation of the nutrition questionnaire's construct. The conceptual framework refers to the broader nutritional issues that are relevant to the target group. This is followed

by the identification of the relevant nutrition knowledge concepts which refer to nutrition topics that should form part of the target group's knowledge on the identified nutrition issues. The conceptual framework and relevant concepts are obtained from various sources that include scientific literature, government publications, textbooks, curriculum guides as well as verbal consultations with professionals specializing in the field of nutrition (Tinsley *et al.* 1981; Lackey *et al.* 1981; Fanslow *et al.* 1981; Dwyer & Stoulorow 1981, Stevens *et al.* 1999; Hoelscher *et al.* 2003; Talip *et al.* 2003).

After the identification of concepts an expert panel, which should consist of various professionals and academics, is consulted to assess the conceptual framework and the framework's coverage of the concepts. The panel is mandated to make appropriate changes to the framework and concepts (Tinsley *et al.* 1981; Lackey *et al.* 1981; Fanslow *et al.* 1981; Dwyer & Stoulorow.1981, Stevens *et al.* 1999; Hoelscher *et al.* 2003;Talip *et al.* 2003), a process which serves to establish the construct of the questionnaire and thus the criteria for assessing the construct validity thereof (see Section 5.2).

4.2 Development of a questionnaire item pool

Once the nutrition concepts have been finalised, all potential items that can be included as questions are formulated for each concept (Tinsley *et al.* 1981; Lackey *et al.* 1981; Fanslow *et al.* 1981; Dwyer *&* Stoulorow 1981, Stevens *et al.* 1999; Hoelscher *et al.* 2003; Talip *et al.* 2003). The formats of the items can vary depending on the aim of the questionnaire and target group involved. Tinsley *et al.* (1981) used multiple-choice questions because of their suitability for "objective measurement of application and analysis", as well as recall and comprehension. "True/false", "yes/no", open-ended questions (Dwyer & Stoulorow, 1981) and Likert-type summated scale formats (Sullivan & Schwartz 1981) can also be used.

The items in the pool can be refined further through editing or revision, or they can be removed from the item pool after consultation with an expert panel. During this type of consultation each item's appropriateness, accuracy, clarity, construction, format, ambiguity, freedom from clues and overall value in representing the concepts is assessed (Tinsley *et al.* 1981; Rosander & Sims1981; Lackey *et al.* 1981; Fanslow *et al.* 1981; Dwyer & Stoulorow 1981). In the study by Fanslow *et al.* (1981) a specialist member of the expert panel evaluated the questionnaire for its adherence to item writing principles while schoolteachers who were also members of the panel assessed the content and reading level of the questions that were aimed at different grade levels. Such a process ensures content and face validity of the questionnaire (see Section 5.2).

4.3 Construction of a preliminary questionnaire

After the above-mentioned evaluation the items in the item pool are used to construct a preliminary questionnaire. This questionnaire is pre-tested on a study sample similar to the questionnaire target group using interviews, focus group discussions and cognitive interviewing techniques to determine the clarity, interpretation and comprehensibility of the items (Stevens *et al.* 1999; Anderson *et al.* 2002; Hoelscher *et al.* 2003). Where necessary, items were refined accordingly after the testing phase. This process serves to further ensure face validity of the questionnaire (see section 5.2).

4.4 Refining of preliminary questionnaire through item analysis

The next step involves refining the questionnaire based on statistically determined variables. Firstly, the difficulty level of each item, which is defined as the proportion of individuals who respond correctly to the item in question (difficulty index), is assessed. Very difficult or very easy items are considered inappropriate in reflecting the knowledge of an individual and their removal is recommended (Dwyer & Stoulorow 1981; Byrd-Benner 1981; Parmenter & Wardle 1999; Anderson *et al.* 2002). However, no set criteria are available that define the cut-off points of a difficulty index. Dwyer and Stoulorow (1981) and Talip *et al.* (2003) used the difficulty index criteria of less than 0.1 and more than 0.9 to exclude items; Anderson *et al.* (2002) used 0.2 to 0.8; Parmenter and Wardle (1999) used 0.3 to 0.9; while Byrd-Benner (1981) only included items with a difficulty index of 0.7 and above. In addition, test developers may include some items considered necessary to maintain the content validity of the questionnaire regardless of the outcome of difficulty index assessments, as was done by Parmenter and Wardle (1999) and Talip *et al.* (2003).

In addition to the refinement of questionnaire items according to difficulty indices, discrimination indices are also used. The discriminatory index of an item reflects its ability to discriminate between those with different levels of knowledge. The discriminatory index of an item is determined by calculating the item to total score correlation coefficient (Talmage & Rasher 1981; Parmenter & Wardle 1999). The inclusion and exclusion criteria based on correlation coefficients are also not set, as is evident from the fact that some authors use correlation coefficients 0.2 or more (Dwyer & Stoulorow 1981; Anderson *et al.* 2002) and others use 0.4 or more as criteria for retaining items (Lackey *et al.* 1981). Again, test developers may retain items that fall outside their set correlation coefficient criteria because the items address important concepts and/or promote awareness and discussion (Lackey *et al.* 1981).

4.5 Validity and reliability assessment

The assessment of validity and reliability in questionnaire development is conducted to refine the questionnaire until acceptable levels of validity and reliability are achieved i.e. the questionnaire measures what it is supposed to measure and also that does so in the best possible way (Stevens *et al.* 1999; Talip *et al.* 2003). Certain forms of validity assessment as well as all forms of reliability assessment are conducted by administering the questionnaire to an appropriate study sample resulting in a statistical representation of the validity and reliability. However, some assessments of validity are done subjectively/qualitatively.

4.5.1 Validity assessment

Validity has been described as an expression of the degree to which an instrument measures what it is supposed to measure (Sapp & Jensen 1997; Saw & Ng 2001). The first type of validity relevant to questionnaire development is *construct validity*, which is based on the underlying construct of the questionnaire as defined in the initial stages of questionnaire development (Hawkes & Novak 1998). For a nutrition knowledge questionnaire, the construct includes the conceptual framework that was formulated as well as the related nutrition concepts. It thus follows that to be able to ensure construct validity, the test developer needs to develop a questionnaire that is based on a sound conceptual framework and that the questionnaire items cover the nutrition concepts adequately. Consideration, discussion and recommendations by expert panel on these issues will qualitatively establish construct validity of a questionnaire (Tinsley *et al.* 1981; Lackey *et al.* 1981; Fanslow *et al.* 1981; Dwyer & Soulorow 1981; Stevens *et al.* 1999; Hoelscher *et al.* 2003; Talip *et al.* 2003). In addition to subjective assessment, construct validity of a nutrition knowledge questionnaire can be objectively assessed. For example, Hawkes and Novak (1998) assessed construct validity by administering their questionnaire to two groups known to possess varying levels of nutrition knowledge. A significant difference in the scores obtained by the groups was described as indicative of construct validity.

The second type of validity is *content validity*, which refers to the appropriateness of all items included in an instrument in representing the construct. To establish content validity all items in the questionnaire should be formulated based on the construct. Whether or not a test has content validity can only be determined using qualitative techniques such as assessment by a panel of experts (Talmage & Rasher 1981; Sapp & Jensen1997; Hawkes & Novak1998; Stevens *et al.* 1999; Saw & Ng 2001; Talip *et al.* 2003).

Face validity refers to whether the items in a questionnaire and the overall instrument are reasonable for the target group. Reasonableness in this regard refers to the language, format, layout and procedures of the items and instrument (Talmage & Rasher.1981; Stevens *et al.* 1999; Hoelscher *et al.* 2003; Talip *et al.* 2003). Similarly to construct and content validity, face validity is also assessed by an expert panel (Talmage & Rasher 1981; Stevens *et al.* 1999; Hoelscher *et al.* 2003; Talip *et al.* 2003). A further step in face validity assessment involves the appraisal of the questionnaire by a group representative of the target group. Further adjustments to the questionnaire items can then be made if necessary to improve the questionnaire's face validity (Stevens *et al.* 1999; Hoelscher *et al.* 2003; Talip *et al.* 2003).

Lastly, *criterion validity* can be determined by comparing the outcome of the questionnaire with a known gold standard. For example, the criterion validity of a tool meant to assess 'diabetes control' can be assessed by comparing the score observed using the tool with the results of a glucose tolerance test. Criterion validity is thus the correlation between the instrument score (the predictor) and the other variable (the criterion) and the higher the correlation between a predictor and the criterion, the better the validity (Sapp & Jensen 1997; Saw & Ng 2001).

4.5.2 Reliability assessment

A reliable instrument is described as one which measures a given trait with a minimum of error (Streiner & Norman 1995) which means that the instrument must be accurate, dependable and yield the same results if used again under different circumstance (Talmage & Rasher 1981; Last 1983; Sapp & Jensen 1997; Saw & Ng 2001). Reliability of a questionnaire is reflected in a numerical value ranging between 0 and 1 referred to as the reliability coefficient for an assessment tool. The closer to 1 an instrument's reliability coefficient is calculated to be, the more reliable it is (Miller 1989).

The reliability of an instrument can be measured in various ways which include *stability equivalence* and *internal consistency* testing. A test can be administered twice (test-retest) to measure stability; two equal forms of one test can be formulated and each one administered to the same sample to measure equivalence; and the once off administration of a test and checking to determine how consistently the items are answered reflects internal consistency (Kerlinger 1986; Miller 1989; Saw & Ng 2001; Chong unpublished document; Suhr unpublished document). Internal consistency testing is a widely used method to determine reliability because unlike stability and equivalence, it only requires a single test administration (Chong unpublished document).

There are two methods for measuring the internal consistency reliability of an instrument, namely the split-half technique and calculating the coefficient alpha. When the split-half technique is used, two similar and equal halves of the instrument are administered to a sample. The scores obtained for each test are then correlated while correcting for difference in length using the Spearman-Brown formula. The final reliability coefficient obtained after correction will indicate the reliability of the instrument (Miller 1989). However there are problems associated with using the split-halves technique. Firstly, there are many ways in which a test can be divided and secondly, it is not possible to determine which items are contributing to low reliability, rendering the technique ineffective for the refining of the instrument. These problems are addressed by the use of the other technique which involves calculating the reliability coefficient using either the Cronbach alpha or the Kuder-Richardson-20 (KR-20) formulae (Streiner & Norman 1995). Justifiably, these two formulas are the most commonly used methods to measure internal consistency reliability that is used for reliability assessment (Lackey *et al.* 1981; Byrd-Banner 1981; Sullivan & Schwartz 1981; Miller 1989; Trexler & Sargent 1993; Parmenter & Wardle 1998; Anderson *et al.* 2002; Talip *et al.* 2003).

The KR-20 formula can be applied only when questionnaire items are dichotomous, which means that they have only two values such as yes/no, true/ false, or scored as right/ wrong and the formula used is as follows;

$$KR-20 = \frac{n}{n-1}\left(1-\frac{\sum p_i q_i}{\sigma\tau^2}\right)$$

Where n is the number of items
P_i is the proportion of subjects who answered *i* correctly
$q_i = (1-P)$
σ_T is the standard deviation of the total score (Streiner & Norman 1995, p. 64)

The Cronbach α can be used for both dichotomous and questionnaire data with more that two responses (Suhr unpublished document) and is calculated very similarly to the KR-20 except that the standard deviation for each item is substituted for p*i*q*i*:

$$\alpha = \frac{n}{n-1}\left(1-\frac{\sum \sigma_l^{\,2}}{\sigma_\tau^{\,2}}\right)$$

(Streiner & Norman 1995, p. 64)

For reliability assessment, a data set is collected from a sample population using the developed questionnaire. The questionnaire is generally administered and completed under supervised test conditions for children and students (Trexler & Sargent 1993; Anderson *et al.* 2002) and mailed to respondents of adult study populations (Lackey *et al.* 1981; Byrd-Banner 1981; Sullivan *et al.* 1981; Parmenter *et al.* 1998; Talip *et al.* 2003). The reliability of the questionnaire is then determined using any or both of the above-mentioned formulae.

Reliability assessment can also be used as means for the further refinement of a questionnaire. This is done by removing or editing existing items that negatively influence reliability by lowering the reliability coefficient (Sapp & Jensen 1997; Stevens *et al.* 1999). In such instances, the reliability of the final refined questionnaire will be reassessed and the new reliability coefficients used as indication of the final reliability of the questionnaire.

A certain amount of unreliability is present in all instruments due to reasons other than measurement error. Firstly, methods for estimating reliability that require administration of a test more than once can be negatively affected by changes in individual knowledge, motivation and ability in-between the administration of the two tests. Secondly, the testing environment with regard to venue and the test administrator can also change and impact negatively on reliability. Thirdly, the length of a test has an impact on reliability as a longer test has been found to fare better than a shorter test in producing a good reliability value. Finally, using a wide range for the sample population in terms of grades or ages can result in a better instrument reliability (Suhr unpublished document).

4.6 Performance-rating scales

After a test has been administered, the next challenge for the researcher lies in the interpretation of scores generated for each subject after completing the questionnaire. A good nutrition knowledge questionnaire should therefore include a performance-rating scale that can be used in rating, classifying and measuring changes in the nutrition knowledge of testees (Miller 1989). The literature distinguishes between three types of performance-rating scales namely; norm-referenced, criterion referenced, and content-referenced performance-rating scales (Morganthau 1990; McCloskey 1990).

A norm-referenced performance-rating scale rates a child's performance in relation to that of a set of scores (norms) that have been established using a standardisation group. The norms can be interpreted according to standard scores, T scores, percentile ranks, or stanines. A criterion-referenced scale rates a performance against a predetermined standard which is usually the mastery level, thus comparing the

children against each other. These are usually interpreted within an age/gender-related framework. Content-referenced performance-rating scales are based on a range of developmental objectives and are usually interpreted according to the number of objectives that have been accomplished (Morganthau 1990; McCloskey 1990; Taylor & Walton 2001).

4.6.1 Norm –referenced performance-rating scales

Norm-referenced performance-rating scales are the most widely used rating scales for psychological, educational, developmental and perceptual tests because of the ease of interpretation thereof (Miller 1989; Morganthau 1990). This type of scale is designed in such a way that a testee's performance can be placed on one specific point of a normal curve of which the midpoint is the mean of a standardisation group's performance. The subject's performance will thus be rated as below the average, average, or above the average of the performance of a standardisation group (Miller 1989; Morganthau 1990). When using such a scale to rate a subject's performance on a knowledge questionnaire, it will thus reflect his/her performance compared to that of comparable subjects.

To develop norms for a questionnaire, the latter is administered to a standardisation (norm) group. For these purposes, a well-defined sample that is representative of the target population must be selected (Hopman *et al.* 2000). The sample should be representative in terms of culture, language, gender, race and sufficient numbers (Storms *et al.* 2004; Gericke *et al.* 1987). The percentage scores obtained by the norm group are then ranked from the lowest to the highest performance and graphically represented in a curve, which if the norm group is appropriate, should be bell-shaped. According to this curve, 50% of those who completed the test will fall below and 50% will fall above the total group norm's average (Miller 1989; Taylor & Walton 2001).

The next step is to select a method for interpreting the norms and as previously mentioned, stanines, percentiles, T-scores, grade equivalents, age equivalents or age-standardised scales (McCloskey 1990; Taylor & Walton 2001; Shagen 1999). These reference scores can then be used to rate the performance of other groups or individuals after the same test has been administered to them. The use of stanines for these purposes is recommended because of their ease of interpretation and appropriateness for a knowledge assessment tool (Morganthau 1990). The first step in computing stanines is to convert the percentage scores into z-scores by using the following formula;

$$z = \frac{X - \overline{X}}{SD}$$

X = the performance score of an individual
$\overline{X}$ = mean performance score of a norm group
SD = Standard deviation (Miller, 1989, p. 107; Streiner *et al.* 1995, p. 94)

Z-scores are therefore the percentage scores converted to variables with a mean of 0 and a standard deviation of 1. Once all the percentage scores have been converted to z-scores, the latter can be grouped according to cut-off points representative of the nine stanines as shown in Table 3. Regardless of the cut-off points, stanines 2 to 8 all have upper and lower boundaries, stanine 1 has no lower boundary and stanine 9 has no upper boundary (Gericke *et al.* 1987; Miller 1989).

Table 3: Z-scores cut-off points for each stanine in the development of norms*

Z-score range	**Stanine category**
Below -1.75	1
-1.75 to -1.25	2
-1.25 to -.75	3
-.75 to -.25	4
-.25 to .25	5
.25 to .75	6
.75 to 1.25	7
1.25 to 1.75	8
1.75 or higher	9

*(Adapted from Miller 1989)

Once the z-scores derived from the norm group's percentage scores have been allocated into stanines, a testees calculated z-score can be used to classify his/her performance under a stanine category for further interpretation. The following classification is suggested by Miller (1989);

Stanine 1	Very poor performance
Stanines 2, 3	Poor performance
Stanines 4, 5, 6	Average performance
Stanines7, 8	Above average performance
Stanine 9-	Excellent performance

4.7 Implications for questionnaire development

The discussion of the theory of questionnaire development has highlighted the various forms of validity and reliability and provided clear descriptions and indications of what ensuring these entails. It is clear that validity assessments of a questionnaire should at least focus on construct, content and face validity. For reliability assessment determining the internal consistency reliability would most probably be the most practical and appropriate method. The information available on norm development is very limited but it would be seen that the development of a norm-referenced performance-rating scale would be the most appropriate.

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CHAPTER 3

ARTICLE 1

INTRODUCTION

The Birth-To-Twenty (BTT) cohort study is a longitudinal study following the physical and psychological development of children, from birth till age twenty. The BTT cohort group of n=3 273 was recruited at birth from the Soweto-Johannesburg area, and includes mostly black, but also white, Indian, and children of mixed ancestory. The group has been followed up on various social, environmental, psychological, educational, and biological aspects. The study, while continuing with its original objectives, has recently included an investigation into risk factors for chronic diseases of lifestyle such as coronary heart disease and diabetes, presenting in the now adolescent group (Richter *et al*. 2004). Nutrition knowledge has been identified as a factor influencing the nutritional behaviour of adolescents (Delisle *et al*. unpublished document). Consequently, the BTT participants' nutrition knowledge was to be assessed periodically every two years from age 13 to 20 years. The process required a well-developed nutrition knowledge assessment instrument[2].

The main criteria well-developed assessment and evaluation instruments need to meet are appropriate levels of reliability and validity (Parmenter & Wardle 1999). Therefore a valid and reliable nutrition knowledge test would be the ideal instrument to assess the knowledge of the BTT study participants. However, in South Africa there are only two nutrition knowledge tests that have been developed with validity and reliability ensured. The questionnaires include one for assessing the nutrition knowledge of white adults (Gericke *et al.* 1987) and one for assessing health professionals' knowledge of nutrition and other lifestyle risk factors for the development of chronic diseases of lifestyle (Talip *et al.* 2003). Although researchers in countries like the United States have developed numerous knowledge tests for various groups, including adolescents (Rosander & Sims 1981; Fanslow *et al.* 1981; Hawkes & Novak 1998), these tests are not suitable for use in the BTT study because the focus and content of such questionnaires as well as the specific target groups are not compatible with the BTT research aims and target group. A clear need for the development of a valid and reliable nutrition knowledge test for the BTT adolescents group is therefore evident.

In South Africa a nutrition component is included by the Department of Education in the national school curriculum. It is included in the subject 'Life Orientation', which is taught to all learners from grades R to 12 as a means of equipping them with various life skills during their school years (Department of Education 2002). The nutrition content of this subject can therefore be viewed as a

[2] Instrument refers to any object that can be used to assess specific identified aspect in or of an individual. The words instrument, test, questionnaire, and tool are used interchangeably in text

source of structured nutrition education available nationwide to adolescents attending government schools, including BTT participants. However, it must be borne in mind that this may not be the only source of nutrition information to adolescents. We speculate that children may receive additional nutrition information from their community library, peers, family, health professionals, the written and audiovisual media and other unidentified sources. Due to the many diverse sources of information available to children in South Africa, it is important to define the concept of nutrition knowledge for the target group of this study.

Defining nutrition knowledge for a target group serves as the first step in the development of a reliable and valid knowledge test. This is referred to as establishing the construct, which is the measurable attribute of the questionnaire (Hawkes & Novak 1998). Most test developers formulate a conceptual framework to serve as a guide when defining the construct of the questionnaire. For knowledge questionnaires aimed at assessing the success of a nutrition education program, including a school education curriculum, the main aim or objectives set out in the programme or curriculum could serve as the conceptual framework (Rosander & Sims 1981; Fanslow *et al*. 1981). On the other hand, for those questionnaires aimed at assessing general nutrition knowledge of a group, a general conceptual framework should be developed which an expert panel should then assess (Sullivan & Schwartz 1981). This is followed by the identification of concepts relevant to the conceptual framework and verification thereof by an expert panel (Byrd-Bredbenner 1981; Lackey *et al*. 1981; Stevens *et al.* 1999; Talip *et al.* 2003).

Following the definition of the conceptual framework and the identification of relevant concepts, an item pool for potential inclusion in the questionnaire is developed. The items are then subjected to various evaluations to determine whether they should be included in the final test or not. These evaluations could include assessment by expert panels and pilot testing using a group similar to the target group to ensure content and face validity (Fanslow *et al.* 1981; Sapp & Jensen 1997; Hawkes & Novak 1998). For statistical assessments such as item analysis for the determination of item difficulty and discrimination, as well as Cronbach α to assess internal consistency (reliability), the questionnaire can be completed by different suitable groups (Parmenter & Wardle 1999). As an assessment of construct validity, the questionnaire should be able to distinguish between groups known to differ in terms of the knowledge being measured (Sapp & Jensen 1997; Hawkes & Nowak 1998).

