The association between nutrition knowledge and intake of healthy and unhealthy foods in 6 to 8 year old South African children

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Dissertation submitted in fulfilment of the requirements for the degree *Master of Science in Nutrition* at the North-West University

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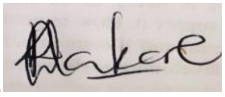
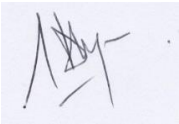
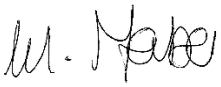
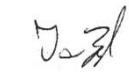
Preface

This dissertation is submitted for the degree Master of Science in Nutrition at the North West University. All the work presented was conducted at the Centre of Excellence for Nutrition (CEN) under the supervision of Prof. HS Kruger, Prof. MK Faber and Dr T Van Zyl. To the best of my knowledge unless referenced, work from this dissertation is original and unpublished. The dissertation will be presented in article format and a version of the article (Chapter 4) will be submitted to the journal 'Appetite' for publication.

Ms P Makore … 

Prof. HS Kruger … 

Prof. M Faber 

Dr T VAN ZYL  ……..

2 Peter 1:5 For this very reason, make every effort to add to your faith goodness; and to goodness, knowledge.

Acknowledgements

It is my greatest pleasure to be expressing my appreciation to the following individuals for their support and contributions to my MSc studies and writing this mini dissertation.

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Gill Smithies, thank you for assisting with the language editing of this dissertation (see Annexure A).

My mom and dad, siblings Patience, Perseverance and Tatenda you are the tall shoulders that I stand on to reach greater heights thank you for carrying me through the rough times and believing in me.

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My grandmother and aunts thank you for the support you are my cheerleaders.

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A very sincere thank you to you all!

Abstract

Background: The increasing prevalence of overweight and obesity in school going children has driven more focus on exploring their dietary intakes. Poor dietary habits are one of the key determinants of obesity and overweight. Dietary habits are influenced by several factors that include social, environmental and individual factors such as nutrition knowledge. Encouraging healthy food group intake can help in alleviating occurrence of childhood overweight and obesity. Improving knowledge on consumption and function of foods can enhance food intake however little is known on how much nutrition knowledge influence food group intake in children.

Aim: The aim of the study was to determine the association between nutrition knowledge and intake of healthy and unhealthy food groups in children 6 to 8 years.

Methods: Using a simple food frequency questionnaire and a nutrition knowledge questionnaire, information was collected from 269 children aged 6 to 8 years from five primary schools in Tlokwe Municipality, in Potchefstroom, South Africa.

Results: The general nutrition knowledge was better than knowledge on the importance of food groups. Low median frequency of intakes of healthy and unhealthy foods was observed though frequency of sugar sweetened cold beverages was high, at 5 - 6 days a week. The median frequency of intakes for healthy food groups were better compared to that of the unhealthy food groups. Food group associations observed showed that the frequency of milk and milk products group intake was positively correlated with food groups like fruit (r = 0.158, p = 0.0001) and sugar sweetened cold beverages (r = 0.126, p = 0.0001). Frequency of sweets intake was positively correlated with animal source protein foods and all unhealthy food groups; a negative correlation was also noted with vegetables food group. Frequency of sugar sweetened cold beverages intake was significantly (p = 0.01) associated with all food groups except with fruit group. Nutrition knowledge score correlated positively with frequency of milk and milk products group intake. No association was observed between nutrition knowledge and any other food group. Household income and parental education were associated with children's nutrition knowledge score, as well as frequency of intakes from the fruit, animal source protein food and milk food groups. These results persisted after further analysis using a multivariable linear regression model with adjustment for possible covariates.

Conclusion: We found no association between nutrition knowledge and frequency of intake of healthy and unhealthy foods in young children aged 6 to 8 years

Key terms

Nutrition knowledge; Nutrition literacy; Nutrition education; South Africa; Dietary intake; Food intake; School children; Healthy food; Unhealthy food

Abbreviations

IAEA	International Atomic Energy Agency
BC-IT	Body Composition by Isotope Techniques
BIA	Bioelectrical impedance analysis
BMI	Body mass index
BMIZ	Body mass index for age z-score
CAPS	Curriculum and Assessment Policy Statement
CVD	Cardiovascular diseases
FAO	Food and Agriculture Organisation
FBDG	Food-Based Dietary Guideline
HART	Hypertension in Africa Research Team
ISAK	International Society for the Advancement of Kinanthropometry
KAB	Knowledge-Attitude-Behaviour
NCD	Non-communicable disease
NCDs	Non-communicable diseases
NCS	National Curriculum Statement
NK	Nutrition Knowledge
NSNP	National School Nutrition Programme
PI	Principal Investigator
% BF	Percentage body fat
PFBDGs	Paediatric Food-Based Dietary Guidelines
PHASREC	Physical Activity, Sport and Recreation Science
S.A	South Africa
SANHANES	South Africa National Health and Nutrition Examination Survey
WHO	World Health Organisation

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Chapter 1 Introduction

1.1 Background and Motivation

Obesity among children is a growing public health problem that is currently receiving increasing attention globally (WHO, 2016). Childhood obesity prevalence is rapidly rising in low- and middle-income countries, resulting in a rate of increase of 30% higher than that in high income countries (WHO, 2016). The estimated prevalence of childhood obesity in children under five in Africa, in 2010, was 8.5% and it is expected to reach 12.7% by 2020 (De Onis *et al*., 2010). Results from the South African Health and Nutrition Examination (SANHANES) Survey 2012 showed that the prevalence of overweight and obesity was significantly higher in girls than boys aged 2-14 years (16.5% and 7.1% vs 11.5 and 4.7%, for girls and boys, respectively) (NDoH, Stats SA, SAMRC & ICF, 2017). Raised body mass index (BMI) is a risk factor for non-communicable diseases, such as cardiovascular diseases (CVD), type 2 diabetes and hypertension (James *et al*., 2004; WCRF, 2007). Overweight and obesity in childhood are described as a threat to the favourable trends in decreasing cardiovascular morbidity and mortality that occurred during the previous century (Daniels et al.,2005). Besides indicating a greater health burden in life, childhood obesity can also cause psychological problems, which hinder a child's well-being (Rankin *et al*., 2016).

Ogden *et al*., (2010) specified that improving healthy lifestyle habits, such as healthy eating, can lower the risk of becoming obese and developing related diseases. Food intake throughout childhood is an influencing factor of child growth and development. Research has demonstrated that children's dietary behaviours are influenced by characteristics of both the physical and social environment (Larsen *et al*., 2015). These characteristics include factors such as parents' and children's nutrition knowledge, food availability, accessibility and ethnicity (Lin *et al*., 2007). Poor diets are linked to obesity, as a variable factor in the control and prevention of obesity (Beckman et al., 2006; Collins *et al*., 2010). Food preference learning starts during infancy and remains relatively stable during childhood years (Skinner *et al*., 2002). This is a very important stage for creating health eating habits however Food choices can be modified over time during adolescence, but they can face resistance as some original food habits persist and are reflected in food choices that are made later in life (Hawkes *et al*., 2015; Montaño *et al*., 2015). Interactions among the food environment and children's food preferences are key in identifying the factors that can be modified in order to improve healthy eating habits in children (Hawkes *et al*., 2015). Unfortunately, the current food environment does not support healthy food preference learning.

Nutrition knowledge helps individuals to make more informed decisions; therefore, it can be expected to improve the quality of children's diets when the food is available (Hirvonen *et al*.,

2017). Learning plays an important role in the development of children's eating behaviour, implying that parents and teachers inevitably play important roles in influencing children's food choices by providing information and responding to children's concerns about food (Chen *et al*., 2010). Besides providing information, children also tend to imitate their parent's food choices. Information on food, influences food choices and understanding how they are influenced by nutrition knowledge is important to improve the quality of foods preferred (Kraak *et al*., 2006; Miller & Cassady, 2015). However, more study attention is currently given to other factors influencing children's eating behaviours for promoting healthy eating with little focus on nutrition knowledge (DeCosta *et al* 2017). The assessment of nutrition knowledge is the basis for further determination of nutrition-related behaviours, this is based on study findings that suggest nutrition knowledge as a significant stimulus of dietary intakes in intervention studies (Asakura *et al*., 2017; Pérez-Rodrigo & Aranceta, 2001). Majority of public health nutrition interventions that have focused on improving nutrition knowledge like Grosso *et al.* (2013) have reported nutrition knowledge to play a small but significant role in the adoption of healthier food habits. It is therefore the aim of this study to determine the association between the nutrition knowledge of food groups and frequency of intake of healthy and unhealthy foods by children 6 to 8 years and add to the information there of.

1.2 Significance of the study

Many studies have focused on nutrition knowledge of the caregiver and rarely on the children's knowledge (Vereecken and Maes., 2010). More studies have also focused on nutrition knowledge of older children neglecting the elementary or foundation phase age groups 6 to 9 years. Focus needs to be given on how young children's nutrition knowledge play a role in influencing their own food choices as they eat some foods away from home and at school. A review of literature on children's healthy eating habits shows that nutrition education of school children can bring change in dietary behaviours, which can last up to two years (Worsley, 2002). These studies revealed the possibility of improving healthy eating habits early by increasing nutrition knowledge in children (Birch *et al*., 2007; Dudley *et al*., 2015; Fahlman *et al*., 2008). Determinants of food choices should be a priority for research and more importantly for the development of effective early interventions (Wen *et al*., 2017). To support this, a study by Pienaar (2015) in North West Province, South Africa, showed that overall obesity prevalence increased significantly over three years from the age of 6 to 9 years. They recommended early prevention strategies as the cycle is difficult to break once established at this age because of the established dietary habits persisting. For implementation of such interventions, credible data of influence on food choices is insufficient, specifically on the association of children's nutrition knowledge and food intake. It is therefore important to have information on the knowledge that children must inform content of nutrition

education programmes and efficiently improve knowledge and improve food choices. Thus, the focus of this study is on nutrition knowledge and frequency of consumption of healthy and unhealthy food groups.

1.3 Research aim

The aim of this study is to determine the association between the nutrition knowledge of food groups (meats, cereals, fruits, vegetables, sweets, fats and milk), and frequency of intake of healthy and unhealthy foods by children aged 6 to 8 years in Tlokwe municipality in North West Province.

1.4 Research objectives

(1) To describe children's knowledge of food groups (meats, cereals, fruits, vegetables, sweets, fats and milk).