The aim of this study was to develop a valid and reliable nutrition knowledge questionnaire for urban adolescents by implementing the necessary steps to ensure validity and internal consistency reliability.

THE QUESTIONNAIRE DEVELOPMENT PROCESS

For the purpose of this study, the following definitions of key terms were formulated.

1. 'Nutrition knowledge' for urban South African adolescents is defined as knowledge about nutrition that is required for good health as well as for the prevention and management of nutrition–related diseases and conditions, based on current South African recommendations for healthy eating behaviour (Vorster *et al.* 2001).

2. 'Reliability' is defined as an instrument's relative lack of error (Talmage & Rasher 1981). Internal consistency is one way of assessing reliability and refers to the degree to which individual items within a scale or subscale relate to the total subscale score (Parmenter & Wardle 1999). Cronbach α is used to estimate reliability by determining the internal consistency of the instrument. If the values are dichotomous (0,1) the Cronbach α value is equivalent to the Kuder-Richardson 20 (KR-20) reliability measure. (Talmage & Rasher 1981; SAS Institute 1999-2001)

3. 'Validity' is defined as an expression of the degree to which an instrument measures what it is supposed to measure. Three types of validity that have been described for the purpose of developing nutrition knowledge questionnaires and which were investigated included in this study are 'face', 'construct' and 'content' validity (Talmage & Rasher 1981; Sapp & Jensen 1997).

4. The 'construct validity' of the questionnaire refers to the measurable attribute thereof (Hawkes & Novak, 1998). In the case of this study the measurable attribute is nutrition knowledge, which should be based on a well-defined conceptual framework (Talmage & Rasher 1981).

5. 'Content validity' refers to the subject matter of the instrument and considers how representative and appropriate the items[3] are in covering the subject matter of an instrument (Talmage & Rasher 1981; Sapp & Jensen 1997).

6. 'Face validity' refers to how reasonable the items and overall questionnaire are for its target group from the perceptive of the test developer, as well as from the perspective of a pilot group representative of the target group. The concept of 'reasonableness' refers to the questionnaire's language, format and procedures (Talmage & Rasher 1981).

[3] The words item refers to a question that might be included as part of the developed questionnaire

A summary of the process followed in the development of the nutrition knowledge questionnaire for urban South African adolescents is outlined Figure 1.

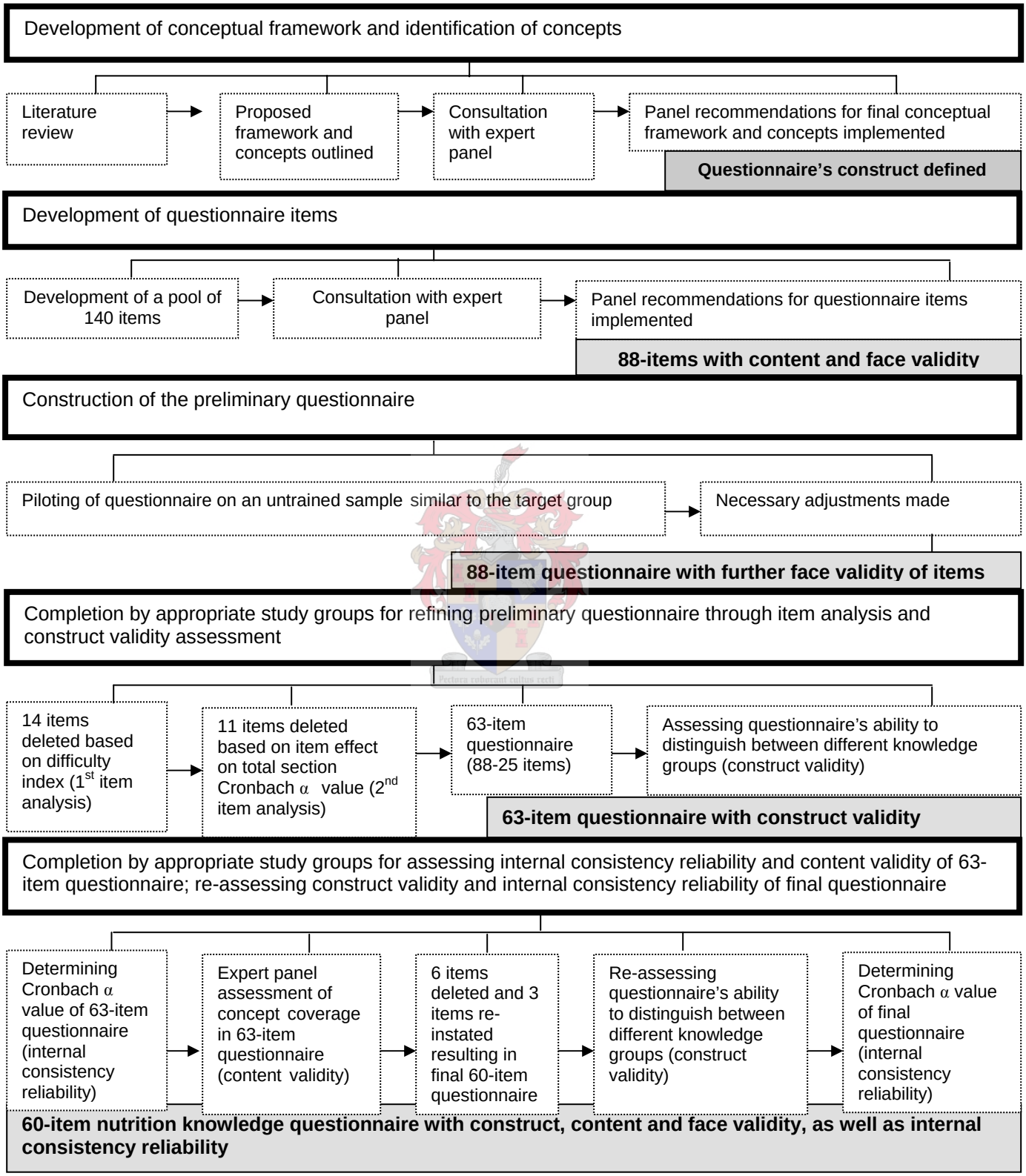

Figure 1: Summary of steps followed in the development of the nutrition knowledge questionnaire for urban adolescents

Development of conceptual framework and identification of concepts

To define the construct of the questionnaire, the development procedure started with the development of a conceptual framework of areas of nutrition knowledge to be measured. As a starting point the WHO "conceptual framework of nutritional problems and causal factors in adolescence" was reviewed (Delisle *et al.* unpublished document). The framework provides an indication of how different factors, including environmental, political, social, and individual factors, can lead to nutrition-related problems in adolescents in developing countries. The framework was subsequently adapted for the South African adolescent population after an extensive review of relevant literature. The review involved identifying nutritional issues relevant to South African adolescents by means of electronic and hard copy journal articles, reputable websites, and South African government agencies and departments. In addition, electronic mail and verbal correspondence with experts from educational institutions also provided information.

However, due to the fact that there was insufficient research relating to South African adolescents available, most of the nutrition issues considered for the framework were derived from issues that had been identified for younger South African children that may perpetuate into adolescence, as well as issues related to adolescents in other countries that could also be relevant for South African adolescents.

The most common nutrition-related problems among South African children aged 1-9 years were found to be inadequate dietary intake leading to underweight and stunting, as well as micronutrient deficiencies including iron, vitamin A, iodine, calcium, and zinc (Steyn 2000). Conversely, the high percentage contribution to total energy intake of sugar (10.7% and 14%) among male and female black adolescents aged 15-18 years could be indicative of the presence of risk factors for oral diseases and obesity for the group, as the WHO recommends an intake <10% of total energy intake from sugar for the prevention of dental caries (Steyn *et al.* 2002).

Chronic diseases of lifestyle such as coronary heart disease, cancer, osteoporosis, overweight and obesity; hypertension and Type 2 diabetes are known to be prominent among South African adults. In the United States, adolescent eating behaviour has been implicated as possible contributing factor to the development of the above-mentioned chronic diseases of lifestyle as well as a spectrum of eating disorders (Lytle 2002). It can be speculated that a similar situation might be present in South Africa.

Another prominent problem experienced in South Africa is that over half of the approximately four million HIV infected South Africans are youths aged 15-24 (Bradshaw *et al.* 2000), indicating the need for nutrition knowledge concerning the promotion of the immune system in times of infections. Teenage pregnancies have also been found to be very prevalent in South Africa (Bradshaw *et al.* 2000). Poor pregnancy outcomes have been observed in teenagers with low nutrient stores (Delisle *et al.* unpublished document), which emphasises the fact that adolescents should have knowledge relating to basic nutritional recommendations for pregnancy. Reports also point to the fact that alcohol use and abuse is a problem among South African youths, with a binge-drinking rate in excess of 20% amongst school going youths for certain population/gender groupings (Parry 1994). Finally, food safety was speculated to be an area of concern for all South African populations, with adolescents also being susceptible to contracting food-borne illnesses through incorrect purchasing, storage and preparation methods as well as preferences for specific foods. Integration of this information with the previously mentioned WHO framework in Delisle *et al.* (unpublished document) resulted in the proposed conceptual framework for this study (Figure 2).

The prescribed nutrition content of the "Life-Orientation" subject in the national curriculum (Department of Education 2002) was subsequently used to identify nutrition concepts that are required for adolescents to know in order to prevent potential nutrition-related problems included in the conceptual framework. The identified concepts include recommendations for a healthy lifestyle using guides based on the food guide pyramid, nutritional needs for adequate growth and development, individual nutrients, portion sizes, recommended number of servings, media messages regarding nutrition, meal planning, food habits, cooking methods, specific meals, food labels, food supplements, as well as the relationship between diet and disease, weight management, sport nutrition, nutrition in pregnancy and vegetarianism.

An expert panel was convened to review and discuss the proposed framework and associated concepts (Figure 2 & Addendum A). The panel included six dieticians (three being the test developers) practicing in different fields of nutrition, including research, community nutrition, academia, as well as one community health worker recommended by the Department of Health. The framework was accepted without change and the panel made additional recommendations on the proposed concepts.

Chronic Diseases of Lifestyle	Nutrient Deficiencies
Cardiovascular disease, diabetes, hypertension, overweight and obesity, osteoporosis, dental disease, certain cancers	Iron, calcium, vitamin A, iodine, zinc, carbohydrates, and protein
Infectious Diseases	**Other Issues**
HIV/ AIDS	Eating disorders, alcohol abuse, teenage pregnancies, food-borne illness

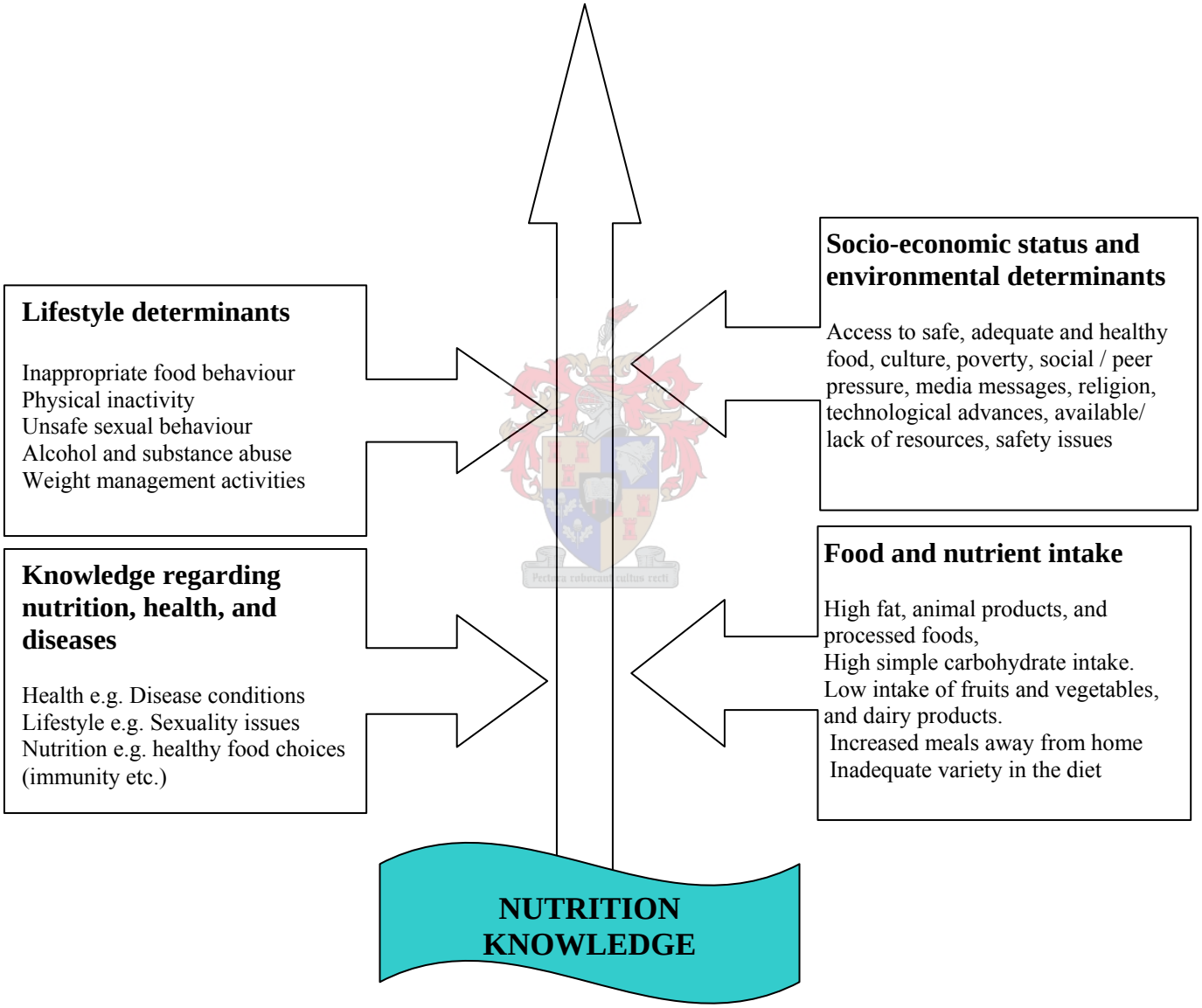

Figure 2: Conceptual framework of nutrition-related issues and causal factors for urban South African adolescents

The panel recommended the following regarding the proposed concepts,

- That the newly developed South African Food-Based Dietary Guideline (FBDGs) (Voster *et al.* 2001) should be included as a key concept and that the guidelines should serve as basis for the assessment of knowledge regarding recommendations for a healthy dietary lifestyle;
- That food sources of nutrients should only involve carbohydrates, proteins, fibre, vitamins A, iron, iodine and calcium;
- That food labels should not be included as a concept, as their inclusion would test skills and not knowledge; and
- That a focus group discussion should be conducted with adolescents to determine whether media messages on nutrition should be included as a concept.

The panel also formulated the following recommendations regarding the development and formulation of items:

- Where feasible, items for each identified concept should be formulated within the context of the South African Food-Based Dietary Guidelines (FBDGs);
- Items should not make reference to food guides such as the 'five food groups' and 'food pyramid';
- No items on portion sizes of foods should be included, with the exception of fruits, vegetables, and milk;
- Items on the use of nutritional supplements should only involve recommendations for a healthy lifestyle and nutrition in pregnancy; and
- Weight management items should exclude technical terms such as body mass index (BMI) and ideal body weight.

A focus group discussion was subsequently conducted with seven adolescents (10-16 years old) who were conveniently selected from a Johannesburg suburb. The results indicated that the group knew that most advertisements were marketing strategies aimed at encouraging them to buy certain products and therefore were not necessarily a source of accurate information. It was thus decided that media

messages would not be included as a concept. However, a need to identify adolescents' sources of nutrition information was identified.

The result of these activities was the conceptual framework (Figure 2) and a final list of five nutrition knowledge concepts (Table 1). The process that was followed ensured that the construct of the questionnaire was defined, which was such that it covered essential current and relevant nutrition issues for the urban South African adolescent population. The criteria for content validity, namely the final five concepts, were also defined.

Table 1: Final nutrition knowledge concepts and number of items developed for each concept

Group	Concept	No. of Items Developed
A	Recommendations for a healthy dietary lifestyle according to the South African FBDGs*	41
B	Proper dietary lifestyle for the maintenance of good health and weight control	21
C	Food sources of selected nutrients (carbohydrates, proteins, fibre, vitamins A, iron, iodine, and calcium) for the prevention of nutrient deficiencies.	11
D.	Ways to ensure the safe consumption of selected foods (meat, fish, chicken, water, fruits and vegetables).	5
E	The basic nutrition requirements during pregnancy	10

*The South African FBDG's include, 1.Enjoy a variety of foods; 2.Be active; 3.Make starchy foods the basis of most meals; 4.Eat plenty of fruits and vegetables everyday; 5.Eat dry beans, peas, lentils, and soya regularly; 6.Chicken, fish, meat, milk or eggs could be eaten daily; 7. Eat fats sparingly; 8.Use salt sparingly; 9.Drink lots of clean, safe water; 10. If you drink alcohol, drink sensibly; 11.Eat and drink food and drinks that contain sugar sparingly and not in-between meals (Vorster *et al.* 2001)

Development of questionnaire items

A total pool of 140 items consisting of items originally formulated by the researchers as well as items identified and extracted from other published questionnaires, quizzes, textbooks and various other texts, was developed. This involved formulating items within the context of each FBDG for each of the

five concepts where feasible. For example, using the FBDG 'Be active', items relating to concepts A, B, and E (Table 1) were formulated. However, items could not be formulated for concepts C and D (Table 1) with this guideline, as there is no link between physical activity and food sources (concept C) or physical activity with food safety (concept D). Furthermore, care was taken to keep the needs of specific groups in mind, e.g. in the formulation of activity-related items, the creation of the perception that unlimited physical activity is good was avoided as it can be unsafe during pregnancy.

After all possible FBDG-based items had been formulated, additional items covering the body of knowledge relating to each concept were formulated or identified as necessary. For example, items referring to foods as possible sources of the specified nutrients (concept C) were formulated. Additionally, in accordance with recommendations following the focus group that was conducted with adolescents, two items concerning sources of information were developed.

All items were written in true/false format or as four-option multiple-choice questions. The latter format was used because of the suitability thereof for objective measurement of recall and comprehension (Tinsley *et al.* 1981), and true/false items were included based on the assumption that they are easy to complete and thus appropriate for adolescents.

To ensure the content and face validity of the developed items, a 10-member expert panel was convened. The panel consisted of the seven individuals who participated in the first panel discussion. A questionnaire development expert, a high school "Life Orientation" teacher and a community health worker were also included in the 10-member expert panel. The panel was once again first presented with background information on the research process followed up to the point of the meeting, but this time in writing prior to the meeting. They also received a list of the items and were requested to evaluate the items for appropriateness, relevance, accuracy, and formulation prior to the meeting. Although all panel members were asked to assess all aspects of the items, the dieticians gave specific attention to the correctness and appropriateness of the nutrition content of the items. The teacher concentrated on the appropriateness of item content in relation to the subject curriculum and item reading level in relation to all secondary school grade levels (8 to 12). At the meeting each item was considered, discussed and was then either retained unchanged, or edited, or removed as per recommendations by the members of the panel. The entire process resulted in the removal of 52 items and the retention of 88 items. The two (additional) items on sources of nutrition information were also retained, but were not included in any further assessments.

The process that was followed ensured the content and face validity of the 88 remaining items because only items that appropriately and accurately addressed the concepts and that were properly formulated, were retained. For further assessment, the items were categorised in sections A to E based on the five concepts (Table 1).

Construction of the preliminary questionnaire

A self-administered questionnaire was compiled using the 88 selected items (Addendum B). The first page of the questionnaire included clear instructions for completion and a few demographic questions to characterise respondents. The latter included age, date of birth (to verify age), educational institution, gender and grade level/ degree. Since subjects remained anonymous, names were not requested.

The 88 items were ordered randomly within their respective sections (A to E) in the questionnaire using the random number selection tables in Katzenellenbogen *et al.* (1999). The use of random number selection tables ensured that there was no intentional bias in the positioning of items in the questionnaire. The two questions on sources of information were included in a separate section (F) at the end of the questionnaire.

The questionnaire was piloted on seven conveniently selected adolescents (13-17 years old) in the Western Cape area to determine clarity and readability of the individual items and of the overall questionnaire, thus contributing to face validity of the items. The respondents completed the questionnaire under the supervision of the researcher and were encouraged to ask questions on any aspect of the questionnaire that seemed to be unclear. The results indicated that most of the items were understandable, although a few items were confusing or contained words that were too technical for the 13-year-olds. The confusing items were simplified, taking care not to compromise the original formulation of the items and /or giving away the answer in the question. Technical words including nutritional terms such as 'iodine', 'fibre', and 'starches', that proved to be problematic could not be simplified further without giving away the correct answers to the questions and therefore were retained unchanged. The piloting also gave an indication of the length of time it took to complete the questionnaire, which on average was 36 minutes.

Refining of preliminary questionnaire through item analysis and construct validity assessment

The first aim of this step was to determine the appropriateness of each item for inclusion in the questionnaire, statistically referred to as item analysis. The assessments that were completed for this purpose included the following:

- Item difficulty index assessment, which refers to the proportion of individuals correctly responding to the item in question (Fanslow *et al.* 1981) and
- The effect of each individual item on the Cronbach α value of the section (A to E) in which it appears.

The second aim was to assess the construct validity of the items remaining after the item analysis had been completed. Construct validity is ensured if the combination of items (therefore the questionnaire) distinguishes between groups with known different knowledge levels (Sapp & Jensen 1997; Hawkes & Nowak 1998).

For the effective accomplishment of both aims, non-expert (not knowledgeable about nutrition), and expert (knowledgeable about nutrition) adult and adolescent groups were required to complete the questionnaire. The expert groups were expected to score significantly better on the test, with the adult expert group expected to fare better than the adolescent expert group. The inclusion of adolescents in this step also ensured that the age group (adolescents) similar to the BTT cohort group was included in the process.

Study population (Sample 1)

The three academic institutions in the Western Cape with a dietetics training program/degree were approached telephonically for permission to administer the questionnaire to their final year dietetics, and non-dietetics students (adults). Permission was obtained from the University of Stellenbosch. The final year dietetics students (all female) were approached during a lecture session and the purpose of the study was explained to the group and their voluntary participation requested. At the same time non-dietetic/nutrition male students in a university residence were recruited to participate in the study. Verbal consent for participation was also obtained form both groups.

For the adolescent expert and non-expert groups, it was assumed that secondary school scholars in grade 12 who took Home Economics (now referred to as Consumer Science) as a subject had a better

level of nutrition knowledge compared to their counterparts who were not taking the subject. Home Economics historically and currently includes an extensive nutrition component (Department of Education 2003).

A list of secondary schools in Soweto and Johannesburg was obtained from the Gauteng Education Department. Four secondary schools on the list were randomly selected and approached with a letter and an information sheet (Addendum C) requesting the participation of grade 12 scholars who have and those who do not have home economics as a subject. Permission was obtained from the principal of Immaculata School in Soweto. The purpose of the study was explained to its scholars and those willing to participate completed a written consent form (Addendum C).

The final sample included 20 fourth year dietetics students and 51 grade 12 scholars who took home economics as a subject (as experts). The non-experts included nineteen male non-dietetic/ nutrition university students and sixty-three grade 12 scholars who did not take home economics as a subject (n= 63).

Data collection and processing

The different groups completed the preliminary 88-item self-administered questionnaire (Addendum B) described in the previous section. The university students completed the questionnaire under supervision at different times while the high school students all completed the questionnaire during one session under supervised test conditions.

The data was entered into an 'Excel' spreadsheet. For all items, whether true/false or multiple choice, there was only one correct answer. Items to which a participant failed to respond (blank values) were also regarded as incorrect responses. Each correct response was allocated one point and an incorrect or no response allocated zero points, which implied that all knowledge related variables were dichotomous. The resulting scores were used for further data analysis.

Statistical analyses

The data was analysed using the SAS system for windows, version 8.2. Item analysis was carried out for items within their respective categories i.e. sections A, B, C, D, and E (Table 1). Item analysis was first executed using the total data set to determine each item's difficulty index. The difficulty index is described as the proportion of individuals correctly responding to the item in question and may range from 0 for an exceptionally difficulty item, to 1 for a very easy item (Fanslow *et al.* 1981). Very

difficult or very easy questions are seen as not reflective of the actual knowledge of an individual (Parmenter & Wardle 1999).

For the purpose of this study an item answered correctly by 90% or more participants was regarded as too easy and an item answered correctly by 10% or less, as too difficult. This meant that only items with a difficulty index within the range of 0.1 - 0.9 were eligible to be retained. This difficulty index criterium is similar to the one used by Dwyer and Stoulorow (1981) in their development of a knowledge test for high school students.

The second part of the item analysis process involved determining each item's effect on the Cronbach α of the section in which it appears. The overall aim was to produce a combination of items that would result in the highest possible Cronbach α value for each section and per implication, for the whole questionnaire. If the deletion of an item from a section produced a higher Cronbach α value for the total section than was originally obtained, it was removed from the section. This process is illustrated in the following example.

Section A
Cronbach α value of the total section: 0.757818
Cronbach α value after deletion of item No. 1: 0.763920
Section A will have a higher Cronbach α value if the item is deleted, therefore item
No. 1 was deleted.

On the other hand, if removal of an item resulted in a lower Cronbach α value for the total section, the item was retained.

The ability of the remaining items (combined) to distinguish between groups with known different knowledge levels was assessed by comparing the values of the expert and non-expert groups, using the Kruskal-Wallis rank order test. The Kruskal-Wallis was used because the distributions of the populations were not normal and therefore a non-parametric test was required. When the p-value is less than the reference probability (> 0.05), it can be assumed that the rank sums of the groups are different from each other without actually indicating which rank sums or values actually differ from each other. To investigate the latter, the Bonferroni *post hoc* test was used.

Results and Discussion

Fourteen items had a difficulty index of less than 0.1 or more than 0.9 and were therefore deleted. The fact that the sample population included adults as well as adolescents with different knowledge levels ensured that the item difficulty indices obtained were relevant.

A further eleven items were removed from the questionnaire based on their effect on the Cronbach α value of the section in which they appeared (see Addendum D for the relevant Cronbach α values). Two items were not removed despite the fact that their inclusion decreased the Cronbach α value of a particular section. This was necessary to ensure the retention of sufficient items in each of the five sections (A-E, Table 1), and thus maintain content validity. Parmenter and Wardle (1999) who developed a knowledge questionnaire for adults also recommended the retention of certain items to ensure the content validity of the questionnaire. A summary of the 25 deleted items and the criteria/reasons for their deletion are presented in Appendix E. The outcome of the item analysis process therefore was a 63-item questionnaire.

The results of the assessment of the 63-item questionnaire's ability to distinguish between groups with known differences in knowledge levels are presented in Table 2.

Table 2: Mean scores ± SD and other locations of expert and non-expert groups (sample 1) on the 63-item questionnaire

Group	N	Mean	Median	25th Percentile	75th Percentile	Minimum	Maximum
University final year dietetic students	20	56.85 ±3.01SD* A°	57.00	55.50	58.50	48.00	62.00
University non-dietetics students	19	44.05 ±5.30SD B°	45.00	40.00	49.00	35.00	52.00
Grade 12 without home economics	63	33.57 ±6.04SD C°	34.00	29.00	38.00	22.00	49.00
Grade 12 with home economics	51	33.96 ±6.82SD C°	34.00	31.00	40.00	19.00	47.00

Kruskal-Wallis test (P<0.0001)
*SD= Standard deviation
° Bonferroni *post hoc* test (means of groups with the similar letter do not differ significantly)

The results indicate that the mean score of the dietetic students (expert group) was significantly higher than that of any of the other three groups. The non-dietetic male students (non-expert group) obtained a mean score that was significantly higher than the adolescent expert and non-expert groups. There was no significant difference in the mean scores obtained by the two adolescent groups.

The good performance by the university expert group was expected. Being final year dietetic students, they have been exposed to a wide range of nutrition-related information that will enable them to work as professionals in the field of nutrition and dietetics. The relatively good performance by the university non-expert group can possibly be explained by several factors. Even though the male university students were not studying dietetics or nutrition, it is not impossible that they could have been exposed to nutrition information in their life span. Consequently, as the questionnaire items were not developed to test mastery of nutrition, but rather basic nutrition knowledge that all individuals should have to be able to follow a healthy dietary lifestyle, it is possible for anyone exposed to nutrition and health-related information over a period of time to perform well in the questionnaire. It can therefore be speculated that the older the non-expert group, the higher the possibility that the group might perform well.

The poor performance by the adolescent expert group compared to the adolescent non-expert group was unexpected. The main possible reason for this could be that the adolescents in the sample were attending a Soweto school (Immaculata), which can be described as a historically disadvantaged school. In such schools the education system was characterised by inequalities and inadequacies, which could have had a negative impact on the quality of education, a situation that the current government is still in the process of rectifying (Department of Education 2003). The legacy of this education system could be that scholars in such schools like Immaculata, are inadequately equipped to understand the language (English not being their first language) and consequently, properly conceptualise the nutrition related questions and terms used in the questionnaire. The results therefore possibly reflect lack of comprehension rather than lack of nutrition knowledge.

Ultimately, the better performance by the university expert group compared to any of the other groups is sufficient to show that the 63-item questionnaire is able to distinguish between groups with different knowledge levels. This finding indicates that the questionnaire does satisfy the statistical criteria of construct validity as set out by Hawkes and Novak (1998).

Assessment of internal consistency reliability of the 63-item questionnaire

An important further step in the development of the questionnaire was the evaluation of the questionnaire's internal consistency reliability (ICR) using a sample population representative of the BTT cohort group. Since the nutrition knowledge questionnaire under construction is aimed at urban adolescents aged 13-14 years and will be used till they are 20 years old, this step involved the completion of the questionnaire by 13-18 year old black and white adolescents in the greater Johannesburg and Soweto area.

Study population (Sample 2)

The sample for this assessment phase consisted of twelve strata, which included three age ranges (13-14, 15-16, 17-18 years), with each age strata including two races (black and white) and both genders. With government legislation stating that South African children can only start school at age seven or should be turning seven in the course of that calendar year of entry (Department of Education 1998), it was determined that children in school grades 8, 10, and 12 would fall within the three age ranges.

It was assumed that black scholars would be found exclusively in Soweto schools, while a mix of races would most likely be found at any Johannesburg suburban school. Therefore, a list of public schools in Soweto and Johannesburg was obtained from the Gauteng Provincial Department of Education. Four randomly selected schools in Soweto and Johannesburg were sent information sheets (Appendix F) and letters requesting their participation in the study. School officials in Bhukulani, a historically disadvantaged school in Soweto; and Sandringham (not historically disadvantaged) in Johannesburg, gave consent for their scholars to participate in the study. Informed written consent (Appendix F) was requested and obtained from each participant from the three grade levels. The final study population comprised 402 adolescents from the two schools.

Data collection and processing

The 63-item questionnaire was completed separately by the different grades in each school under supervised test conditions. To allow for collection of other demographic information essential for the analysis of data gathered, a question on ethnicity was included. The data was entered into an 'Excel' spreadsheet. For all items in the 63-item questionnaire there was only one correct answer. Items to which a participant failed to respond (blank values) were also regarded as incorrect. Each correct response was allocated one point and an incorrect or no response allocated zero points.

Statistical analysis

The data was again analysed using the SAS for windows, version 8.2. The Cronbach α value was used to determine the questionnaire's ICR, which can have a value ranging from 0 to 1. The higher the Cronbach α value the higher the ICR of the questionnaire. A minimum Cronbach α value of 0.7 is generally accepted as indicative of acceptable ICR (Sapp & Jensen 1997; Parmenter & Wardle 1999). The Cronbach α values of the 63-item questionnaire were determined for each school, for each predetermined grade level, for black adolescents separately and for all the groups together.

Results and discussion

Of the total sample (n=402), 241 scholars were from Sandringham while 161 were from Bhukulani. The pupils ranged in age from 12-23 years, of whom 128, 143, and 98 were from the age ranges of 13-14, 15-16, and 17-18 years respectively. The two genders were represented almost equally. As far as educational level is concerned 158, 149, and 95 pupils were from grades 8, 10, and 12 respectively. Although the sample included participants from other racial groups (6%), the majority were black and white (Figure 3).

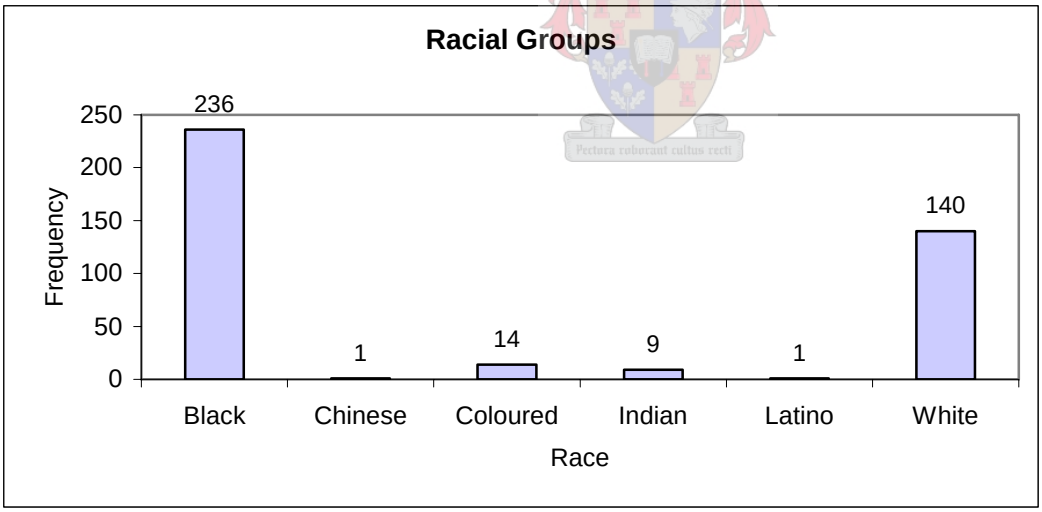

Figure 3: Race distribution of the study population (sample 2)

The results of the reliability assessment on the 63-item questionnaire for each of the schools by grades and trends thereof are presented in Table 3 and Figures 4 and 5.

Table 3: Cronbach α values of 63-item questionnaire for the study population (sample 2) grouped by schools, races, and grade levels

School	Grade 8	Grade 10	Grade 12	All Grades
Bhukulani (black scholars only)	0.48	0.43	0.58	0.55
Sandringham (all races)	0.55	0.85	0.83	0.79
Sandringham (black scholars only)	0.44	0.77	0.88	0.69
Bhukulani and Sandringham	0.69	0.79	0.80	0.77

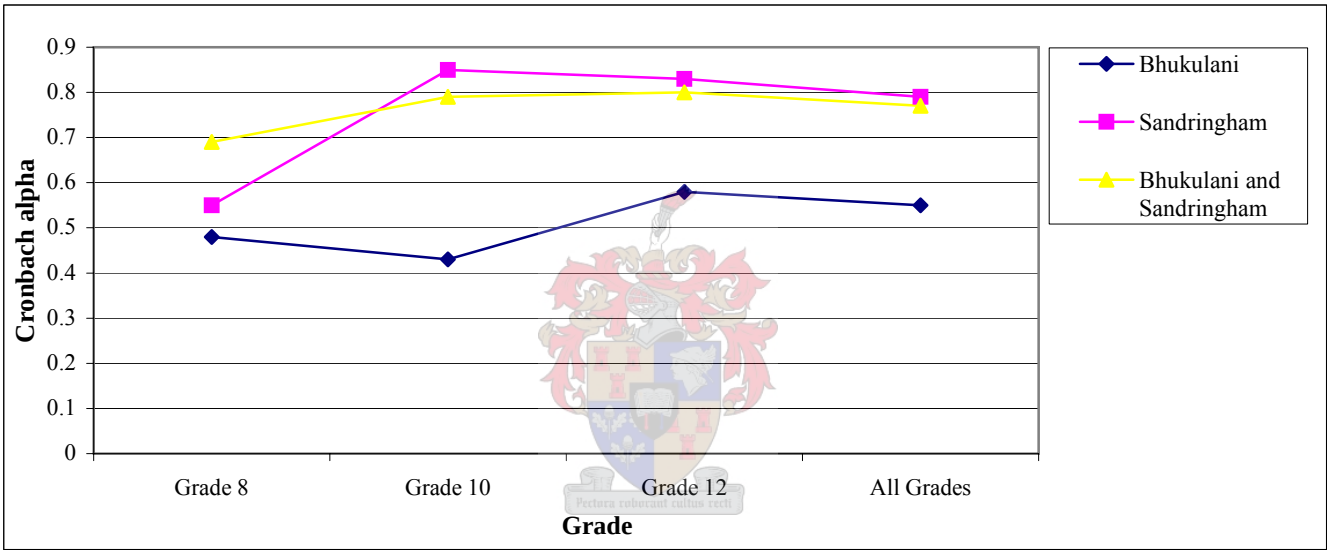

Figure 4: Cronbach α values of 63-item questionnaire for the two schools (sample 2) according to grades

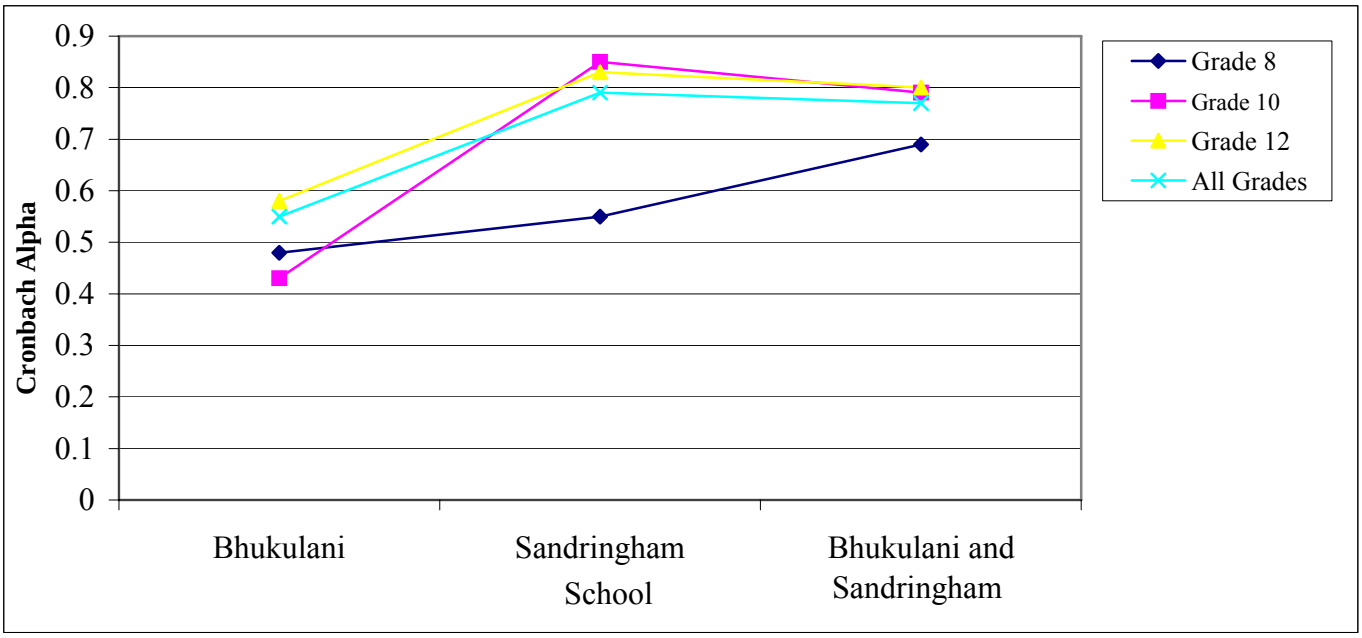

Figure 5: Cronbach α values of 63-item questionnaire for the three grades (sample 2) according to schools

The results indicated that the ICR was satisfactory (≥0.7) for all grade levels and races if the data for the two schools were combined. However results which distinguished between grade levels, racial groups and schools indicated that the ICR was not satisfactory for certain subgroups. The ICR of the 63-item questionnaire was poor for the black Bhukulani scholars, regardless of grade level, while for Sandringham, a poor reliability was only observed for the youngest age group regardless of race, after which it improved to an acceptable level of a Cronbach α value of >0.7. However, the results showed that the questionnaire attained satisfactory reliability for the black adolescents attending Sandringham, except again for the younger age group. The difference in the ICR of the questionnaire for adolescents of the same age and ethnicity, but attending historically different schools again points to the inadequacies and inequalities which are still being experienced within such schools, namely that children attending historically disadvantaged schools receive a poorer quality of education than their better off peers (Department of Education 2003). Consequently, scholars attending Bhukulani may have had an inadequate overall understating of the questions as well as associated language and nutritional related terms used, which lowered the ICR of the questionnaire for the group. The implication is that in order to obtain reliable data all adolescents attending historically disadvantaged schools in Soweto require the assistance of trained interviewers in completing the questionnaire. The poorer ICR found for the youngest group, regardless of school or race, could also possibly be explained

by the fact that they did not understand the questions as well as their older peers. This also points to the need for the younger age group to receive assistance by a trained interviewer when completing the questionnaire. In both cases, the interviewer would ensure that the interviewee has a clear understanding of each question without leading to or giving away the answers.

The Cronbach α value for adolescents in the three grades and for the whole adolescent study population compared well with the values obtained by other test developers (Byrd-Bredbenner 1981; Cunningham *et al.* 1981; Dwyer & Stoulorow 1981); Byrd-Bredbenner 1981) reported a Cronbach α value range of 0.63-0.73 for different professional groups when reported separately, and a Cronbach α value of 0.81 when all the groups were combined. Cunningham *et al.* (1981) achieved a Cronbach α value of 0.76 and 0.73 for the two knowledge tests developed for adolescents in grades 7-9 and 10-12 respectively. For their nutrition knowledge test for high school students Dwyer and Stoulorow (1981) achieved a KR-20 value of 0.88, which is equivalent to Cronbach α value for dichotomous variables (SAS 1999-2001).