(2) To describe the frequency of intake of healthy food groups (meats, fruits, vegetables, milk) by children 6 to 8 years

(3) To describe the frequency of intake of unhealthy food groups (sweets, sugar in tea, sugar sweetened beverages, cakes, salty snacks, fast foods) by children 6 to 8 years.

(4) To determine the association between nutrition knowledge and frequency of intake of healthy food groups with adjustment for possible covariates.

(5) To determine the association between nutrition knowledge and frequency intake of unhealthy food groups, with adjustment for possible covariates.

1.5 Null hypothesis

There is no significant association between nutrition knowledge and the frequency of intake of healthy and unhealthy food groups.

1.6 Research team and authors contribution

The roles that were played by members of the research team are outlined in Table 1-1.

1.7 Other study contributors

Postgraduate researchers from Physical Activity, Sport and Recreation Science (PHASREC) and Hypertension in Africa Research Team (HART) research units were involved in data

Table 1-1: Research team members

Partner name	Team member	Qualification, knowledge, experience, skills	Professional registration	Role and responsibility
North-West University, Centre of Excellence for Nutrition	Prof HS Kruger	PhD, Nutrition. Child nutrition expertise	Dietitian, HPCSA	- Principal investigator -Supervisor for MSc student -Planning and supervision of methods to describe the intake of healthy and unhealthy food groups
North-West University, Centre of Excellence for Nutrition	Dr T Van Zyl	PhD Dietetics Dietary assessment expertise	Dietitian, HPCSA	-Student co-supervisor -Planning of methods to describe the intake of healthy and unhealthy food groups
North-West University, Centre of Excellence for Nutrition	Ms P.K Makore	BSc Food Science and Nutrition.		-MSc student -Planning and execution of study. - Data collection, statistical analysis and writing of manuscripts for publication and mini-dissertation.
South African Medical Research Council	Prof M Faber	PhD Dietary assessment expertise	Dietitian, HPCSA	-Student co-supervisor. -Planning of methods to describe the intake of healthy and unhealthy food groups
North-West University, PhasRec	Prof MA Monyeki	PhD Body composition expertise		-Principal investigator of the BC-IT Study -Supervision of the nutrition knowledge data collection

collection. Data was collected at the same time with collection of data for the Body Composition by Isotope Techniques study (BC-IT). Fifteen team members were involved in the data collection. The researchers were experienced in their fields and they received training on data collection using standard methods to ensure that accurate data was collected.

1.8 Structure of mini dissertation

The referencing method used in this mini dissertation is according to North-West University Harvard reference style. This MSc mini-dissertation is presented in the following chapters:

- **Chapter 1** is a brief background and motivation for this study. It details the aim, objectives and the contribution of the research team members.

- **Chapter 2** is a detailed review of literature on obesity, food intake and nutrition knowledge in children. The review is divided into three sections. The first part of the literature review is on obesity and the second part is on food intake. The third part focuses on the influence of nutrition knowledge on food intake.

- **Chapter 3** describes the methods of the study in detail.

- **Chapter 4** is an article written in the style of the journal 'Appetite' and describes the Introduction, Methods, Results and Discussion of the frequency of intake of healthy and unhealthy foods, children' nutrition knowledge and the association of the nutrition knowledge with the frequency of food intake from different food groups.

- **Chapter 5** summarises the main findings from this study and states the limitations that were present. Conclusions and recommendations for further research are also given.

References

Asakura, K., Todoriki, H. & Sasaki, S. 2017. Relationship between nutrition knowledge and dietary intake among primary school children in Japan: Combined effect of children's and their guardians' knowledge. *Journal of epidemiology,* 27(10):483-491.

Beckman, H., Hawley, S. & Bishop, T. 2006. Application of theory-based health behavior change techniques to the prevention of obesity in children. *Journal of pediatric* nur*sing*, 21(4):266-275.

Birch, L., Savage, J.S. and Ventura, A., 2007. Influences on the development of children's eating behaviours: from infancy to adolescence. *Canadian journal of dietetic practice and research: a publication of Dietitians of Canada= Revue canadienne de la pratique et de la recherche en dietetique: une publication des Dietetistes du Canada*, *68*(1), p.s1.

Chen, Y.-H., Yeh, C.-Y., Lai, Y.-M., Shyu, M.-L., Huang, K.-C. & Chiou, H.-Y. 2010. Significant effects of implementation of health-promoting schools on schoolteachers' nutrition knowledge and dietary intake in Taiwan. *Public health nutrition*, 13(4):579-588.

Collins, C., Watson, J. & Burrows, T. 2010. Measuring dietary intake in children and adolescents in the context of overweight and obesity. *International journal of obesity*, 34(7):1103.

Daniels, S.R., Arnett, D.K., Eckel, R.H., Gidding, S.S., Hayman, L.L., Kumanyika, S., Robinson, T.N., Scott, B.J., Jeor, S.S. & Williams, C.L. 2005. Overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment. *Circulation*, 111(15):1999-2012.

De Onis, M., Blössner, M. & Borghi, E. 2010. Global prevalence and trends of overweight and obesity among preschool children. *The American journal of clinical nutrition*, 92(5):1257-1264.

DeCosta, P., Møller, P., Frøst, M.B. & Olsen, A. 2017. Changing children's eating behaviour-A review of experimental research. *Appetite*, 113:327-357.

Dudley, D.A., Cotton, W.G. and Peralta, L.R., 2015. Teaching approaches and strategies that promote healthy eating in primary school children: a systematic review and meta-analysis. *International journal of behavioral nutrition and physical activity*, *12*(1), p.28.

Fahlman, M.M., Dake, J.A., McCaughtry, N. and Martin, J., 2008. A pilot study to examine the effects of a nutrition intervention on nutrition knowledge, behaviors, and efficacy expectations in middle school children. *Journal of school health*, *78*(4), pp.216-222.

Grosso, G., Mistretta, A., Turconi, G., Cena, H., Roggi, C. & Galvano, F. 2013. Nutrition knowledge and other determinants of food intake and lifestyle habits in children and young adolescents living in a rural area of Sicily, South Italy. *Public health nutrition*, 16(10):1827-1836.

Hawkes, C., Smith, T.G., Jewell, J., Wardle, J., Hammond, R.A., Friel, S., Thow, A.M. & Kain, J. 2015. Smart food policies for obesity prevention. *The lancet*, 385(9985):2410-2421.

Hirvonen, K., Hoddinott, J., Minten, B. & Stifel, D. 2017. Children's diets, nutrition knowledge, and access to markets. *World development*, 95:303-315.

James, W.P.T., Jackson-Leach, R., Mhurchu, C.N., Kalamara, E., Shayeghi, M., Rigby, N.J., Nishida, C. & Rodgers, A. 2004. Overweight and obesity (high body mass index). In: Ezzati, M., Lopez, A.D., Rodgers, A. and Murray, C.J.L. (eds).Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors, Geneva, World Health Organization 1:497-596.

Kraak, V.I., Gootman, J.A. & McGinnis, J.M. 2006. Food marketing to children and youth: threat or opportunity?: Wahington DC, National academies press.

Lin, W., Yang, H.-C., Hang, C.-M. & Pan, W.-H. 2007. Nutrition knowledge, attitude, and behavior of Taiwanese elementary school children. *Asia pacific journal of clinical nutrition,* 16(S2):534-546.

Miller, L.M.S. & Cassady, D.L. 2015. The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*, 92:207-216.

Montaño, Z., Smith, J.D., Dishion, T.J., Shaw, D.S. & Wilson, M.N. 2015. Longitudinal relations between observed parenting behaviors and dietary quality of meals from ages 2 to 5. *Appetite*, 87:324-329.

Ogden, C., Carroll, M.D., Curtin, L.R., Lamb, M.M. & Flegal, K.M. 2010. About childhood obesity. *Journal of the American medical association*, 303(3):242-249.

Patrick, H. & Nicklas, T.A. 2005. A review of family and social determinants of children's eating patterns and diet quality. *Journal of the American college of nutrition*, 24(2):83-92.

Pérez-Rodrigo, C. & Aranceta, J. 2001. School-based nutrition education: lessons learned and new perspectives. *Public health nutrition*, 4(1a):131-139.

Pienaar, A.E. 2015. Prevalence of overweight and obesity among primary school children in a developing country: NW-CHILD longitudinal data of 6–9-yr-old children in South Africa. *BioMed central obesity*, 2(1):2.

Rankin, J., Matthews, L., Cobley, S., Han, A., Sanders, R., Wiltshire, H.D. & Baker, J.S. 2016. Psychological consequences of childhood obesity: psychiatric comorbidity and prevention. *Adolescent health, medicine and therapeutics*, 7:125.

National Department of Health (NDoH), Statistics SA (Stats SA), South African Medical Research Council (SAMRC), & ICF, 2017. South Africa Demographic and Health Survey 2016: Key indicators. Pretoria, South Africa, and Rockville, Maryland, USA: NDoH, Stats SA, SAMRC and ICF.

Skinner, J.D., Carruth, B.R., Bounds, W. & Ziegler, P.J. 2002. Children's food preferences: a longitudinal analysis. *Journal of the American dietetic association*, 102(11):1638-1647.

Vereecken, C. and Maes, L., 2010. Young children's dietary habits and associations with the mothers' nutritional knowledge and attitudes. *Appetite*, *54*(1), pp.44-51.

World Cancer Research Fund and American Institute for Cancer Research, WCRF. 2007. Food, Nutrition, Physical Activity, and the Prevention of Cancer: A Global perspective (Vol. 1). American Institute for Cancer Research.

Wen, L.M., Rissel, C. & He, G. 2017. The effect of early life factors and early interventions on childhood overweight and obesity. *Journal of obesity*, Volume 2017.

World Health Organization, WHO, 2016. Consideration of the evidence on childhood obesity for the Commission on Ending Childhood Obesity: report of the ad hoc working group on science and evidence for ending childhood obesity, Geneva, Switzerland.

Chapter 2 Literature Review

2.1 Introduction

Obesity is an important risk factor for poor health and mortality (Swinburn *et al.*, 2019). Childhood obesity has now become a public health threat with its alarming rise in both low- and middle-income countries (LMICs) and high-income countries (WHO, 2016). The World Health Organization (WHO) estimated that 38 million children under five years of age worldwide are affected by overweight and obesity and has predicted a further rise in prevalence to one billion by 2030 (WHO, 2018). Prevalence of overweight and obesity differs between countries depending on the environment in which children live (Atay & Bereket, 2016). The increasing prevalence in childhood obesity has led to increased concern about food intake patterns and dietary quality of schoolchildren. Parental food attitudes, early infant feeding practices, children's food choices and television viewing times are among the most identifiable determinants of childhood obesity (Wen *et al.*, 2017). Dietary choices are usually well established by the age of 13 years, and the food habits that develop before the stage when children are afraid of new foods (neophobic stage) are likely to persist into adulthood (Feeley *et al.*, 2011; Kraak *et al.*, 2006). Children with poor dietary habits that result in overweight and obesity and continue into adulthood have greater chances of becoming overweight or obese adults (Kelsey *et al.*, 2014; Singh *et al.*, 2008). It is therefore important to understand determinants of children's eating habits and behaviours to monitor and prevent childhood obesity and overweight by creating positive nutritional behaviour which involves frequent health food group intake (Miller & Cassady., 2015).