Re-assessment of content validity of the 63-item questionnaire

Although content validity was established during the initial stages of questionnaire development, this step was aimed at re-assessing whether the remaining 63 items in the questionnaire still covered the identified concepts adequately (A-E, Table 1). An expert panel comprising the three researchers performed this assessment, which was as follows:

Firstly, all items were grouped according to the initial criteria that were used in their development, namely the FBDGs. When items were found to be repetitive or very similar within their groups, the best one was retained. This selection was based on the correlation coefficients of each item with the total score. The item with the highest positive correlation when compared to similar items was retained (Kerlinger 1986; Fanslow *et al.* 1981). A total of 6 items were deleted during this process and therefore 57 items remained.

Subsequently, the panel evaluated whether the remaining 57 items covered the five concepts (Table 1) adequately. Two of the concepts were found to be inadequately covered and therefore three of the items previously deleted from the 88-item questionnaire were re-instated to ensure content validity of the questionnaire. Lackey *et al* (1981) followed the same procedure in their development of a knowledge test for teachers.

The final 60-item questionnaire (Addendum H) included the following number of items per concept (Table 1), Concept A, 30 items, Concept B, 11 items, Concept C, 8 items, Concept D, 4 items, Concept E, 8 items and one item covering both concepts B and C equally. At the same time, each of the 11 FBDGs were represented by the following number of items: Guideline 1, 6 items; Guideline 2, 4 items; Guideline 3, 6 items; Guideline 4, 6 items; Guideline 5, 5 items; Guideline 6, 6 items; Guideline 7, 5 items; Guideline 8, 4 items; Guideline 9, 3 items; Guideline 10, 2 items; Guideline 11, 5 items and the 8 items covering the nutrition in pregnancy concept.

Re-assessment of construct validity and internal consistency reliability (ICR) of the 60-item questionnaire

Because of the changes that were made to the 63-item questionnaire to generate the 60-item questionnaire it was deemed necessary to re-assess the construct validity of the 60-item questionnaire (whether it distinguishes between groups with different knowledge levels) and ICR of the questionnaire.

Procedure, methods and data analysis

Construct validity of the 60-item questionnaire was reassessed using data obtained from sample 1 for the assessment of the construct validity of the 63-item questionnaire and the same statistical methods were also used.

The ICR of the 60-item questionnaire was reassessed using data obtained from sample 2 obtained for the assessment of the ICR of the 63-item questionnaire, and also using the same statistical methods. However, the 60-item questionnaire included three items re-instated from the 88-item questionnaire to ensure content validity, which had not been completed by sample 2. The re-assessment analyses of the ICR therefore only involved 57 items, which according to the statistician (Lombard C, personal communication) adequately represented the ICR of the 60-item questionnaire.

Results and discussion

The results of the assessment of the 60-item questionnaire's ability to distinguish between groups with known differences in knowledge levels are presented in Table 4.

Table 4: Mean scores ± SD and other locations of expert and non-expert groups (sample 1) on the 60-item questionnaire

Group	N	Mean	Median	25th Percentile	75th Percentile	Minimum	Maximum
University final year dietetic students	20	51.50 ±3.00* A°	51.50	50.00	53.50	42.00	56.00
University non-dietetics students	19	39.68 ±4.79* B°	41.00	37.00	44.00	30.00	46.00
Grade 12 taking home economics	63	30.06 ±5.68* C°	30.00	26.00	34.00	19.00	45.00
Grade 12 not taking home economics	51	30.43 ±6.54* C°	31.00	27.00	35.00	15.00	43.00

Kruskal-Wallis test (P<0.0001)
*SD= Standard deviation
° Bonferroni *post hoc* test (groups with the similar letter do not differ significantly)

A trend similar to the one observed for the 63-item questionnaire is evident. The university expert group achieved a significantly higher mean score than any of the other groups; the university non-expert group had a significantly higher mean score that the school expert and non-expert group and the latter two did not differ significantly. It can therefore be concluded the final 60-item questionnaire has construct validity based on its ability to distinguish between groups with known differences in knowledge levels.

The results of the ICR assessment on the 60-item questionnaire for each of the schools by grades are presented in Table 5 and Figures 6 and 7.

Table 5: Cronbach α values of the 60-item questionnaire for study population (sample 2) gruped by schools, races and grade levels

School	Grade 8	Grade 10	Grade 12	All Grades
Bhukulani (black scholars only)	0.43	0.45	0.63	0.57
Sandringham (all races)	0.56	0.84	0.82	0.78
Sandringham (black scholars only)	0.45	0.74	0.89	0.62
Bhukulani and Sandringham	0.71	0.78	0.81	0.77

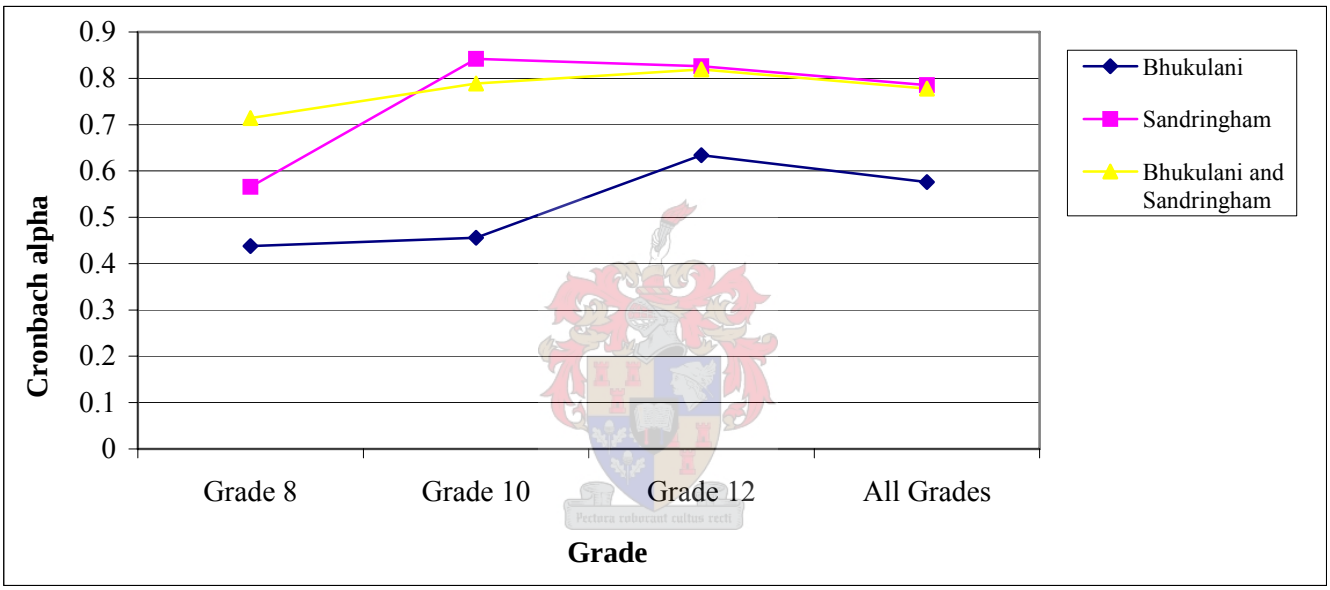

Figure 6: Cronbach α values of final 60-item questionnaire for the two schools (Sample 2) according to grades

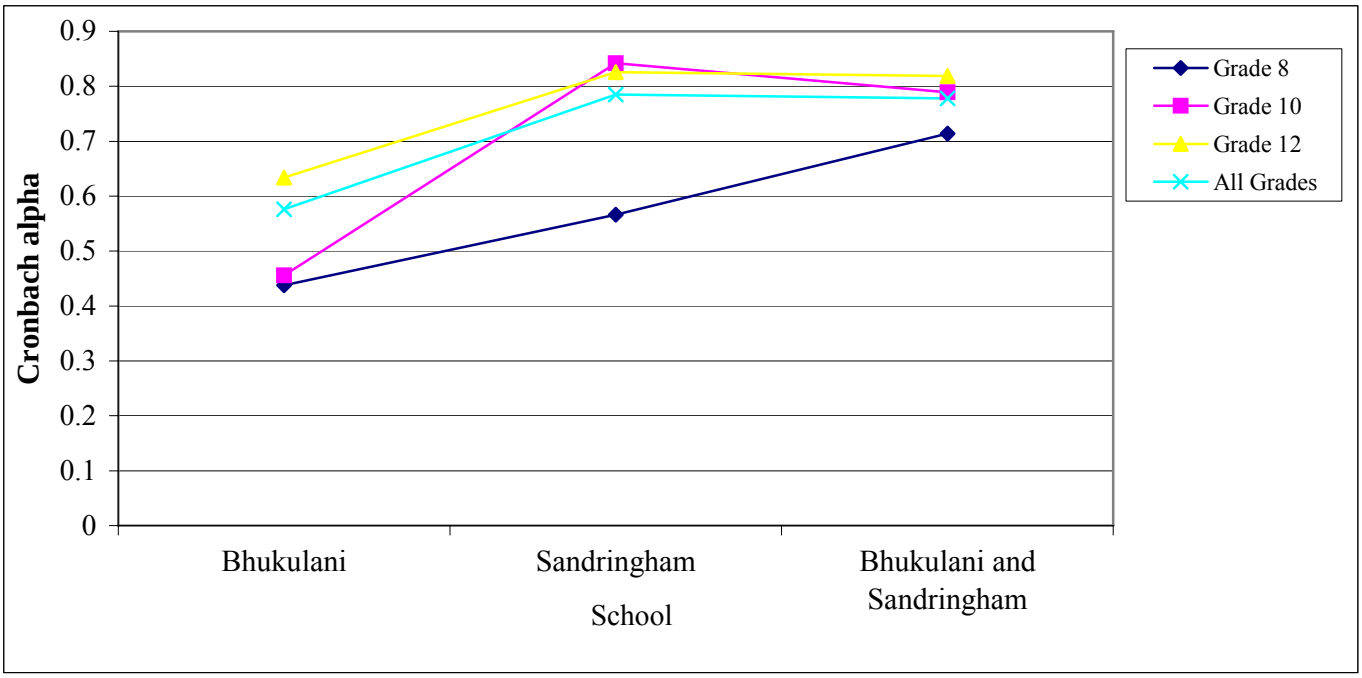

Figure 7: Cronbach α values of final 60-item questionnaire for all grades (sample 2) according to schools

The results indicate a similar trend in the ICR of the questionnaire as was found for the 63-item questionnaire. The ICR for the combination of the two schools was acceptable with a Cronbach α value of more than 0.7. Despite the slight improvement, the ICR of the final questionnaire was still poor for the black adolescents attending Bhukulani, regardless of grade level, while for black and white Sandringham scholars a poor reliability was again only observed for the youngest age group, which improved to an acceptable level with increasing educational level. The latter indicates that the recommendation that the younger age groups an adolescents attending schools in Soweto should receive the assistance of a trained interviewer when completing the questionnaire still stands.

GENERAL DISCUSSION AND CONCLUSION

A valid and reliable nutrition knowledge questionnaire was developed for urban South African adolescents, which is suitable for use on the Birth-to-Twenty cohort group. The questionnaire complies with criteria for construct, content and face validity, as well as internal consistency reliability. This was accomplished by following the process outlined in Figure 1.

The development of the questionnaire was based on a combination of proposed methods used by other test developers. However, a few aspects that could be considered by future test developers, which were not included in the development of this questionnaire, include the following:

1. The inclusion of a 'don't know" option in multiple-choice items can possibly prevent low reliability arising from guessing.

2. Criterion validity is another form of validity assessment that should be considered. Criterion validity refers to the correlation coefficient between the instrument score (the predictor) and another variable (the criterion), with the latter being able to provide values as close to the truth as possible. The higher the correlation between a measure and the criterion, the better the validity. The most difficult aspect in assessing this type of validity is selecting the criterion, especially in the development of nutrition knowledge tests (Talmage & Rasher 1981; Kerlinger FN 1986; Sapp & Jensen 1997; Ng & Saw 2001). As no criterion (another valid and reliable nutrition knowledge test with a similar construct) was available, it was not possible to assess the criterion validity in the development of our nutrition knowledge questionnaire.

3. The problem experienced with the comprehension of the English language and nutrition related terms by the children from historically disadvantaged schools could be addressed by translation of the questionnaire into one or more of the adolescents' vernacular languages. However, this would not solve the underlying problems of inequalities and inadequacies in education still faced by scholars attending historically disadvantaged schools (Department of Education, 2003).

4. Test-retest reliability is the ideal way to assess the reliability of an instrument and requires the repeated administration of the questionnaire to the same sample with an adequate time-lapse in-between the two administrations (Parmenter & Wardle 1999; Stevens *et al.* 1999). The reliability values obtained after each administration must be compared and the higher the correlations of the two reliability values, the better the reliability of the instrument. This method was not used in the development of our questionnaire because of time constraints and the difficulty of reaching the same groups more than once, particularly because of the distance between Cape Town where the researchers were based and Johannesburg where the field work was conducted.

The developed 60-item nutrition knowledge questionnaire for urban adolescents has several potential applications. It can be used to meet specific research objectives for a group or population of urban South African adolescents. It can also be used to evaluate the success of nutrition education

interventions for adolescents, for example, the South African national curriculum objectives set out in 2002 (Department of Education 2002).

Questionnaire development and associated psychometrics have not received adequate attention in South Africa, as is shown by the lack of valid and reliable tools available. The development and use of such tools will not only produce reliable research results but may also assist in elevating the quality of research done to a higher level in order to compare with international standards.

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CHAPTER 4

Article 2

INTRODUCTION

Various authors such as Murray (1999) and Charlton (2000) have highlighted the need for the use of reliable and valid instruments in research. Wilcox (1999) in his editorial on "a quest for better questionnaires" also highlighted the need for increasing the availability of the actual instruments used in research projects to other researchers either for their own use or to guide new questionnaire development. In South Africa, no reliable and valid nutrition knowledge questionnaire was available for use on adolescent groups. The need for such a questionnaire was identified in the Birth to Twenty (BTT) study, which involves the monitoring of health status and related factors of urban- born children from birth until age twenty. When the cohort reached age 13 years in 2003, nutrition knowledge assessment was identified as an important new priority. Subsequently a valid and reliable nutrition knowledge questionnaire was developed for the BTT cohort group by Whati *et al.* (2005).

The process followed in the development of this questionnaire involved the development of a conceptual framework of nutrition-related issues facing urban South African adolescents and identification of related nutrition concepts. A pool of items reflecting the concepts was subsequently developed. These items were evaluated by an expert panel to ensure content and face validity before being structured into a questionnaire. An 88-item questionnaire was completed by adult and adolescent samples, each age group comprising subgroups of those likely to have good nutrition knowledge and those likely to have poor nutrition knowledge. The data obtained from the completion of the questionnaire by these groups was used to assess difficulty and discriminatory parameters as well as construct validity. The 63-item questionnaire that resulted after these analyses was completed by an adolescent sample population considered to be representative of the BTT cohort in order to assess internal consistency reliability. The final result was a 60-item questionnaire with satisfactory validity and reliability that could be used in the BTT study. However, to ensure the accurate interpretation of scores obtained by testees, the development of a performance-rating scale was necessary.

Performance-rating scales are developed by transforming actual scores of a large representative population into a standard scale to which the performance of a similar group or an individual can be compared (Shagen 1999). Performance-rating scales can be criterion-referenced, content-referenced or norm-referenced (McCloskey 1990). A criterion-referenced performance-rating scale rates a person's performance in relation to mastery levels (McCloskey 1990), which is the testee's ability to perform a given set of competencies independently of other test-takers (Shrock & Coscarelli 1989). Content-

referenced performance-rating scales are based on a range of objectives for developmental skills and therefore rate the number of objectives that have been accomplished by a person (McCloskey 1990). A norm-referenced performance-rating scale rates a person's performance in relation to that of others (Shrock & Coscarelli 1989; Thomas-Tate *et al.* 2004). The scale therefore, is based on a set of scores that were derived from a large group of individuals (norm group) that is representative of a given population (Morganthau 1990). To develop this type of scale, the norm group is tested and the actual scores obtained on the questionnaire manipulated to produce reference scores such as stanines, percentiles, t-scores, grade equivalents, age equivalents or age-standardised scales (McCloskey 1990; Taylor & Walton 2001; Shagen 1999). These reference scores can then be used to rate the performance of other groups or individuals after the same test has been administered to them. Since the aim of the BTT was to compare and monitor nutrition knowledge levels over a period of time, the questionnaire developers decided that a norm-referenced performance-rating scale would be the most appropriate rating scale to use in the interpreting of the test scores of participants.

The first step in the development of a norm-referenced performance-rating scale, from hereon referred to as norms, involves administering the questionnaire to a large representative group referred to as the 'norm group'. The norm group's scores are then ranked from the lowest to the highest performance. To be acceptable as norms, these scores should graphically form a normal distribution (bell-shaped) curve, according to which 50% of the norm group should score below the average and 50% above the average (Taylor & Walton 2001). The resulting norms can then be used to determine whether a group or an individual performed below or above the average for their country, age, or gender (Hopman *et al.* 2000).

Finally, the question of validity of the norms arises. Most published articles on the development of norms do not refer to this issue. However, to ensure a high standard of research, we felt that the assessment of the validity of the developed norms should also be considered. Validity in this context could be described as the ability of the norms to accurately reflect the performance of the testees. Ideally, a validity assessment should be based on the comparison of testees' performance-ratings on the newly developed questionnaire according to the newly developed norms and the same testees' performance-rating on a second valid and reliable questionnaire based on a similar construct, using norms validated for the latter questionnaire. This type of validity is referred to as criterion validity (Sapp & Jensen 1997; Saw & Ng 2001).

The aim of this paper is to describe the development of norms for the nutrition knowledge questionnaire developed by Whati *et al*. (2005), for the purpose of comparing and monitoring nutrition knowledge levels. This article is divided into two sections, the first being the process followed to develop the norms and the second, assessing the validity of the norms.

DEVELOPMENT OF NORMS

Study design

For the purpose of developing norms, the nutrition knowledge questionnaire had to be administered to a study population representative of the proposed target group (Hopman *et al.* 2000). The target group was urban adolescents participating in the BTT study. The questionnaire was to be administered to the BTT cohort group for the first time at age 13-14 and then every second year thereafter until the group reached age 20. Scholars in grades 8, 10 and 12 in urban schools in the Soweto-Johannesburg area were seen as most representative of the mentioned age groups and thus an appropriate study population to use for the formulation of norms.

Study population (norm group) and sampling

For sampling purposes, four high schools in urban and peri-urban Johannesburg were randomly selected from the Department of Education's list of public schools in the area. Letters were sent out requesting the school's participation in the study. Three schools gave consent for their scholars to participate in the study. Sandringham, a multiracial school in suburban Johannesburg and Bhukulani, a Soweto school attended by black scholars only, gave consent for their entire grade 8, 10 and 12 class groups to participate. Permission was also granted for grade 12 scholars from Immaculata, another school in Soweto, to complete the questionnaire. Informed written consent was obtained from all the scholars and the final study population consisted of 516 scholars. The norm group was highly representative of the BTT cohort as members of the two groups have various similar characteristics. They were from the same geographical area of Johannesburg-Soweto, consequently they attended similar schools in terms of location and accessible educational facilities. They also had a similar composition in terms of race, gender, as well as socio-economic background (Richter *et al.* 2004).

Data collection and processing

All the scholars completed the questionnaire under supervised test conditions. Data from the completed questionnaires were entered into an 'Excel' spreadsheet. For all items in the nutrition knowledge questionnaire, whether true/ false or multiple choice, there was only one correct answer. Each correct response was allocated one point and an incorrect or no response allocated zero points. Items to which a participant failed to respond (blank values) were also regarded as incorrect responses. The resulting scores were used for data analysis.

Data analysis

The data was analysed using the SAS System for Windows, Version 8.2. The first step in data analysis involved testing the normal distribution of the scores (from hereon referred to as performance scores) obtained by the norm group, using the Shapiro-Wilk test. The performance scores represent the score (in percentage) for each individual obtained after completing the nutrition knowledge test.

The second step involved converting the performance percentage scores for the total study population to z-scores by transforming the scores into variables that have a mean of '0'and a standard deviation of '1' so that scores are expressed in standard deviation units. The following formula was used for these purposes.

Formula No. 1

$$z = \frac{X - \overline{X}}{SD}$$

(Miller 1989, p 107, Streiner & Norman 1995, p. 67)

However, z-scores are generally not easy to use in interpreting scores. Therefore, the resulting z-scores were divided into nine numerical categories of equal length referred to as stanines (Table 1). These categories represent a range of performance-ratings starting from the lowest (stanine 1) to the highest (stanine 9).

Table 1: Z-score cut-off points for stanines (Adapted from Miller, 1989)

Z-score range	Stanine category
Below -1.75	1
-1.75 to -1.25	2
-1.25 to -.75	3
-0.75 to-0.25	4
-0.25 to 0.25	5
0.25 to 0.75	6
0.75 to 1.25	7
1.25 to 1.75	8
1.75 or higher	9

A representative norm sample should provide a performance-rating distribution curve similar to that shown in Figure 1

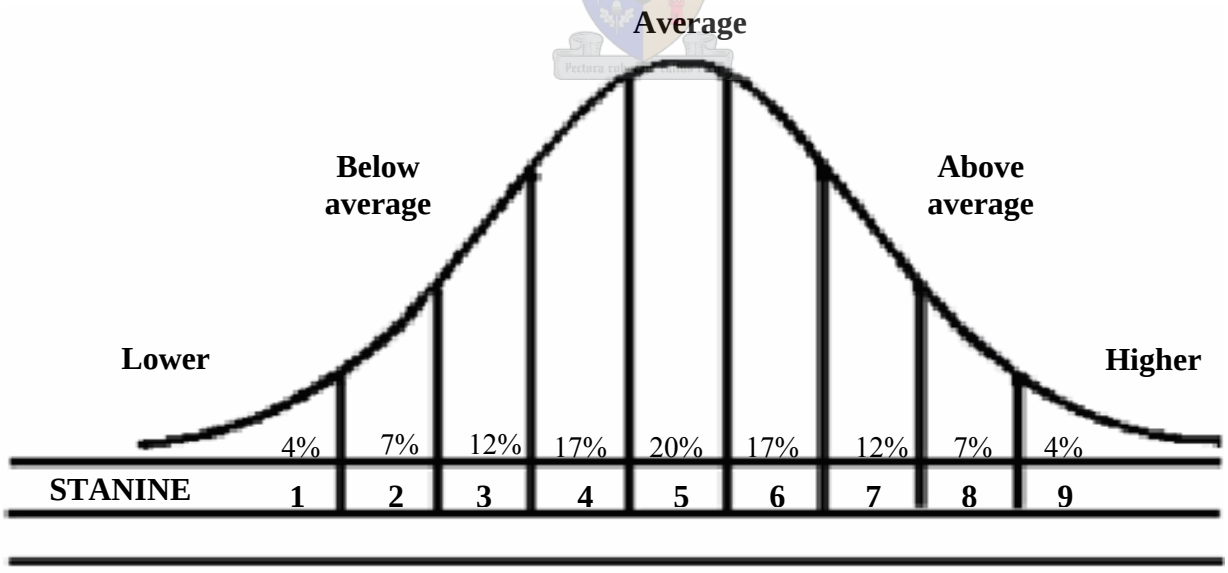


Figure 1: Application of stanines in performance-rating (Adapted from Miller, 1989)

This indicates that 4% of the norm group should achieve z-scores that will place them under stanine 1 and another 4% under stanine 9, 7% under stanines 2 and 8, 12% under stanines 3 and 7, 17% under stanines 4 and 8, and 20% under stanine 5. The interpretation of each stanine is also illustrated in Figure 1. For example, if a subject's z-score places him/her under stanine 5, his/her performance is rated as average. The performance is rated as above average if under stanines 6, 7 or 8, and as outstanding if under stanine 9. A z-score that places a subject under stanine 2, 3 or 4 indicates below average performance and under stanine 1 as very poor performance.

To ensure easy and effective interpretation of each testee's performance, the stanine cut-off points were transformed from z-scores back to percentage scores using Formula 2 that was derived from Formula 1

Formula No. 2

$$z(SD) + \overline{X} = X$$

Cut-off point (percentage score) = (Standard deviation x z-score upper limit) + mean performance score

Results and Discussion

The Shapiro-Wilk test for normality resulted in a p-value of 0.03, which could be interpreted as an indication that the distribution of the sample was not normal, i.e. just below the reference probability of 0.05 (95 % Confidence Interval). However, when a reference probability of 0.01 (90% CI) is used, the p value of 0.03 reflects a normal distribution. Based on the p-value and normal probability plot, the distribution was accepted as normal and further analyses were carried out based on this assumption. The stanine distribution of the z-scores for the total norm group is presented in Figure 2

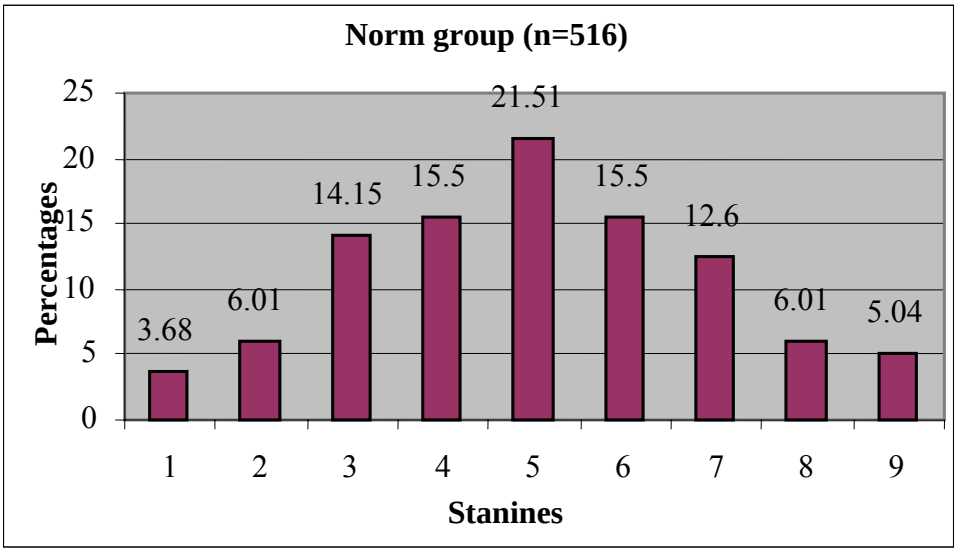
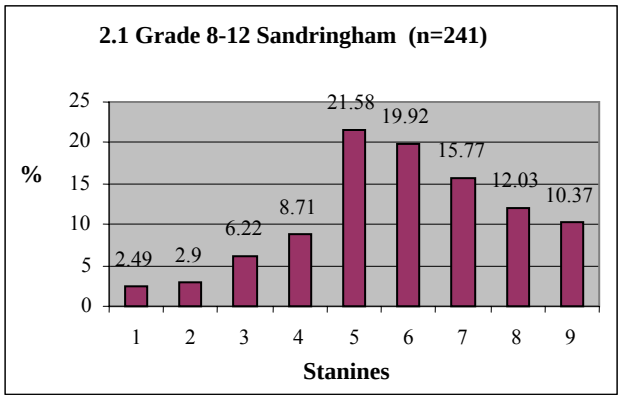
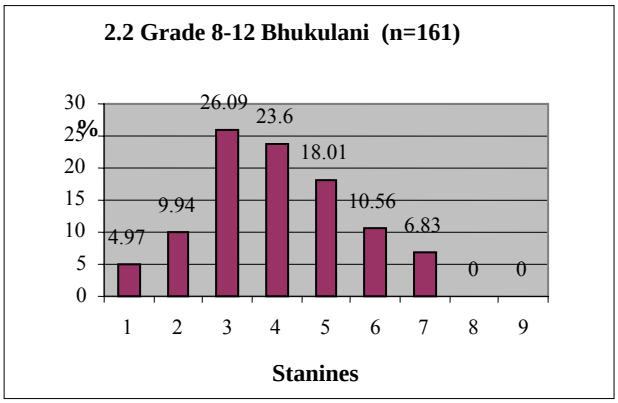


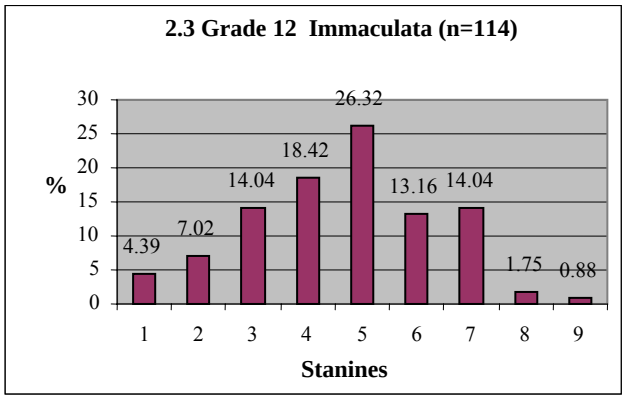
Figure 2: Stanine distribution based on the z-scores of the norm group

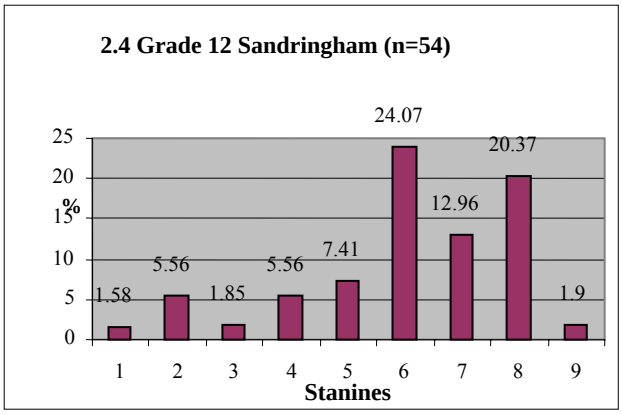
The stanine distribution for the norm group is very close to the bell-shaped curve illustrated in Figure 1, which is indicative of a normal distribution. This indicates that the population selected for the purpose of developing norms for the nutrition knowledge questionnaire for the BTT cohort was suitable, as an acceptable range of scores ranging from poor to outstanding was evident.

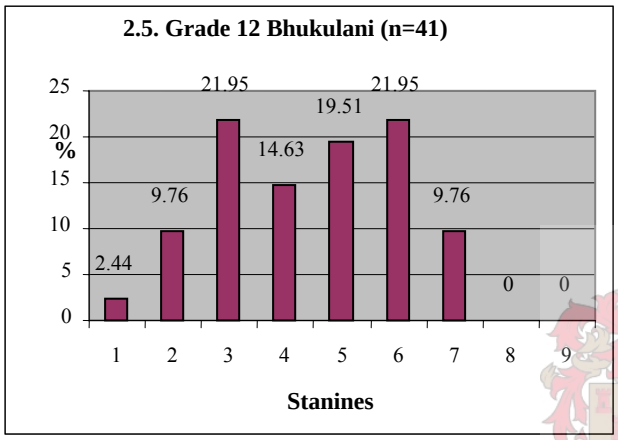
Figures 2.1.to 2.12 represent the stanine distribution separately for the different grade levels and school groups included in the total sample to give an indication of how the sub-groups performed in comparison to each other.

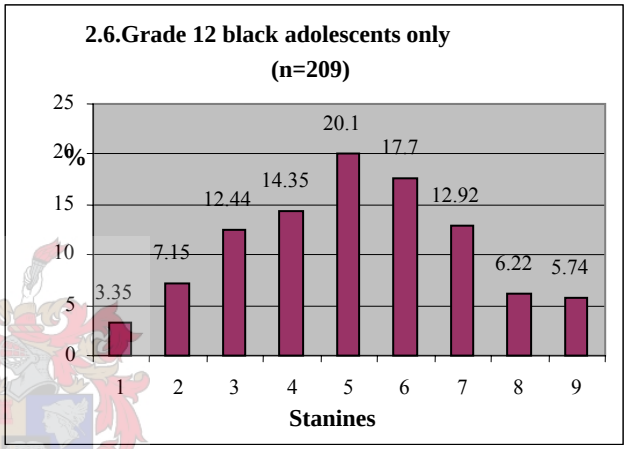


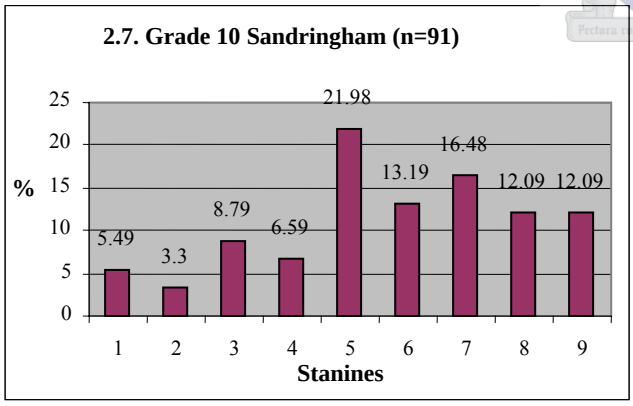


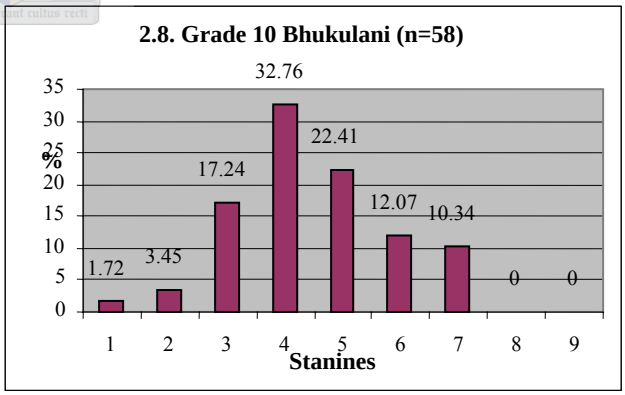

2.3 Grade 12 Immaculata (n=114)
%
Stanines
4.39
7.02
14.04
18.42
26.32
13.16
14.04
1.75
0.88

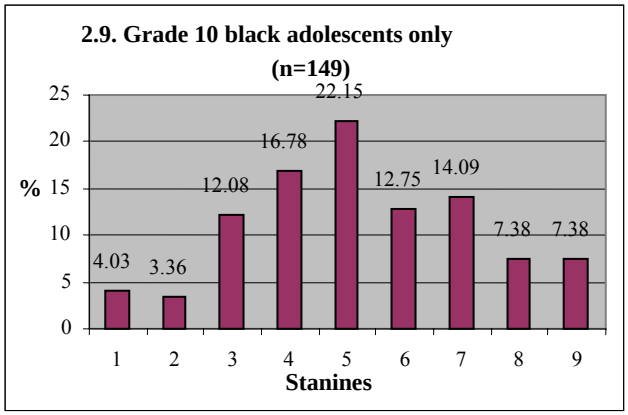

2.4 Grade 12 Sandringham (n=54)
%
Stanines
1.58
5.56
1.85
5.56
7.41
24.07
12.96
20.37
1.9

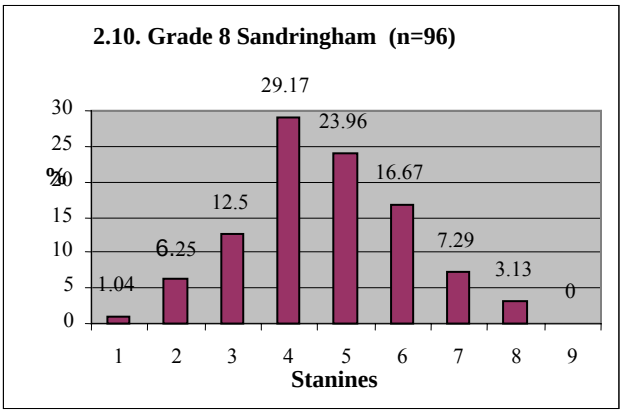

2.5. Grade 12 Bhukulani (n=41)
%
Stanines
2.44
9.76
21.95
14.63
19.51
21.95
9.76
0
0

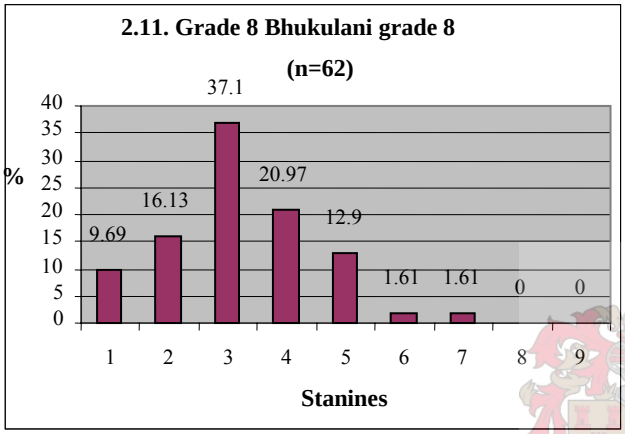

2.6.Grade 12 black adolescents only (n=209)
%
Stanines
3.35
7.15
12.44
14.35
20.1
17.7
12.92
6.22
5.74

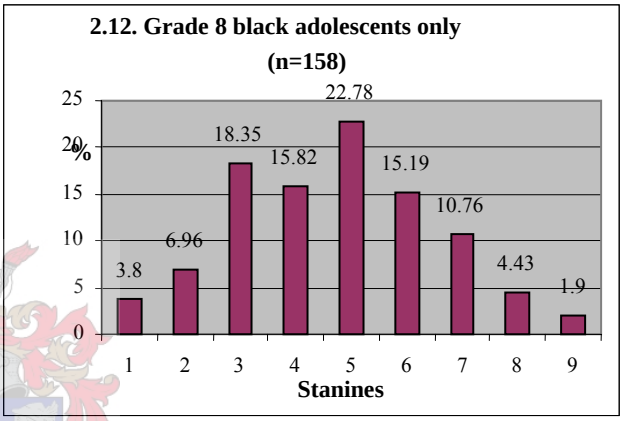

2.7. Grade 10 Sandringham (n=91)
%
Stanines
5.49
3.3
8.79
6.59
21.98
13.19
16.48
12.09
12.09


2.8. Grade 10 Bhukulani (n=58)
%
Stanines
1.72
3.45
17.24
32.76
22.41
12.07
10.34
0
0









Figures 2.1-2.12: Stanine distribution of the z-scores of the different grade levels and school groups

It is evident that the distributions were different from the normal curve obtained for the total norm group (Figure 2) and displayed a shift to the left or right depending on the grade level and school attended. For grade 8-12 Sandringham scholars, the curve shifts towards the right with more scholars falling under stanines 5, 6, 7 than under the lower stanines, indicating that adolescents attending this particular school performed at or above average on the nutrition knowledge questionnaire. However, the opposite applies in the case of grade 8-12 Bhukulani scholars. More of these adolescents fell under stanines 3, 4 and 5 and none under stanines 8 or 9, indicating that most of the adolescents performed at or below average. Immaculata, the school from which only the grade 12 class group completed the questionnaire, also displayed a distribution that is more to the left, yet with some scholars falling under stanines 8 and 9.

To understand these trends it is important to consider the backgrounds of the different schools. Sandringham is a historically and economically advantaged school while in contrast Bhukulani is a historically and economically disadvantaged school where the injustices of South Africa's apartheid policy government are still in the process of being corrected. From the results it is clear that those attending the more affluent school performed a lot better than those attending the poorer/less affluent school, indicating that socio-economic status could have played a role in the differences in performance by scholars from the two schools. This trend is supported by the findings of other researchers. Thomas–Tate *et al.* (2004) highlighted the negative effect poverty has on the amount of home training first graders from a low-income families receive. This was seen to contribute to such children's poorer language development, resulting in a poorer vocabulary and poorer reading skills in later grades. Willie (2001) also referred to social scientists' belief that differences in achievement between minority (black and Hispanic) and white groups in the United States are due to the higher incidence of poverty in families of minority groups. This belief is based on studies that showed that a higher proportion of students who score below the national norm were from poverty-concentrated schools, irrespective of racial group. Low-income black Americans were also found to exhibit delayed language skills and use of few conceptual categories and abstractions (Castenell & Castenell 1988). This phenomenon was found to be linked to their cultural heritage, political background of slavery, discrimination and socialisation that resulted in their preference to intuitive rather than deductive reasoning; approximation of concepts such as space, number and time rather than striving for exactness; dependence on non-verbal rather than verbal skills and being object-orientated. All these studies implicate socio-economic status as one of the main cause of disparities in academic performance found between black and white students. Within the framework of the findings by the above-mentioned researchers, it can be speculated that the inequalities associated with past and current socio-economic backgrounds of scholars attending Sandringham school on the one hand and Bhukulani school on the other hand could explain the differences in performance displayed by the scholars.

When the performance of scholars attending the two schools was compared based on grade levels, both similarities and differences were found. Overall, the performance of the grade 8 scholars from both schools was mostly below or at average levels, with a large percentage of the scholars falling under stanines 1 to 5. The performance of grade 10 scholars was better than that of the grade 8 scholars with most scholars falling under stanines 5 and above. The latter trends remained similar for the grade 12 scholars. This pattern was expected since grade 8 scholars can be expected to perform poorer than their older counterparts who have more life experience and have gone though more years of school

education. However, when the grade levels were compared between the two schools, Sandringham scholars performed better than Bhukulani scholars for all grade levels. The performance of grade 12 scholars from Immaculata was similar to that of grade 12 scholars from Bhukulani. This was as expected as both schools had similar socio-economic and historical backgrounds. To determine whether the difference in performance of scholars attending Sandringham and Bhukulani could be linked to race, black scholars from all three schools were grouped together and their performance assessed. The results depicted in Figures 2.6, 2.9 and 2.12 show that combining black scholars from the three grade levels and three schools resulted in a more 'normal' stanine distribution when compared to Figure 1. A possible explanation for this finding could be that like the white scholars in Sandringham, the black scholars at Sandringham have a better knowledge than those attending the other two schools. This then moved the total curve to the right, resulting in a more normal distribution. This finding also supports the possibility that the scholars' performance was influenced more by their socio-economic background than by race.

The fact that the results of the total norm group reflect a normal curve very similar to the 'prototype' depicted in Figure 1, despite the apparent difference in socio-economic backgrounds and educational levels of the scholars, indicates that the norms are relevant for use among all urban South African adolescents. Finally, to ensure optimal application of the norms in the assessment of nutrition knowledge of urban adolescents using the questionnaire by Whati *et al.* (2005), cut-off points for levels of knowledge in percentage scores were identified and the 9 stanine categories were reduced to five categories namely: very poor; fair/below average; good/average; very good/ above average, and excellent. These scores reflect the final norm-referenced performance-rating scale and are depicted in Table 2.