2.2 Childhood Overweight and Obesity

2.2.1 Prevalence of childhood overweight and obesity

Childhood obesity is on a significant rise globally, making it a serious public health problem of the 21st century (Poskitt, 2014). The number of overweight and obese children under the age of 5 years in Africa has nearly doubled, from 5.4 million in 1990, to 10.3 million in 2014 (WHO, 2016). If these alarming trends continue increasing without any intervention, an estimated 70 million children globally will be overweight and obese in 2025 (Black *et al*., 2013). Figure 2-1 shows prevalence trends for child overweight and obesity for older children and adolescents in the USA and eight low-income and middle-income countries including South Africa. In 2012, successive national surveys in South Africa reported a decrease in the prevalence of underweight in children and an increase in the prevalence of chronic over-nutrition (overweight and obesity) (NDoH, Stats SA, SAMRC & ICF, 2017). South Africa is ranked among the leading countries in Africa in terms of childhood obesity prevalence and predictions are that it will be among the top 20 countries

globally in 2025 (Lobstein & Jackson-Leach, 2016; Reddy *et al*., 2009). The South African National Health and Nutrition Examination Survey (SANHANES-1), 2012, reported combined overweight and obesity prevalence of 13.5% for children aged 6-14 years, which was higher than the global prevalence of 10% in school children (Gupta *et al*., 2012; NDoH, Stats SA, SAMRC & ICF, 2017). In a longitudinal study carried out in children in the North West Province it was observed that obesity prevalence rose significantly from ages of 6 to 9 years (Pienaar, 2015). The significant rise of childhood obesity and its impact on later life health has encouraged the focusing of intervention efforts in ages that are more susceptible to developing obesity to reverse the alarming trends (Poskitt, 2014).

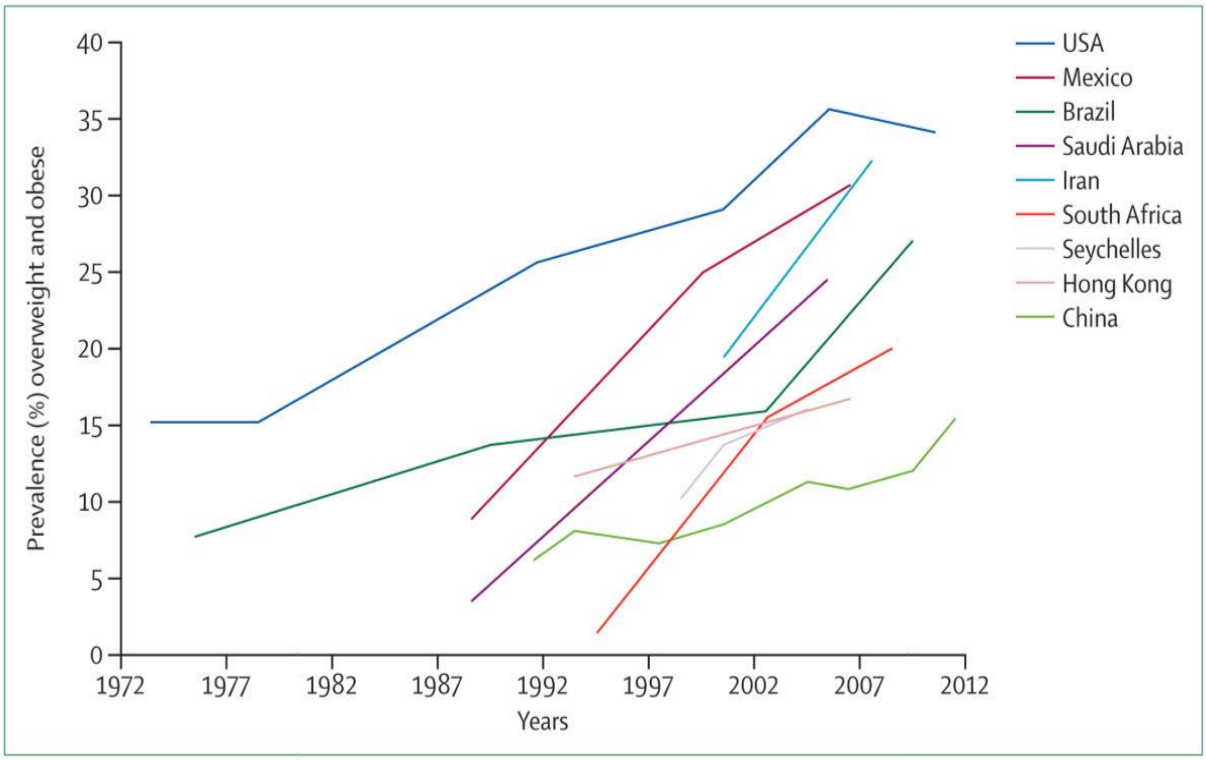

Figure 2-1: Prevalence trends for child overweight and obesity in older children and adolescents in the USA and eight low-income and middle-income countries. (Lobstein *et al.,* 2015)