Table 2: Norm referenced performance–rating scale for the nutrition knowledge questionnaire developed by Whati *et al*, 2005*

Stanine	Performance score (%)	Interpretation
1	<34	Very poor
2-4	34-51	Fair/ below average
5	52-57	Good/ average
6-9	58-75	Very good/ above average
9	76 +	Excellent

*Based on Formula No. 2

When using this scale it should be remembered that the scale compares the performance of an individual or group with that of urban South African adolescents in the Johannesburg-Soweto areas. When using the questionnaire and norms among other adolescent groups, the applicability of the norm group used for the development of the norms should be considered.

ASSESSING THE VALIDITY OF THE NORMS

Study design

As was mentioned in the introduction, the ideal method to assess the validity of the norms would be to assess nutrition knowledge and to compare the performance-rating of testees using the questionnaire by Whati *et al.* (2005) and its norms (Table 2), and to correlate the results with those obtained using another similar questionnaire with its own validated norms. This would ensure criterion validity. However, no such similar nutrition knowledge questionnaire with a validated norm-referenced rating scale was available for such a comparison. As an alternative it was decided to administer the nutrition knowledge questionnaire to groups with known nutrition knowledge levels ranging from excellent to average and to determine the following:

- Whether rating of the nutrition knowledge of each group using the norms was in line with performance expectations based on their known knowledge levels, and
- Whether the performance-rating of the different knowledge groups differed significantly.

If the groups perform according to expectations and the ratings differ significantly from each other, it would be a strong indication that the norms have discriminant validity (Sapp & Jensen 1997).

Study population (validation groups)

For the purposes of the validity assessment of these norms the questionnaire was administered to 4th year university dietetics students, non-dietetics university students, and primary school teachers. The dietetic students were completing their final year of tertiary education with nutrition as a major, therefore they were expected to have excellent nutrition knowledge. The non-dietetic male university students were expected to perform above average compared to their younger adolescent counterparts. This was based on the assumption that these students were three to eight years older than the adolescents and thus have had more life experience during which they could have been exposed to a variety of nutrition-related messages. However, they were not expected to fare as well as the dietetic students as they had had no formal university training in nutrition. Primary school teachers were also expected to have more nutrition knowledge than the adolescents because like the non-dietetic students, they were older and may have been exposed to nutrition information during their life experience as well

as in their capacity as educators. However, they were also not expected to perform as well as the dietetics students since they were not exposed to the same level of nutrition education.

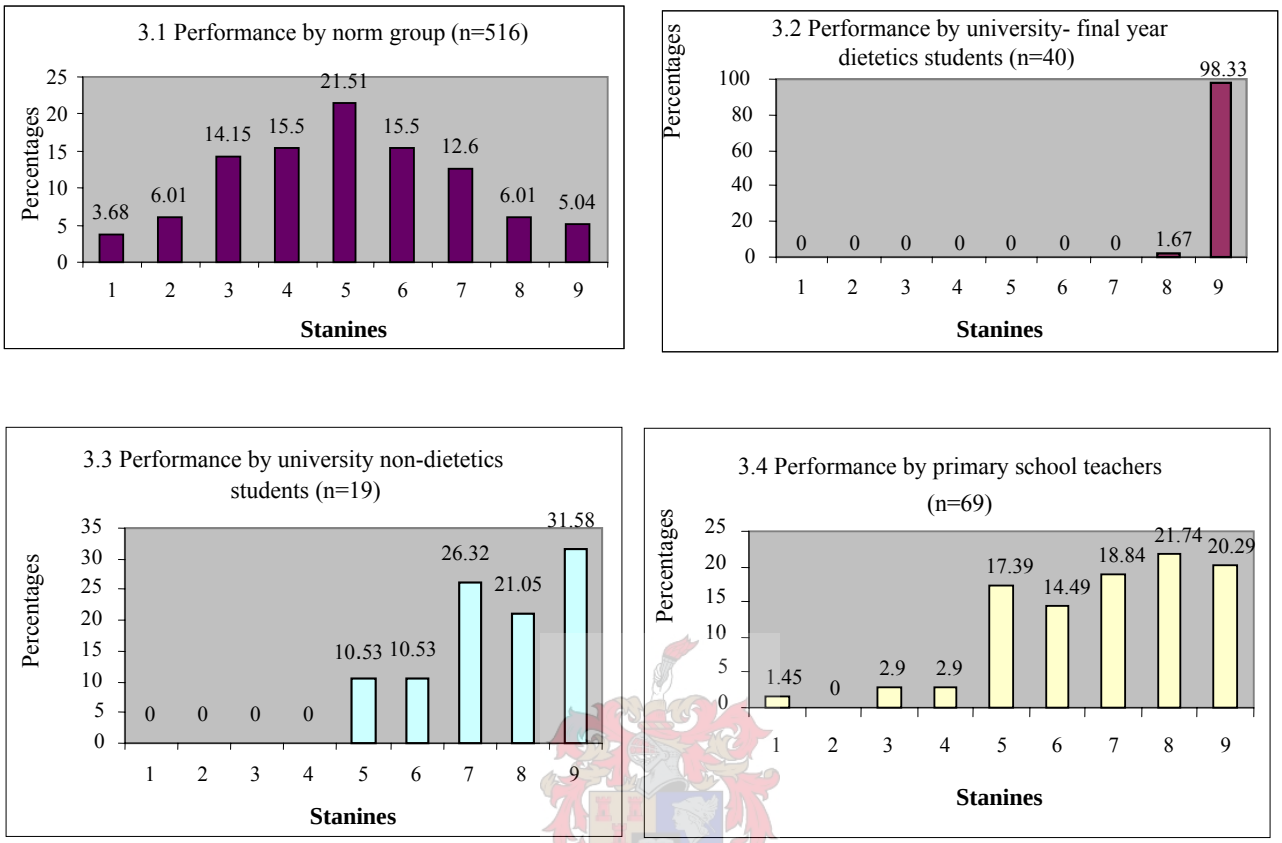
For sampling purposes, four universities offering dietetics training were requested to participate in the study. The head of the dietetics departments of the University of Stellenbosch (US), University of Natal (UN), University of Cape Town (UCT) and University of the Western Cape (UWC) gave consent for their students to complete the questionnaire. Subsequently a total of 60 final year dietetic students completed the questionnaire. To find non-dietetics students, male students at a University of Stellenbosch residence whose studies did not include nutrition were approached for their participation. Nineteen of the students volunteered to participate. The primary school teachers came from three randomly selected schools in the Cape Town metropole. Their permission was requested and sixty-nine agreed to participate. Informed written consent was obtained from all participants and the final study population included 148 subjects.

Data collection, processing and analyses

All participants completed the questionnaire under supervision and the data was processed as was described for the norm group using the SAS System for Windows, Version 8.2. The performance scores in percentages for each group were rated using the developed performance-rating scale (Table 2). To determine whether there is a difference in the performance rating of the three validation groups, a contingency table was constructed with validation groups as classification variable. The Chi-square test was used to test for significant difference ($P < 0.05$)

Results and discussion

The stanine distributions of the z-scores of the validation groups that formed the validation group are presented in Figures 3.1 to 3.4, with the norm group curve included for comparison purposes.



Figures 3.1-3.4: Stanine distributions of the z-scores of the validation groups

All three validation groups performed as expected. The university dietetics students performed excellently the performance of most students' falling under stanine 9 and a few under stanine 8. The male university students performed from levels 'at and above the average up to excellently, thus definitely better than the adolescents but not as well as the dietetics students. Primary school teachers achieved performances that ranged from a small percentage with 'poor and below average' performance but with most of them performing 'at and above average up to excellently'. The performance-rating of the three validation groups also differed significantly, as is shown in Table 3

Table 3: Column percentages for performance-rating in stanines by validation group

Stanines	Interpretation	University students (final year dietetics)	Primary school teachers	University students (non-dietetics)	Norm group*
1	Very poor	0	1.45	0	3.68
2	Fair/below average	0	0	0	6.01
3		0	2.90.	0	14.15
4		0	2.90	0	15.50
5	Good/average	0	17.39	10.53	21.51
6	Very good/above average	0	14.49	10.53	15.50
7		0	18.84	26.32	12.60
8		1.67	21.74	21.05	6.01
9	Excellent	98.33	20.29	31.58	5.04

*Not included in the Chi-square, only presented for comparative purposes
Chi square value = 85.55
Degrees of freedom = 8
P = <0.0001
Data should be interpreted with caution because 53% of the cells were empty

These results clearly indicate that the norms are valid because the validation groups performed as indicated when the norms were applied and the performance-ratings of the three groups differed significantly.

GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Performance-rating scales are a very important part of assessment tools. They give meaning to performance scores obtained through using the tool and also give context to the variable that was assessed. A norm-referenced performance-rating scale was developed for the nutrition knowledge questionnaire for urban adolescents through a process which involved firstly administering the nutrition knowledge questionnaire to a sample representative of the questionnaire target group, referred to as the norm group. The performance scores (in percentages) obtained by the norm group were then transformed to z-scores which were categorised into stanines using established z-score cut-off points. As required of an ideal norm group, these scores formed a normal distribution (formed a bell-shaped curve).

To facilitate the interpretation of the results the z-score cut-off points for these categories were transformed back to performance scores (%) so that the performance of a testee on the questionnaire can be interpreted directly from his/her performance in percentages. Furthermore the 9 stanine

categories were reduced to five categories namely: very poor; fair/below average; good/average; very good/ above average, and excellent

The discriminant validity of the norms was also substantiated by showing that groups with known nutrition knowledge levels were rated appropriately and that the performance ratings of these groups differed significantly. The norm-referenced performance-rating scale (Table 2) can thus be used to interpret performance scores achieved by a testee on the nutrition knowledge test developed by Whati *et al*; (2005) and can therefore be used to draw conclusions regarding the nutrition knowledge level of a testee.

The norms can be used with confidence for all urban South African adolescents in the Johannesburg-Soweto area regardless of race and background. However, the scale should not be used for performance-rating 10 years after its development as norms are likely to have changed after such a period (Morganthau 1990).

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CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

1. SUMMARY

To ensure optimal growth and development, adolescents need to practice healthy eating behaviour. Eating behaviour refers to the quality and quantity of food and drinks consumed, meal patterns, as well as other associated behaviours such as alcohol intake and physical activity. Healthful eating behaviour promotes good nutritional and overall health, and also reduces the risk for the development of nutrition-related health problems in the adolescence phase as well as later in life. Various factors relating to the individual, social environment, physical environmental as well as the macrosystem have been found to exert an influence on adolescent eating behaviour. Investigating the presence and effect of such influences on the eating behaviour and consequently the growth and development of adolescents born and living in the Johannesburg-Soweto areas, was one of the study objectives in the Birth-to-Twenty (BTT) longitudinal study (Richter *et al* 2004). One of the possible individual factors influencing adolescent eating behaviour is nutrition knowledge, and its assessment was introduced at year 13 of the BTT study. For effective nutrition knowledge assessment an appropriate questionnaire was essential. Literature searches indicated that such a questionnaire was not available for urban South African adolescents. Therefore, the primary aim of this study was to develop a nutrition knowledge questionnaire suitable for use on the BTT study.

Assessment tools need to be valid and reliable and therefore, a well-defined process needs to be followed in developing these tools (Contento *et al.* 2002). In this instance, the nutrition knowledge questionnaire for the BTT study needed to be valid and reliable for use on black and white adolescents from ages 13 to 20 years. The questionnaire development process started with the development of a conceptual framework as well as relevant nutrition concepts addressing the framework, which were assessed and approved by a panel of experts. The nutrition-related issues facing urban South African adolescents (See Chapter 3, Figure 2) was used as basis for the framework that was approved by the panel. With regard to the nutrition concepts the recently developed South African food-based dietary guidelines (FBDGs) were selected as key concepts. In addition to the FBDGs, the following were also identified as key concepts; How the FBDGs relate to lifestyle for the maintenance of good health and weight control; food sources of selected nutrients, food safety issues; and nutrition during pregnancy. This process ensured that the construct of the questionnaire and thus the basis on which construct validity could be assessed, was established

The second step involved formulating possible items for the questionnaire based on each of the nutrition concepts. A pool of 140 items was formulated and an expert panel was requested to assess the

items' appropriateness, relevance, accuracy, formulation and coverage of the nutrition concepts. The panel's recommendations were implemented and resulted in 88 true/false and 4-option multiple-choice items with each item having only one correct answer. This step established content and face validity of the items.

The third step involved using the formulated items to construct a self-completion preliminary questionnaire. This involved composing a cover page with instructions on completion and questions on demographics; breakdown of the concepts into sections; the random placement and numbering of each item within the relevant sections, as well as appropriate formatting of the whole questionnaire. To further ensure face validity, this preliminary questionnaire was piloted on seven adolescents aged 13-17 years residing in Gugulethu, a township in the Western Cape Province. The adolescents assessed the preliminary questionnaire for clarity and readability, and changes were made to the items as necessary.

The fourth step involved statistical analyses to assess the difficulty and discriminatory indices of each item. For this purpose the questionnaire was completed by an appropriate study sample. To ensure balance between easy and difficult items in the questionnaire, a group who was expected to be knowledgeable in nutrition and another who was expected to be less knowledgeable in nutrition needed to complete the questionnaire. To ensure that the adolescent group was represented, high school students also had to be included in this sample. Based on all these requirements the study sample (Sample 1) comprised university final year dietetic students (n=20) and grade 12 scholars who had home economics as a subject (n=51) as the knowledgeable groups. The less knowledgeable group comprised university non-dietetic students (n=19) and grade 12 scholars not studying home economics (n=63). The difficulty criteria used in the item analysis were defined as follows: items that 90% of the total sample answered correctly were considered as too easy and items which 10% or less of the total sample answered correctly were considered as too difficult and were removed from the questionnaire. To assess the discriminatory index of items, each item's effect on the Cronbach α of the section in which it was included was determined. An item which lowered the Cronbach α value of a particular section was removed while those that increased the Cronbach α value of the relevant section was retained. Based on these criteria, a total number of 11 items were removed from the questionnaire, resulting in a 63-item questionnaire.

Subsequently, the construct validity of the 63-item questionnaire was assessed (the fifth step) by determining the questionnaire's ability to differentiate between groups with different knowledge levels. The Kruskall-Wallis ($P < 0.0001$) and Bonferroni *post hoc* tests showed a significant difference in

knowledge levels between the groups comprising Sample 1, thereby confirming construct validity of the questionnaire.

The sixth step involved assessing the reliability of the questionnaire using Cronbach α as indication of internal consistency reliability. This required the administration of the questionnaire to a sample representative of the BTT cohort. This sample (Sample 2) had to include three age groups; namely 13-14; 15-16 and 17-18 years, the ages at which BTT adolescents' knowledge were to be assessed. The racial breakdown of this sample was of black and white scholars who all reside in the Johannesburg-Soweto suburbs, similarly to the BTT cohort. For these purposes, the grade 8, 10 and 12 scholars attending two high schools in Johannesburg (Sandringham) and Soweto (Bhukulani) completed the questionnaire (n=402). Overall, internal consistency reliability (ICR) at 0.77 was acceptable for the total sample as 0.7 is considered as the acceptable cut-off point for questionnaire reliability (Sapp & Jensen 1997). However, the results showed a poorer ICR for scholars in grade 8 (0.69), regardless of the school they were attending and a better reliability for scholars in grades 10 (0.79) and 12 (0.8). When comparing schools, the questionnaire had a poorer ICR for all scholars attending the Soweto school that was attended by black adolescents who were mostly from historically disadvantaged backgrounds. With regard to the Johannesburg school (Sandringham), ICR was only poorer for grade 8 scholars but acceptable for grades 10 and 12 scholars. Sandringham School was attended by adolescents from middle-class backgrounds of various races although black and white scholars were in the majority. This suggested that the poorer questionnaire ICR observed for grade 8 scholars in general could have been as a result of their younger age. Consequently, cognitive abilities that were still developing could have an effect on their comprehension of the questions. Regarding the results obtained for Bhukulani School, historical background and the resulting socioeconomic status, as well as poorer cognitive and language abilities were suggested as possible reasons for the poorer questionnaire ICR found in these adolescents. Since cognitive abilities were assumed to be the source of poorer questionnaire ICR among some adolescent groups, it is recommended that these adolescents complete the questionnaire with the assistance of a trained interviewer who will ensure that the testee has a clear understanding of each question, without the interviewer leading to or giving away the answers.

As indicated in the fourth step, items had been deleted because they were too easy/difficult or had poor discriminatory ability. Therefore, the content validity of the questionnaire needed to be reassessed (the seventh step in the questionnaire development process). For these purposes, an expert panel determined

whether each nutrition concept was still adequately covered after removal of the items in Step 4. Poor coverage of some concepts was found and consequently, items were re-included in the questionnaire. It was also noted that some of the remaining items were repetitive and in these cases the item with the highest correlation with the total score was retained. This resulted in a 60-item questionnaire with the content validity being assured.

As a consequence of the changes from the 63-item to the 60-item questionnaire, the construct validity and ICR of the final 60-item questionnaire was reassessed. This was done as outlined in Steps 5 and 6. The results indicated that the questionnaire still differentiated between groups with different knowledge levels, confirming its construct validity. In fact, the ICR had improved, with overall ICR for the total sample above 0.7, even for the grade 8 scholars. Although the ICR values showed a slight improvement within the two schools and even for their respective school grades, the ICR values for grade 8 scholars compared to other grade levels as well as for all the adolescents attending Bhukulani School remained lower compared to Sandringham scholars.

The final result of all these steps was a nutrition knowledge questionnaire for use on the BTT group with acceptable levels of construct, face and content validity as well as internal consistent reliability. It is important to note that although the questionnaire is meant for self-completion, younger adolescents aged 13-14 years as well as black adolescents attending Soweto schools will require the assistance of a trained interviewer when completing the questionnaire.

In a longitudinal study such as the BTT it is important to be able to rate the individual's knowledge to facilitate determining the relationship between individual knowledge and eating behaviour. Changes in knowledge levels and associated behaviour also need to be traceable over time. For these purposes a performance-rating scale was required. After investigating various possibilities, a norm-referenced performance-rating scale (norms) was identified as the most appropriate scale for the BTT group. For the development of norms, the first step involved administering the nutrition knowledge questionnaire to a sample representative of the BTT cohort (norm group). The sample comprised mostly black and white scholars in grades 8, 9, and 12 of three schools in the Johannesburg-Soweto area (n=516). The second step was to standardise the performance scores (%) by converting each of the scholar's performance scores to z-scores that have a mean of 0 and a standard deviation of 1. The third step was to group the z-scores according to a standard that can be used in interpreting the scores. Stanines which refer to nine classification categories (stanine 1-9) were selected for this purpose. The distribution of the z-scores within the stanines was plotted on a histogram and yielded a bell-shaped curve, which was

indicative of a normal distribution and indicated that the selected study sample was appropriate as a norm group.

To avoid the need for converting testees' performance scores to z-scores before performance-rating can take place, the z-score cut-off points were converted to performance score (%) ranges as the final step in norm development. This allows the researcher to use a testees' performance score (%) for the nutrition knowledge questionnaire, establish the stanine category under which the score falls and then interpret the performance accordingly. In addition, the 9 stanine categories were reduced to five categories namely: very poor; fair/below average; good/average; very good/above average, and excellent.

Following the development of norms their discriminant validity was determined. Discriminant validity is described as the ability of the norms to reflect differences in knowledge levels based on performance-ratings. This was done by administering the nutrition knowledge questionnaire to three validation groups that comprised groups who were expected to obtain different performance-ratings on the questionnaire based on their varying levels of nutrition knowledge. The three groups included final year university dietetic students (*n*=60) who were expected to perform excellently on the questionnaire based on their formal nutrition training; male university non-dietetic students (*n*=19) who were expected to perform above the norm group's average (based on knowledge accumulated during their life experience) but who were not expected to perform as well as the dietetic students; and primary school teachers (*n*=69), who, were also expected to perform above the norm group's average (based on different life experiences) but also not as well as the dietetic students. The validation groups performed as expected, with significant differences in performance-rating profiles found among the three groups.

2. FINAL CONCLUSION AND RECOMMENDATIONS

Questionnaire development and associated psychometrics have not received adequate attention in South Africa, as is shown by the lack of available valid and reliable tools. The development and use of such tools will not only produce reliable research results but may also assist in elevating the quality of research done to a higher level in order to compare with international standards. The study was successful in developing a reliable and valid nutrition knowledge questionnaire to be used on the urban adolescents participating in the BTT study. Furthermore, most adolescents should be able to complete the questionnaire on their own. However, the younger adolescents and those from historically disadvantaged backgrounds should receive the assistance of a trained interviewer when completing the

questionnaire. The assistance by an interviewer will ensure that a testee has adequate comprehension of each item before giving his/her response to each said item.

A norm-referenced performance-rating scale for use with the questionnaire was also successfully developed. The questionnaire and norms will be useful in assessing nutrition knowledge as well as in comparing the changes in knowledge of the cohort as they move from lower to higher school grades. This will ensure that one of the BTT study objectives is carried out in a scientifically sound manner, resulting in valid and reliable information that can be disseminated to the relevant stakeholders.

It is recommended that the nutrition knowledge questionnaire and norms can also be used on other urban South Africa adolescent groups as means of assessing their nutrition knowledge levels on relevant nutrition issues e.g. for the evaluation of the nutrition component of life orientation course in South African high schools. However, other researchers need to ensure that the characteristics of the study sample and norm group that were used for the development of this questionnaire and its norms are in line with the characteristics of their target group. Finally, it is important to note that norms change over time and it is suggested that the use of the actual questionnaire and the norms should be limited to a maximum of ten years.

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ADDENDUM A:

Addendum A Final suggested concepts and specific objectives for review by an expert panel

CONCEPTS
1. Recommendations for a healthy lifestyle using food guides such as the food pyramid and 5-food groups
2. Nutritional needs for adequate growth and development ➢ Food and Nutrients Selected nutrients; their main functions and common food sources *Macronutrients*: Carbohydrates, fat, protein, fibre *Vitamins*: A, C, B complex. *Minerals:* Iron, zinc, iodine, and calcium ➢ Portion/ serving size Determine portion size of common foods representative of each of the 5 food groups: Carbohydrates, fats, protein, fruits, and vegetables ➢ Recommended number of servings Daily recommendations to meet needs as outlined on food guide pyramid
3. Media messages regarding proper nutrition Common media messages (print and television) on food and how they are interpreted; specifically those referring to carbohydrates, sugar, fat, fibre, energy drinks, alcohol (beer, ciders, wine, spirits, brandy),nutritional supplements, and weight loss products

4.Proper meal planning

- Food habits

Determine options representing healthy food habits

- Cooking methods

Determining healthy cooking methods

- ***Breakfast/ lunch/ supper and snacks and drinks***

Determining the food options representing healthy meals and snacks

- Food labels

Interpretation of food label to make healthy choices

- Nutritional supplements

Conditions in which nutritional supplements should be used

5.Relationship between diet and disease

- Chronic Diseases of Lifestyle (CDL0

Nutrient intake as risk factors in the development of CDL

- Undernutrition

Nutrient deficiencies as risk factors for poor growth and development, and disease

6. Weight management

Defining healthy weight

Identifying fad diets used in weight loss versus healthy weight loss methods

Identifying fad diets used in weight gain

Poor weight control and the development of eating disorders

7. Food safety for the prevention of food-borne illness

Determining safe food purchasing, preparation, and storage practices. Also safe drinking water procurement.

8. Sports nutrition Timing of meals before exercise Content of meals before exercise Function of sports drinks during exercise Appropriate weight for sportspersons Weight loss methods for sportspersons Weight gain methods for sportspersons
9. Proper nutrition in pregnancy Expected weight gain in pregnancy Additional nutrient needs in pregnancy Dietary supplements in pregnancy
10. Ensuring adequate intake in vegetarianism Additional nutrients lacking from the vegetarian diet; iron, calcium, protein, vitamins D and B12, zinc if meat, fish and dairy products are not part of your diet

ADDENDUM B:

Addendum B: 88-item version of the nutrition knowledge questionnaire

Official Use Only

Nutrition Knowledge Questionnaire

Instructions

Section A to E

The following sections contains two types of questions. Multiple choice and true/ false.

For the multiple choice, choose ONE that you think is the best, and make a cross on the number next to the answer.

For the true/false questions, make a cross on the TRUE or the FALSE.

In Section F do the following:
Question 1, select YES or NO for all the options
Question 2, select 1 or 2 or 3 or 4 for those you have chosen YES to in Question 1

Please answer all the questions before moving on to the next one.

Do not page back!

Also note that the questions refer to a healthy person who is not on any medication or special diet.
A reminder that your answers will not be known by anyone other than the researchers

DATE			200	
SUBJECT NUMBER				
AGE				
DATE OF BIRTH				
GENDER		Male	Female	
SCHOOL/ INSTITUTION				
GRADE/ DEGREE				

SECTION A.

1. All boiled water is safe no matter where you get it from

TRUE	FALSE	

2. The healthiest snack is:

A glass of milkshake	1
A tub of unbuttered popcorn	2
A slab of chocolate	3
2 and 3 above	4

3. You can replace water with cold drinks like "Coca Cola"

TRUE	FALSE	

4. It is impossible to g*et al*l the vitamins and minerals you need from food, you need to take a vitamin and mineral pill

TRUE	FALSE	

5. Soya mince is as healthy as meat

TRUE	FALSE	

6. Physical activity should be a part of everyone's daily life

TRUE	FALSE	

7. If you are eating a healthy diet there is no need for you to be physically active

TRUE	FALSE	

8. Sugar and sugar-containing foods are harmful to the body and should be avoided completely

TRUE	FALSE	

9. How many fruits and vegetables should be eaten

1 fruit and vegetable a day	1
3-4 fruits and vegetables a day	2
5 or more fruits and vegetables everyday	3
There is no need to eat fruits and vegetables daily	4

10. Eating a lot of different kinds of foods is healthier than eating only a few kinds foods

TRUE	FALSE	

11. You should eat a lot of sugar to have enough energy

TRUE	FALSE	

12. Your body only needs a little bit of salt to be healthy

TRUE	FALSE	

13. Dry beans, peas, and lentils should be eaten often

TRUE	FALSE	

14. All water is safe to drink

TRUE	FALSE	

15. Sugar and foods that contain sugar should be eaten in small amounts

TRUE	FALSE	

16. Which cooking method will result in the largest amount of fat?

Boiling	1	
Braaiing	2	
Frying	3	
Roasting	4	

17. Foods such as bread, rice, maize meal, or samp, should be the main part of most meals

TRUE	FALSE	

18. What is a portion of cooked vegetables?

I Tablespoon	1	
Half a cup	2	
I Cup	3	
2 Cups	4	

19. Which of the following foods are the lowest in fat:

Corn flakes and full cream milk	1	
Grilled lean steak and boiled carrots	2	
Pizza and milkshake	3	
Fried lamb chops and creamed spinach	4	

20. Salt should be added to all foods except fruits

TRUE	FALSE	

21. Which way of cooking eggs will result in the lowest amount of fat?

Scrambled	1	
Fried	2	
Boiled	3	
None of the above	4	

22 You can eat as much meat as you want everyday

TRUE	FALSE	

23. Which of the following is a low fat snack

"Simba" Chips	1	
Popcorn	2	
Fried chips	3	
"Niknaks"	4	

24. It is healthy to snack on foods that contain a lot of sugar

TRUE	FALSE	

25. A well- balanced diet

Consists mostly of meat, with smaller amounts of starch, fruits, vegetables, and dairy products	1
Consists mostly of vegetables, and smaller amounts of meat and dairy products	2
Consists mostly of starches, vegetables and fruits, with smaller amounts of meat and dairy products	3
None of the above	4

26. It is best to eat sugar- containing foods only as a snack only, instead of as part of a meal

TRUE	FALSE	

27. Foods containing a lot of sugar should not be eaten as snacks

TRUE	FALSE	

28. How much water should you drink a day

You don't have to drink water everyday	1
1 to 3 glasses	2
4 to 6 glasses	3
7 to 9 glasses	4

29. How much milk or maas should you have a day?

None	1
Half a cup	2
One cup	3
Two cups	4

30. The key to a healthy way of eating is to

Eat many different kinds of foods	1
Eat some foods more than other foods	2
Eat certain kinds of foods in moderate or small amounts	3
All of the above	4

31 From which group of foods should you eat the most every day?

Bread, samp, rice, porridge	1
Apples, bananas, spinach, carrots	2
Milk, yogurt, cheese	3
Chicken, fish, beans, eggs	4

32. A healthy diet is one that includes

Mostly meat, fish, chicken	1
Mostly uncooked foods	2
Mostly foods in cans or tins (*tinstuff*)	3
Mostly bread, rice, and maize meal	4

33. Sugar is healthy and should be added to all foods TRUE FALSE

34. Which of the following breakfast menus contain little fat

Whole-wheat toast with thinly spread margarine	1
Weet-Bix with 2% fat milk	2
Bacon and egg	3
1 and 2	4

35. Most of the foods you eat should be

Starches, dairy products, meat and beans	1
Vegetables, fruits and dairy products	2
Starches	3
Vegetables, fruits, meats, and beans	4

36. Sugar contains a lot of vitamins and minerals TRUE FALSE

37. Being physically active means

Going to the gym	1
Walking a lot	2
Playing sports like soccer or netball	3
All of the above	4

38. Fat or fatty foods may be eaten in small amounts TRUE FALSE

39. Dry beans, peas, lentils are a healthy choice to eat in place of meat TRUE FALSE

40. You can drink as much wine, beer, ciders as you want provided you have eaten first TRUE FALSE

41. Drinking lots of water is not necessary TRUE FALSE

SECTION B

1 If one wants to lose weight there is no need to be physically active, it is better that one simply diets

TRUE	FALSE	

2 Drinking boiled water is a good way to lose weight

TRUE	FALSE	

3 Eating a lot of meat instead of other foods is a good way to lose weight

TRUE	FALSE	

4 You cannot develop diseases just by drinking a lot of wine, beer, and ciders

TRUE	FALSE	

5 To protect yourself from disease you should avoid eating many different kinds of foods

TRUE	FALSE	

6 You should add extra salt to your cooked food before you even eat it

TRUE	FALSE	

7 A little sugar can be eaten when one is trying to lose weight

TRUE	FALSE	

8 The following foods must not be eaten at all when one is trying to lose weight

Bread and rice	1	
Meat and fish	2	
Margarine	3	
None of the above	4	

9 Eating a lot of sugar and sugar- containing foods can result in weight gain

TRUE	FALSE	

10 Starchy foods should not be eaten when one is trying to lose weight

TRUE	FALSE	

11 One of the things you can do to be healthy is to

Stay indoors and watch TV or play computer games	1	
Spend most of your time sleeping	2	
Be physically active	3	
Spend a lot of time reading	4	

12 People who are overweight should not be physically active

TRUE	FALSE	

13 Eating foods that have a lot of sugar can protect you against some diseases

TRUE	FALSE	

14 It is not good for one to eat a lot of salt if they are overweight

TRUE	FALSE	

15 Which of the following choice of foods prevent certain diseases

Fish, Chicken without skin, and lean meat	1
Beef sausage, bacon, and lean mince	2
Fried fish, fried chicken, and regular mince	3
All of the above	4

16 Drinking clean water protects you against some diseases

TRUE	FALSE	

17 Eating bread always causes weight gain

TRUE	FALSE	

18 The reason why beans, peas and lentils are good for you is that

They contain only small amounts of fat	1
They contain a lot of fibre	2
They can protect you from some diseases	3
All of the above	4

19 Drinking a lot of wine, beer, cider can cause weight gain

TRUE	FALSE	

20 To make sure that you stay healthy you should eat

Lean meat, fruits and vegetables, low fat dairy products, and breads and cereals	1
Fruit and vegetables only	2
Bread, cereals, fruit and vegetables only	3
Low fat dairy products and lean meat only	4

21 You should not have starches at most meals because

They are not important for your health	1
Even eating small amounts can cause weight gain	2
They cause diseases	3
None of the above	4

SECTION C

1. Which groups of foods contain a lot of calcium?

Green leafy vegetables and fruit	1
Whole-wheat cereals, spaghetti, and bread	2
Milk, cheese, yogurt	3
All of the above	4

2 Which foods contain a lot of starch?

Bread, rice, maize meal, samp	1
Maize meal only	2
Fruits and vegetables	3
Fresh fish and chicken	4

3. Which group of foods has the most Vitamin A?

Oats, whole wheat bread, rice	1
Carrots, spinach, sweet potatoes	2
Pies, cakes, pudding	3
None of the above	4

4. Which one of the following nutrients are found in most fruits

Fibre	1
Iron	2
Fat	3
All	4

5. Which foods contain a lot of calcium?

Chicken and eggs	1
Milk, yoghurt	2
Pilchards	3
2 and 3	4

6. To which of the following foods has iodine been added?

Bread	1
Maize meal	2
Table salt	3
Powdered milk	4

7. Which one of the following groups of nutrients are found in large amounts in fruits and vegetables?

Fibre, Vitamin A	1	
Starches, fat, Vitamin D	2	
Fats, Iron, Calcium	3	
None of the above	4	

8 Which foods contain a lot of fibre?

Oats, apples, beans	1	
Milk, yoghurt, cheese	2	
Beef, chicken, mutton	3	
Butter, margarine	4	

9. Which food has the most fibre?

White rolls	1	
Brown bread	2	
White bread	3	
Whole wheat bread	4	

10 If you were trying to increase the amount of fibre in your diet, which one of the following foods should you eat more of?

Cakes and biscuits	1	
Apples and carrots	2	
Chips and pies	3	
Chicken and fresh fish	4	

11 Red meat, chicken, and fish all have a lot of iron

TRUE	FALSE	

SECTION D

1. Meat/ fish/ chicken will not spoil if you store them

In the cupboard for a few days	1	
In the fridge for 2 days only	2	
In the freezer for 3-4 months	3	
In 2 and 3 above	4	

2. Cooked meat/ fish/ chicken sold on the street may not always be safe to eat because

It may have been undercooked	1	
The cook may not have used fresh meat	2	
It may have been kept for a long time before being cooked	3	
All of the above	4	

3. The best place to defrost meat from a frozen state is to

leave it at room temperature	1
leave it in the fridge	2
leave it in sunlight	3
Meat should never be defrosted	4

4. It is important to wash fruits before eating them

TRUE	FALSE

5. It is usually not necessary to wash vegetables before you cook them

TRUE	FALSE

SECTION E

1. What a pregnant woman eats during pregnancy has no effect on her health and the health of her unborn baby

TRUE	FALSE

2. Pregnant women need to take certain vitamin and mineral pills

TRUE	FALSE

3. A woman needs more nutrients when she is pregnant

TRUE	FALSE

4. It is not healthy for a pregnant woman to drink a lot of wine, beer, cider

TRUE	FALSE

5. Overweight women should try to lose weight when they are pregnant

TRUE	FALSE

6. Which of the following should a pregnant woman eat more of?

Milk, cheese, maas	1
Meat, chicken, fish	2
Fruits and vegetables	3
All of the above	4

7. It is important for a pregnant women to avoid eating different kinds of foods

TRUE	FALSE

8. Women must try not to gain weight when they are pregnant

TRUE	FALSE

9. Which one of the following is not healthy for a pregnant woman to do

Be physically active	1
Eat different kinds of foods	2
Sleep most of the day	3
Drink lots of water	4

10. It is not healthy for a pregnant woman to eat foods like milk, cheese, yoghurt

TRUE	FALSE

SECTION F

1. From where do you get your information about nutrition?

	YES	NO
School	1	2
Peers/ Friends	1	2
Parents	1	2
Radio/ TV/ Magazines	1	2
Other (Specify)		
	1	2

2. Of the choices you have selected above, how would you rate them as sources of information:

1= very unreliable
2= unreliable
3= reliable
4= very reliable

	very unreliable	unreliable	reliable	very reliable
School	1	2	3	4
Peers/ Friends	1	2	3	4
Parents	1	2	3	4
Radio/ TV/ Magazines	1	2	3	4
Other (Specify)				
	1	2	3	4

ADDENDUM C:

Addendum C: Information sheet sent to high school officials for Sample 1

STUDY INFORMATION SHEET

Development of a valid and reliable nutrition knowledge questionnaire for urban teenagers

The Medical Research Council and Birth to Twenty Study Group are in the process of designing a questionnaire that can be used to evaluate the nutrition knowledge of teenagers. Since we want the questionnaire to meet certain criteria before it can be used, it has to undergo certain steps as part of the development process. Some of the steps require that a certain number of school going teenagers complete the questionnaire until a satisfactory one is constructed.

What do we expect from the participants?

The questionnaire needs to be completed by two groups of teenagers in grade 12 .The one group should be studying Home Economics and we expect them to have the best nutrition knowledge, while the 2nd group should not be studying the subject. According to experts on the development of questionnaires. If the questionnaire is a good one, the two groups should score differently to each other, with the home economics students being regarded as the standard for comparison.

The teenagers who participate in our study will complete the questionnaire at their school, during a time the school management decides. The questionnaire will take a maximum of 30 minutes to complete. All information is confidential and the children will not be required to identify themselves or to provide personal information.

What will be done with the results?

At this stage, we only need to make sure that the questionnaire properly tests knowledge about nutrition for the age group in the right way. At a later stage, the questionnaire will be administered to a large number of teenagers of different ages and backgrounds. Thereafter, a report will be sent to the Department of Education. It will then be the responsibility of concerned organizations to make improvements where knowledge is lacking.

Can you refuse to participate in the study?

Yes. The school and the students will not be affected in anyway if you refuse to participate in the study.

Further Questions?

More information can be obtained from the following people:

Ms Lindiwe Ngwenya: 082 957 4706

Dr Nelia Steyn- Medical Research Council Tel: 021 938 0242

Dr Shane Norris- Birth to Twenty Study Tel: 011 488 3609

Addendum C: Consent forms provided to and completed by high school students (Sample 1)

TEENAGER'S CONSENT FORM

Development of a nutrition knowledge questionnaire for urban teenagers

We hereby request your participation in the study. It will only require you complete the questionnaire at a time and place arranged with your school principal. You will not be required to put your name on the questionnaire. Additional information required will only be used to group your results with those of other teenagers. Your completion of the questionnaire will help us to develop a questionnaire that is appropriate for teenagers.

I……, hereby acknowledge that

1. I have been informed about the purpose and nature of the study
2. I know I can refuse to participate even if my parent/ guardian has given permission

I agree/ I do not agree (please circle) to participate in the research study

Signature……. Date…….

ADDENDUM D:

Addendum D: Cronbach α for sections and per section for each deleted item

Cronbach alpha for Section A: 0.757818

Deleted Item	Cronbach alpha
sa01	0.763920
sa02	0.744064
sa03	0.758189
sa04	0.752085
sa05	0.743986
sa06	0.755698
sa07	0.755271
sa08	0.757886
sa09	0.753238
sa10	0.755936
sa11	0.754487
sa12	0.755921
sa13	0.749354
sa14	0.753653
sa15	0.753471
sa16	0.763501
sa17	0.758958
sa18	0.748722
sa19	0.752480
sa20	0.746715
sa21	0.755270
sa22	0.752366
sa23	0.749100
sa24	0.752762
sa25	0.743199
sa26	0.753109
sa27	0.757159
sa28	0.755414
sa29	0.749860
sa30	0.748006
sa31	0.743639
sa32	0.760003
sa33	0.756082
sa34	0.753248
sa35	0.751833
sa36	0.752436
sa37	0.753553
sa38	0.754329
sa39	0.755013
sa40	0.750304
sa41	0.755462

Cronbach α for Section B: 0.685323

Deleted Item	Cronbach alpha
sb01	0.672014
sb02	0.663941
sb03	0.677180
sb04	0.690271
sb05	0.661464
sb06	0.660940
sb07	0.667477
sb08	0.668929
sb09	0.675062
sb10	0.686576
sb11	0.671779
sb12	0.682604
sb13	0.682044
sb14	0.692150
sb15	0.677766
sb16	0.678035
sb17	0.667798
sb18	0.676772
sb19	0.688244
sb20	0.663515
sb21	0.658898

Cronbach α for Section C: 0.653126

Deleted Item	Cronbach alpha
sc01	0.660886
sc02	0.639945
sc03	0.609772
sc04	0.610386
sc05	0.637459
sc06	0.639784
sc07	0.616067
sc08	0.602632
sc09	0.598013
sc10	0.641182
sc11	0.673493

Cronbach α for Section D: 0.477333

Deleted Item	Cronbach alpha
sd01	0.375148
sd02	0.380742
sd03	0.499792
sd04	0.426488
sd05	0.416694

Cronbach α for Section E : 0.595631

Deleted Item	Cronbach alpha
se01	0.548329
se02	0.633556
se03	0.580116
se04	0.546341
se05	0.550533
se06	0.555211
se07	0.544297
se08	0.591318
se09	0.595638
se10	0.543160

ADDENDUM E:

Addendum E: Items deleted from 88-item questionnaire after item analysis and rationale for deletion

Section	**Items deleted +**	**Items deleted ++**	**Items remaining after**
A	6,7,8,21,35,38,41	1,3,16,17,32	2,4,5,9,10,11,12,13,14,15,18,19,20,22,23,24,25, 26,27,28,29,30,31,33,34,36,37,39,40
B	3,11,12,16	4,14,19	1,2,5,6,7,8,9,10,13,15,17,18,20,21
C	2	1,11	3,4,5,6,7,8,9,10
D	4	-	1,2,3,5
E	3	2	1,4,5,6,7,8,9,10

+ Difficulty index not within 0.1-0.9 range

++ Negatively affects Cronbach α for its section

ADDENDUM F:

Addendum F: 63-item version of the nutrition knowledge questionnaire

NUTRITION KNOWLEDGE QUESTIONNAIRE

Office Use

INSTRUCTIONS

Section A to E

The following sections contain two types of questions. Multiple choice and true/ false.
For the multiple choice, choose ONE that you think is the best, and make a cross on the number next to the answer.
For the true/false questions, make a cross on the TRUE or the FALSE.

In Section F do the following:

Question 1, select YES or NO for all the options
Question 2, select 1 or 2 or 3 or 4 for those you have chosen YES to in Question 1

Please answer all the questions before moving on to the next one.
Do not page back!

Also note that the questions refer to a healthy person who is not on any medication or special diet.
A reminder that your answers will not be known by anyone other than the researchers

DATE			200	
SUBJECT NUMBER				
AGE				
DATE OF BIRTH				
GENDER			Male	Female
SCHOOL				
GRADE				
ETHNIC GROUP				

SECTION A.