2.2.2 Classification and measurements of child overweight and obesity

For effective monitoring and prevention of childhood overweight and obesity, comprehensive assessments of nutritional status and growth are essential. Body composition assessments are of great significance in the assessment of changes in the prevalence of overweight and obesity over time (Krebs *et al*., 2007). The most widely used body composition measurements are weight

and height though they provide incomplete data in relation to growth and nutritional status of children (NDoH, Stats SA, SAMRC & ICF, 2017; Wells & Fewtrell, 2006). This is because they are not a direct measure of body fatness, neither do they show the difference between fat and fat-free components, and as such are not good predictors of percentage body fat (% BF) (Talma *et al*., 2013). This has affected the prevalence estimates and comparison across populations and between studies (Wang & Lobstein, 2006). Body mass index (BMI) has been considered the most appropriate and simple indicator by which weight for height can be related to health outcomes. BMI differs considerably by age and gender during childhood and in adolescence, hence the cut-off points in children and adolescents are age and sex specific (Wang & Lim, 2012). BMI is commonly used in clinical practice because it is straightforward and relatively cheap to obtain (Wang & Lobstein, 2006).

Methods such as bioelectric impedance underwater weighing, and dual energy x-ray absorptiometry (DXA) offer accurate measurement of adiposity compared to BMI but are considered unsuitable for routine clinical use because they are invasive, expensive, more complex, and technically demanding (Punyanitya & Clark, 2015). The Centre for Disease Control and Prevention (CDC, 2009), has endorsed the use of BMI to assess weight status in children and they have provided sex-specific BMI distributions (percentile charts) for children aged 2–19 years for growth assessment. WHO has also developed growth curves (AnthroPlus) for children and adolescents aged 5–19 years, which align with adult cut-offs (De Onis *et al.,* 2009). The measurements of different indices are not always the same and their relationships (BMI to adiposity) always depend on age and sex. When there is a possibility that measurements are homogenous in the study population, it is important to measure adiposity directly as a result of differences in disease incidences, ethnicity or timing of puberty (Caprio *et al*., 2008).

2.2.3 Determinants of childhood overweight and obesity

Epidemiological studies covering overweight and obesity suggest that environmental factors are significant in both the aetiology and treatment of childhood obesity (Kruger *et al*., 2006; Mchiza *et al*., 2011). A review on the determinants of stunting and overweight in sub-Saharan Africa showed that the major determinants were demographic, socioeconomic, and environmental factors (Keino *et al*., 2014). Genetic predisposition is another major contributor to the occurrence of childhood obesity epidemic, but it cannot be solely used to explain the recent prevalence rise (Garver *et al*., 2013; Zhao & Grant, 2011). Changes in total energy intake, macronutrient composition of the diet, as well as the types of foods available and affordable have occurred over the past few decades (Popkin, 2011). Papoutsi *et al*. (2013) in another review highlighted that environments created by parents, increased consumption of energy intake and food advertising targeting children, affect children's food choices leading to childhood obesity.

Childhood obesity and overweight results from an imbalance between energy intake from food and beverages, and the energy a child uses to support growth and development (Ogden *et al*., 2010). The existing food environments make it easy to access highly processed food and sugar-sweetened beverages, which increases energy intake (Atay & Bereket, 2016). Dietary intakes are a major contributor to energy imbalance in obesity and diet-related chronic diseases (WCRF, 2007). Excess energy intake results in increased body fat, which is the root cause of excess body weight. Studies show that excessive consumption of high energy foods has an undesirable positive effect on an individual's weight and (body mass index) BMI (Ebbeling *et al*., 2006; Wang *et al*., 2008). Unhealthy snacking (eating between meals) is a food consumption habit that is also accused for unhealthy diets because of high amounts of sodium, fat and sugar; fat and sugar can provide extra energy not required for development (Green *et al*., 2017).

Urbanisation, the use of domestic appliances and electronic equipment has amplified sedentary lifestyles, which bring about an imbalance of energy intake and energy expenditure (Atay & Bereket, 2016; Chaput *et al*., 2011). Furthermore, parents aim to improve food intake by pressuring children to eat healthy foods and restricting unhealthy foods as a way of monitoring the child's food intake, however, this parenting style has resulted in poor eating patterns (overeating) and weight gain (Vaitkevičiūtė & Petrauskienė, 2019; Yavuz *et al*., 2015). The general public has associated overweight and obesity with over eating of unhealthy foods, which they have accused to be a responsibility of the caregiver and the media which advertises unhealthy foods (Covic *et al*., 2007).

2.2.4 Consequences of childhood overweight and obesity

Overweight and obesity are independent risk factors for increased morbidity and mortality throughout the lifecycle. Childhood obesity is a major issue because of its increasing prevalence as well as the health implications it has in adulthood (Rolland-Cachera, 2011). Overweight and obese children are likely to maintain their status into adulthood, which exposes them to significant problems in relation to personal and social life (Atay & Bereket, 2016; Simmonds *et al.*, 2016; WHO, 2016). Raised BMI can adversely affect nearly every organ system in the body, which results in physical complications. Overweight children have increased risks of developing chronic diseases such as hypertension, dyslipidaemia, type 2 diabetes, heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnoea and respiratory problems, and certain cancers (Atay & Bereket, 2016; WHO, 2016). Besides indicating a greater health burden, childhood obesity can also cause psychological problems, such as stigmatisation and poor self-esteem, which hinders a child's well-being (Rankin *et al.*, 2016). Figure 2 shows consequences of childhood obesity during childhood.

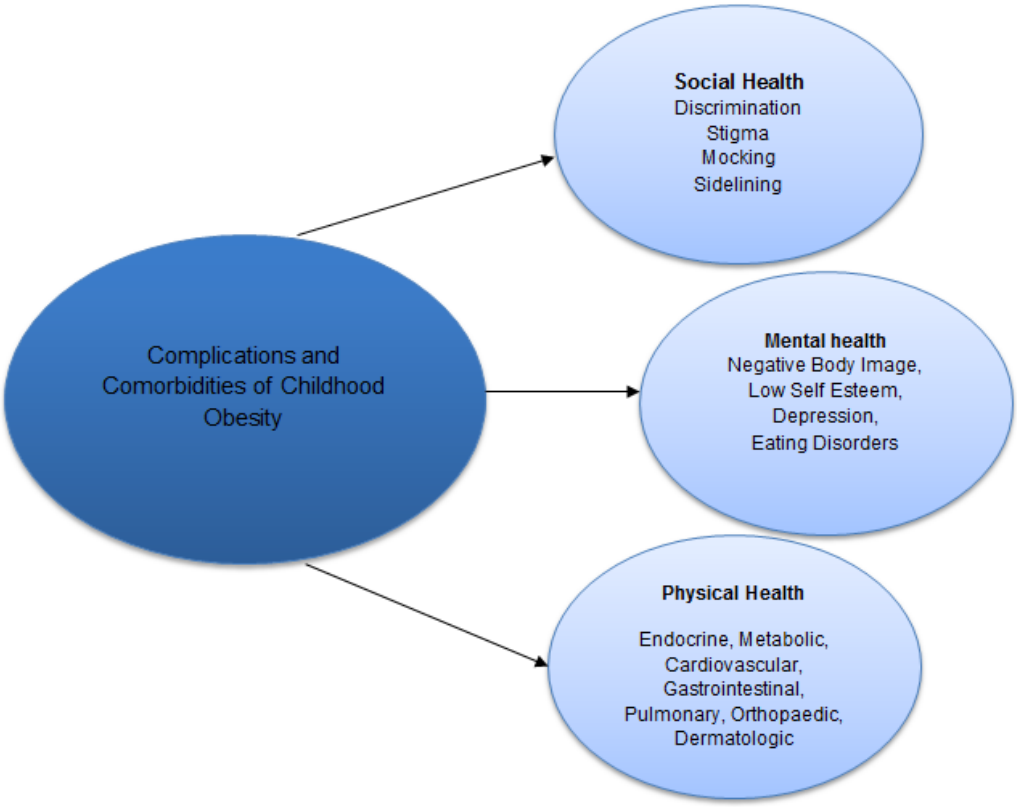

Figure 2-2: Consequences of childhood obesity *(adapted from Atay, and Bereket 2016)*

2.3 Dietary Intake

South Africa is a middle-income country and regarded as being in the final stage of nutrition transition (Steyn & Mchiza., 2014). It is multicultural and a multi-ethnic country in which a major part of the population is transitioning from traditional rural lifestyles to urban, more 'westernised' modern lifestyles. Nutrition transition is characterised by changes in dietary patterns, nutrient intakes, physical activity levels, consumption patterns of beverages, as well as changes in socioeconomic and education status (Vorster, 2010). These changes are inter-related and are partly responsible for the differences in nutrition and health status for the whole population. Urbanisation has resulted in a change in dietary patterns and low physical activity (Kruger *et al.*, 2005). Diverse food environments have exploited biological, psychological, social, and economic vulnerabilities, exposing children to unhealthy food choices subject to their appeal, and may be contributing greatly to the increase in the prevalence of overweight and obesity (St-Onge *et al.*, 2003; WHO, 2015).

The economic crisis and increased food prices have also exacerbated poor dietary intake as children end up eating energy-dense foods that are cheaper and easily accessible (Temple & Steyn, 2011). It is perceived that energy-dense foods in South Africa cost less per unit of energy than animal products and fruit and vegetables. This has in turn caused people who do not have enough resources, to buy less expensive unhealthy food to feed their families and reduce hunger (Temple & Steyn, 2009). Food consumption pattern changes related and contributing to overweight, obesity and non-communicable diseases (NCDs), have resulted from processed foods that are more available, affordable and acceptable to most sectors of the South African population (Igumbor *et al.*, 2012).

2.3.1 Development of food habits in children

With the growing problem of childhood obesity, recent research has begun to focus on family and social influences on children's eating habits. The development of children's food habits is influenced by a multitude of factors. Variyam *et al.* (1998) noted only four categories that influence food intake, these include (1) consumers' incomes, (2) food prices including the prices of other products and services (3) consumers' knowledge of health and nutrition, and (4) consumers' tastes and preferences. Children's habits are, on the other hand, likely to be influenced by parental behaviours which play an important role in the establishment of food habits and preferences (Savage *et al.*, 2007). Genes and home food environments posed by parents provide the potential for weight gain, which is modified by specific foods they make available for their children (Anzman *et al.*, 2010). Children also learn from their parents as they are their role models and their behaviours in specific food situations (Nicklas *et al.*, 2001).