1. The healthiest snack is:

A glass of milkshake	1
A tub of unbuttered popcorn	2
A slab of chocolate	3
2 and 3 above	4

2. It is impossible to g*et al*l the vitamins and minerals you need from food, you need to take a vitamin and mineral pill

TRUE	FALSE

3. Soya mince is as healthy as meat

TRUE	FALSE

4. How many fruits and vegetables should be eaten

1 fruit and vegetable a day	1
3-4 fruits and vegetables a day	2
5 or more fruits and vegetables everyday	3
There is no need to eat fruits and vegetables daily	4

5. Eating a lot of different kinds of foods is healthier than eating only a few kinds foods

TRUE	FALSE

6. You should eat a lot of sugar to have enough energy

TRUE	FALSE

7. Your body only needs a little bit of salt to be healthy

TRUE	FALSE

8. Dry beans, peas, and lentils should be eaten often

TRUE	FALSE

9. All water is safe to drink

TRUE	FALSE

10. Sugar and foods that contain sugar should be eaten in small amounts

TRUE	FALSE

11. What is a portion of cooked vegetables?

I Tablespoon	1
Half a cup	2
I Cup	3
2 Cups	4

12. Which of the following foods are the lowest in fat:

Corn flakes and full cream milk	1
Grilled lean steak and boiled carrots	2
Pizza and milkshake	3
Fried lamb chops and creamed spinach	4

13. Salt should be added to all foods except fruits

TRUE	FALSE

14 You can eat as much meat as you want everyday

TRUE	FALSE

15. Which of the following is a low fat snack

"Simba" Chips	1
Popcorn	2
Fried chips	3
"Niknaks"	4

16. It is healthy to snack on foods that contain a lot of sugar

TRUE	FALSE

17. A well- balanced diet

Consists mostly of meat, with smaller amounts of starch, fruits, vegetables, and dairy products	1
Consists mostly of vegetables, and smaller amounts of meat and dairy products	2
Consists mostly of starches, vegetables and fruits, with smaller amounts of meat and dairy products	3
None of the above	4

18. It is best to eat sugar- containing foods only as a snack only, instead of as part of a meal

TRUE	FALSE

19. Foods containing a lot of sugar should not be eaten as snacks

TRUE	FALSE

20. How much water should you drink a day

You don't have to drink water everyday	1
1 to 3 glasses	2
4 to 6 glasses	3
7 to 9 glasses	4

21. How much milk or maas should you have a day?

None	1
Half a cup	2

One cup	3	
Two cups	4	

22. The key to a healthy way of eating is to

Eat many different kinds of foods	1	
Eat some foods more than other foods	2	
Eat certain kinds of foods in moderate or small amounts	3	
All of the above	4	

23. From which group of foods should you eat the most every day?

Bread, samp, rice, porridge	1	
Apples, bananas, spinach, carrots	2	
Milk, yoghurt, cheese	3	
Chicken, fish, beans, eggs	4	

24. Sugar is healthy and should be added to all foods

TRUE	FALSE	

25. Which of the following breakfast menus contain little fat

Whole-wheat toast with thinly spread margarine	1	
Weet-Bix with 2% fat milk	2	
Bacon and egg	3	
1 and 2	4	

26. Sugar contains a lot of vitamins and minerals

TRUE	FALSE	

27. Being physically active means

Going to the gym	1	
Walking a lot	2	
Playing sports like soccer or netball	3	
All of the above	4	

28. Dry beans, peas, lentils are a healthy choice to eat in place of meat

TRUE	FALSE	

29. You can drink as much wine, beer, ciders as you want provided you have eaten first

TRUE	FALSE	

SECTION B

1 If one wants to lose weight there is no need to be physically active, it is better that one simply diets

TRUE	FALSE	

2 Drinking boiled water is a good way to lose weight

TRUE	FALSE	

3 To protect yourself from disease you should avoid eating many different kinds of foods

TRUE	FALSE

4 You should add extra salt to your cooked food before you even eat it

TRUE	FALSE

5 A little sugar can be eaten when one is trying to lose weight

TRUE	FALSE

6 The following foods must not be eaten at all when one is trying to lose weight

Bread and rice	1
Meat and fish	2
Margarine	3
None of the above	4

7 Eating a lot of sugar and sugar- containing foods can result in weight gain

TRUE	FALSE

8 Starchy foods should not be eaten when one is trying to lose weight

TRUE	FALSE

9 Eating foods that have a lot of sugar can protect you against some diseases

TRUE	FALSE

10 Which of the following choice of foods prevent certain diseases

Fish, Chicken without skin, and lean meat	1
Beef sausage, bacon, and lean mince	2
Fried fish, fried chicken, and regular mince	3
All of the above	4

11 Eating bread always causes weight gain

TRUE	FALSE

12 The reason why beans, peas and lentils are good for you is that

They contain only small amounts of fat	1
They contain a lot of fibre	2
They can protect you from some diseases	3
All of the above	4

13 To make sure that you stay healthy you should eat

Lean meat, fruits and vegetables, low fat dairy products, and breads and cereals	1
Fruit and vegetables only	2

Bread, cereals, fruit and vegetables only	3
Low fat dairy products and lean meat only	4

14 You should not have starches at most meals because

They are not important for your health	1
Even eating small amounts can cause weight gain	2
They cause diseases	3
None of the above	4

SECTION C

1. Which group of foods has the most Vitamin A?

Oats, whole wheat bread, rice	1
Carrots, spinach, sweet potatoes	2
Pies, cakes, pudding	3
None of the above	4

2. Which one of the following nutrients are found in most fruits

Fibre	1
Iron	2
Fat	3
All	4

3. Which foods contain a lot of calcium?

Chicken and eggs	1
Milk, yoghurt	2
Pilchards	3
2 and 3	4

4. To which of the following foods has iodine been added?

Bread	1
Maize meal	2
Table salt	3
Powdered milk	4

5. Which one of the following groups of nutrients are found in large amounts in fruits and vegetables?

Fibre, Vitamin A	1
Starches, fat, Vitamin D	2
Fats, Iron, Calcium	3

None of the above	4	

6 Which foods contain a lot of fibre?

Oats, apples, beans	1
Milk, yoghurt, cheese	2
Beef, chicken, mutton	3
Butter, margarine	4

7. Which food has the most fibre?

White rolls	1
Brown bread	2
White bread	3
Whole wheat bread	4

8. If you were trying to increase the amount of fibre in your diet, which one of the following foods should you eat more of?

Cakes and biscuits	1
Apples and carrots	2
Chips and pies	3
Chicken and fresh fish	4

SECTION D

1. Meat/ fish/ chicken will not spoil if you store them

In the cupboard for a few days	1
In the fridge for 2 days only	2
In the freezer for 3-4 months	3
In 2 and 3 above	4

2. Cooked meat/ fish/ chicken sold on the street may not always be safe to eat because

It may have been undercooked	1
The cook may not have used fresh meat	2
It may have been kept for a long time before being cooked	3
All of the above	4

3. The best place to defrost meat from a frozen state is to

leave it at room temperature	1
leave it in the fridge	2
leave it in sunlight	3
Meat should never be defrosted	4

4. It is usually not necessary to wash vegetables before you cook them

TRUE	FALSE

SECTION E

1. What a pregnant woman eats during pregnancy has no effect on her health and the health of her unborn baby

TRUE	FALSE

2. It is not healthy for a pregnant woman to drink a lot of wine, beer, cider

TRUE	FALSE

3. Overweight women should try to lose weight when they are pregnant

TRUE	FALSE

4. Which of the following should a pregnant woman eat more of?

Milk, cheese, maas	1
Meat, chicken, fish	2
Fruits and vegetables	3
All of the above	4

5. It is important for a pregnant women to avoid eating different kinds of foods

TRUE	FALSE

6. Women must try not to gain weight when they are pregnant

TRUE	FALSE

7. Which one of the following is not healthy for a pregnant woman to do

Be physically active	1
Eat different kinds of foods	2
Sleep most of the day	3
Drink lots of water	4

8. It is not healthy for a pregnant woman to eat foods like milk, cheese, yoghurt

TRUE	FALSE

SECTION F

1. From where do you get your information about nutrition?

	YES	NO
School	1	2
Peers/ Friends	1	2
Parents	1	2
Radio/ TV/ Magazines	1	2
Other (Specify)		
	1	2

2. Of the choices you have selected above, how would you rate them as sources of information:

1= very unreliable

2= unreliable

3= reliable

4= very reliable

	very unreliable	unreliable	reliable	very reliable	
School	1	2	3	4	
Peers/ Friends	1	2	3	4	
Parents	1	2	3	4	
Radio/ TV/ Magazines	1	2	3	4	
Other (Specify)					
	1	2	3	4	

ADDENDUM G:

Addendum G: Information sheet sent to high school officials (Sample 2)

STUDY INFORMATION SHEET

Development of a valid and reliable nutrition knowledge questionnaire for urban teenagers

The Medical Research Council and Birth to Twenty Study are in the process of designing a questionnaire that can be used to evaluate the nutrition knowledge of teenagers. Since we want the questionnaire to meet certain criteria before it can be used, it has to undergo certain steps. Some of the steps require that a large number of school going teenagers complete the questionnaire until a satisfactory one is constructed. Once we have a satisfactory questionnaire it can be used further to find out what teenagers from different cultures know or do not know about nutrition.

Article I. What do we expect from the participants?

The questionnaire needs to be completed by teenagers black and white in grade 8, 10, and 12 who will be 14, 16, and 18 years old by the end of this year. This means that there are questions about nutrition that they will answer. In addition, we will need their personal details as on the Respondent's information sheet. The questionnaire will be completed at school at the time the school management sees suitable, and will take a maximum of 30 minutes to complete. All information and scores will be treated confidentially and will only be used by the Researchers.

What will be done with the results?

At this stage, the results will ensure that the questionnaire properly tests knowledge about nutrition for the age group in the right way. There will be a paper written on the current nutrition knowledge of teenagers. It will thereafter be the responsibility of concerned organizations to make improvements where knowledge is lacking.

Can you refuse to participate in the study?

Yes. The school and the students will not be affected in anyway if you refuse to participate in the study.

Further Questions?

More information can be obtained from the following people

Ms Lindiwe Ngwenya- Medical Research Council Tel:082 957 4706

Dr Nelia Steyn- Medical Research Council Tel: 021 938 0242

Dr Shane Norris- Birth to Twenty Study Tel: 011 488 3609

Addendum G: Consent form provided to and completed by high school pupils (Sample 2)

TEENAGER'S CONSENT FORM

We hereby request that you participate in the study. This will only entail that you complete the questionnaire and provide some of your personal information.

I……, hereby acknowledge that

3. I have been informed about the purpose and nature of the study
4. I know I can refuse to participate even if my parent/ guardian has given permission

I agree/ I do not agree (please circle) to participate in the research study

Signature……. Date…….

ADDENDUM H:

Addendum H: Final 60-item nutrition knowledge questionnaire

NUTRITION KNOWLEDGE QUESTIONNAIRE

INSTRUCTIONS

THE FOLLOWING QUESTIONNAIRE CONTAINS TWO TYPES OF QUESTIONS,

MULTIPLE CHOICE AND TRUE/ FALSE

1. MULTIPLE CHOICE: CHOOSE **ONE** THAT YOU THINK IS THE CORRECT ANSWER AND TICK ON THE NUMBER THAT IS NEXT TO YOUR ANSWER

2. TRUE/ FALSE: CHOOSE THE **TRUE** OR THE **FALSE** AND TICK ONE OF THEM WHICH YOU THINK IS THE CORRECT ANSWER

THE QUESTIONS REFER TO A HEALTH PERSON WHO IS NOT ON ANY MEDICATION OR SPECIAL DIET

Please answer all the questions before moving on to the next ones.

Do not page back!

	YY	MM	DD
DATE			

SUBJECT NUMBER	

1 You should eat a lot of sugar to have enough energy

TRUE	FALSE	
		11A

2 Cooked meat/ fish/ chicken sold on the street may not always be safe to eat because

It may have been undercooked	1	
The cook may not have used fresh meat	2	
It may have been kept for a long time before being cooked	3	
All of the above	4	6D

3 What a pregnant woman eats during pregnancy has no effect on her health and the health of her unborn baby

TRUE	FALSE	
		12

4 You should not have starches at most meals because

They are not important for your health	1	
Even eating small amounts can cause weight gain	2	
They cause diseases	3	
None of the above	4	3B

5 How much water should you drink a day

You don't have to drink water everyday	1	
1 to 3 glasses	2	
4 to 6 glasses	3	
7 to 9 glasses	4	9A

6 You should add extra salt to your cooked food before you even eat it

TRUE	FALSE	
		8A

7 What is a portion of cooked vegetables?

I Tablespoon	1	
Half a cup	2	
I Cup	3	
2 Cups	4	4A

8 Which of the following is a low fat snack

"Simba" Chips	1	
Popcorn	2	
Fried chips	3	
"Niknaks"	4	7A

9 From which group of foods should you eat the most every day?

Bread, samp, rice, porridge	1	
Apples, bananas, spinach, carrots	2	
Milk, yogurt, cheese	3	
Chicken, fish, beans, eggs	4	3A

10 Drinking a lot of wine, beer, cider can cause weight gain

TRUE	FALSE	
		10B

11 Which one of the following is not healthy for a pregnant woman to do

Be physically active	1	
Eat different kinds of foods	2	
Sleep most of the day	3	
Drink lots of water	4	12

12 Women must try not to gain weight when they are pregnant

TRUE	FALSE	
		12

13 It is not healthy for a pregnant woman to eat foods like milk, cheese, yoghurt

TRUE	FALSE	
		12

14 People who are overweight should not be physically active

TRUE	FALSE	
		2B

15 It is usually not necessary to wash vegetables before you cook them

TRUE	FALSE	
		4D

16 The key to a healthy way of eating is to

Eat many different kinds of foods	1	
Eat some foods more than other foods	2	
Eat certain kinds of foods in moderate or small amounts	3	
All of the above	4	1A

17 The following foods must not be eaten at all when one is trying to lose weight

Bread and rice	1	
Meat and fish	2	
Margarine	3	
None of the above	4	1A

18 Which foods contain a lot of calcium?

Chicken and eggs	1	
Milk, yoghurt	2	
Pilchards	3	
2 and 3	4	6C

19 The healthiest snack is:

A glass of milkshake	1	
A tub of unbuttered popcorn	2	
A slab of chocolate	3	
2 and 3 above	4	7A

20 To which of the following foods has iodine been added?

Bread	1	
Maize meal	2	
Table salt	3	
Powdered milk	4	8C

21 If you were trying to increase the amount of fibre in your diet, which one of the following foods should you eat more of?

Cakes and biscuits	1	
Apples and carrots	2	
Chips and pies	3	
Chicken and fresh fish	4	4C

22 Being physically active means

Going to the gym	1	
Walking a lot	2	
Playing sports like soccer or netball	3	
All of the above	4	2A

23 Which of the following choice of foods prevent certain diseases

Fish, Chicken without skin, and lean meat	1	
Beef sausage, bacon, and lean mince	2	
Fried fish, fried chicken, and regular mince	3	
All of the above	4	6A

24 Which foods contain a lot of fibre?

Oats, apples, beans	1	
Milk, yoghurt, cheese	2	
Beef, chicken, mutton	3	
Butter, margarine	4	1C

25 How many fruits and vegetables should be eaten

1 fruit and vegetable a day	1	
3-4 fruits and vegetables a day	2	
5 or more fruits and vegetables everyday	3	
There is no need to eat fruits and vegetables daily	4	4A

26 If you are eating a healthy diet there is no need for you to be physically active

TRUE	FALSE	2A

27 Drinking boiled water is a good way to lose weight

TRUE	FALSE	9B

28 Salt should be added to all foods except fruits

TRUE	FALSE	
		8A

29 If one wants to lose weight there is no need to be physically active, it is better that one simply diets

TRUE	FALSE	
		2B

30 All water is safe to drink

TRUE	FALSE	
		9A

31 You can drink as much wine, beer, ciders as you want provided you have eaten first

TRUE	FALSE	
		10A

32 A little sugar can be eaten when one is trying to lose weight

TRUE	FALSE	
		11B

33 How much milk or maas should you have a day?

None	1
Half a cup	2
One cup	3
Two cups	4

6A

34 Your body only needs a little bit of salt to be healthy

TRUE	FALSE	
		8A

35 A well- balanced diet

Consists mostly of meat, with smaller amounts of starch, fruits, vegetables, and dairy products	1
Consists mostly of vegetables, and smaller amounts of meat and dairy products	2
Consists mostly of starches, vegetables and fruits, with smaller amounts of meat and dairy products	3
None of the above	4

3A

36 Sugar and foods that contain sugar should be eaten in small amounts

TRUE	FALSE	
		11A

37 Eating a lot of different kinds of foods is healthier than eating only a few kinds foods

TRUE	FALSE	
		1A

38 Overweight women should try to lose weight when they are pregnant

TRUE	FALSE	
		12

39 Sugar contains a lot of vitamins and minerals

TRUE	FALSE	
		11A

40 It is impossible to g*et al*l the vitamins and minerals you need from food, you need to take a vitamin and mineral pill

TRUE	FALSE	
		1A

41 It is not healthy for a pregnant woman to drink a lot of wine, beer, cider

TRUE	FALSE	
		12

42 Which one of the following groups of nutrients are found in large amounts in fruits and vegetables?

Fibre, Vitamin A	1
Starches, fat, Vitamin D	2
Fats, Iron, Calcium	3
None of the above	4

4C

43 Which of the following breakfast menus contain little fat

Whole-wheat toast with thinly spread margarine	1
Weet-Bix with 2% fat milk	2
Bacon and egg	3
1 and 2	4

7A

44 It is important for a pregnant women to avoid eating different kinds of foods

TRUE	FALSE	
		12

45 Which food has the most fibre?

White rolls	1
Brown bread	2
White bread	3
Whole wheat bread	4

3C

46 The best place to defrost meat from a frozen state is to

leave it at room temperature	1
leave it in the fridge	2
leave it in sunlight	3
Meat should never be defrosted	4

6D

47 Starchy foods should not be eaten when one is trying to lose weight

TRUE	FALSE	
		3B

48 To make sure that you stay healthy you should eat

Lean meat, fruits and vegetables, low fat dairy products, and breads and cereals	1
Fruit and vegetables only	2

Bread, cereals, fruit and vegetables only	3	
Low fat dairy products and lean meat only	4	7A

49 Eating bread always causes weight gain

TRUE	FALSE	
		3B

50 Which of the following foods are the lowest in fat:

Corn flakes and full cream milk	1	
Grilled lean steak and boiled carrots	2	
Pizza and milkshake	3	
Fried lamb chops and creamed spinach	4	7A

51 To protect yourself from disease you should avoid eating many different kinds of foods

TRUE	FALSE	
		1B

52 It is healthy to snack on foods that contain a lot of sugar

TRUE	FALSE	
		11B

53 Which of the following should a pregnant woman eat more of?

Milk, cheese, maas	1	
Meat, chicken, fish	2	
Fruits and vegetables	3	
All of the above	4	12

54 Dry beans, peas, and lentils should be eaten often

TRUE	FALSE	
		5A

55 Soya mince is as healthy as meat

TRUE	FALSE	
		5A

56 You can eat as much meat as you want everyday

TRUE	FALSE	
		5A

57 Which group of foods has the most Vitamin A?

Oats, whole wheat bread, rice	1	
Carrots, spinach, sweet potatoes	2	
Pies, cakes, pudding	3	
None of the above	4	4C

58 Dry beans, peas, lentils are a healthy choice to eat in place of meat

TRUE	FALSE	
		5A

59 Meat/ fish/ chicken will not spoil if you store them

In the cupboard for a few days	1	
In the fridge for 2 days only	2	

In the freezer for 3-4 months	3	
In 2 and 3 above	4	6D

60 The reason why beans, peas and lentils are good for you is that

They contain only small amounts of fat	1	
They contain a lot of fibre	2	
They can protect you from some diseases	3	
All of the above	4	5B,C

SELECT YES OR NO FOR ALL THE CHOICES

1. From where do you get your information about nutrition?

	YES	NO	
School	1	2	13F
Peers/ Friends	1	2	13F
Parents	1	2	13F
Radio/ TV/ Magazines	1	2	13F
Other (Specify)			
	1	2	13F

2. Of the choices you have selected above, how would you rate them as sources of information:

1= very unreliable
2= unreliable
3= reliable
4= very reliable

	very unreliable	unreliable	reliable	very reliable	
School	1	2	3	4	13G
Peers/ Friends	1	2	3	4	13G
Parents	1	2	3	4	13G
Radio/ TV/ Magazines	1	2	3	4	13G
Other (Specify)					
	1	2	3	4	13G

ADDENDUM I:

Addendum I Categorization of items in questionnaire based on the South African food- based dietary guidelines

Grouping	**No. of Items**	**Item's Numbering in Questionnaire**
Guideline 1	6	16, 17, 24, 37, 40, 51
Guideline 2	4	14, 22, 26, 29
Guideline 3	6	4, 9, 35, 45, 47, 49
Guideline 4	6	7, 15, 21, 25, 42, 57
Guideline 5	5	54, 55, 56, 58, 60
Guideline 6	6	2, 18, 23, 33, 46, 59
Guideline 7	5	8, 19, 43, 48, 50
Guideline 8	4	6, 20, 28, 34
Guideline 9	3	5, 27, 30
Guideline 10	2	10, 31
Guideline 11	5	1, 32, 36, 39, 52
Nutrition in Pregnancy (12)	8	3, 11,12, 13, 38, 41, 44, 53