Children are born without the ability to choose food hence their eating habits and food choices develop through experience and education (Ventura & Mennella, 2011). Experience is known to enhance food preference, and earlier experiences of a food are the major determinants of the food's acceptance. Food neophobia is an important concept to describe the development of food preferences in children (Dovey *et al.*, 2008; Falciglia *et al.*, 2000). Children are usually reluctant to try new foods, but through repeated exposure to the new foods they can overcome the dislike (Laureati *et al.*, 2014). Neophobic children seem to have less variety in their diet compared with neophilic children (Falciglia *et al.*, 2000). Food neophobia has been shown to contribute to rejection or acceptance of fruits and vegetables, hence the lower intakes of these in children can be related to this phenomenon (Dovey *et al.*, 2008; Laureati *et al.*, 2014). Social and cultural changes have been attributed to a leading role in determining the shifting of dietary habits towards other types of diet (Bonaccio *et al.*, 2013).

2.3.2 Factors influencing the food intake of children

Interest in understanding the determinants of the quality of children's diets has been growing for the past three decades. Food choices are influenced not only by individual factors (health, preference or income) but also by a complexity of environmental and systemic drivers (Ronquest-Ross *et al.*, 2015). Social environment, comprising of parents and caregivers, originally shape children's food choices, though they can change in line of new information and marketing (DeCosta *et al.*, 2017; Hawkes *et al.*, 2015). Campbell *et al.* (2013) reported maternal nutrition knowledge and home food availability as important concepts for predicting children's dietary intake. In their study, home availability of fruit, vegetables, salty snacks, confectionary, cakes, soft drink and fruit juice were each significantly and directly associated with children's intake of the corresponding food/drink (Campbell *et al.*, 2013). Children's eating behaviours are also influenced by the kind of information they receive from those who are around them (DeJesus *et al.*, 2019). Children sometimes do not accept foods that are described as "healthy" because they suppose that it does not taste good (Maimaran & Fishbach, 2014). Parental control of food consumption improves children's preference and attitude towards healthy food while reducing the intention to consume unhealthy foods (Lwin *et al.*, 2017).

Dietary intake is also driven by television advertisements, which promote less healthy foods and spread misleading health claims (Harris *et al.*, 2009; Kelly *et al.*, 2010; Mchiza *et al.*, 2013). TV viewing is associated with unhealthy dietary behaviours in children, adolescents, and adults (Pearson & Biddle, 2011). Children are the targets for most unhealthy food advertisements; they are exposed to an estimated 10 000 advertisements for food per year, 95% of which are for fast foods, candy, sugared cereal and soft drinks (Horgen *et al.*, 2001). These findings indicate the need for government interventions to reduce the advertising of unhealthy food-related products and encourage more advertising on promoting healthy foods, and physical activity (Mchiza *et al.*, 2013). Healthful dietary habits established during childhood may be carried into adulthood, this possibility prompts interest in understanding the determinants of children's diets and the pathways that influence growth (Campbell *et al.*, 2013). The model of food choice factors which impact on eating behaviour is displayed in Figure 3-1 as adapted from Story *et al.* (2008).

2.3.3 Influence of food environments on food intake

Food environments encompass physical, economic, political and socio-cultural characteristics that influence dietary intake and nutritional status (Story *et al.*, 2008; Swinburn *et al.*, 2011). Environmental factors, family characteristics, and parenting style all contribute to a child's eating behaviour and perceptions (Golan & Crow, 2004). Eating patterns are therefore influenced by

characteristics of both the physical and social environment. Regarding the physical environment, children eat foods that are available and easily accessible, and they also have a tendency of eating large quantities when larger portions are provided (Patrick & Nicklas, 2005; Zlatevska *et al.*, 2014). Characteristics of the social environment, such as parents' education, culture, time constraints and ethnicity, influence the types of foods children eat. Home food environments are largely constructed by parents, and family and meal time structure is an important factor related to children's eating patterns (Patrick & Nicklas, 2005; Sahoo *et al.*, 2015). Meal time structure involves whether families eat together, whether they watch television during meals and food source, whether it is from restaurants, schools or home cooked (Sahoo *et al.*, 2015). When meals are eaten as a family there seems to be a higher intake of fruit, vegetables, grains and protein, as well as decreased soft drink consumption (Neumark-Sztainer *et al.*, 2002).

2.3.3.1 School environments and food intake

The school food environment can have a significant influence on children's food intake because children may have up to two meals or snacks at school (Kaphingst & French, 2006). School feeding programmes are popular food aid programmes in both middle- and low-income settings (Kazianga *et al.*, 2014). In South Africa, the school feeding programme has been in existence since 1994 (Taljaard *et al.*, 2013). School-based breakfast and lunch programmes have been successful in promoting healthy eating among children and adolescents (Kazianga *et al.*, 2014). Faber *et al.* (2014) investigated the school food environment in terms of breakfast consumption, school meals, lunch boxes, school vending, and classroom nutrition-related activities in targeted schools in all provinces in the country. The survey found that a small number of learners carried a lunch box and the school meals provided by the National School Nutrition Programme (NSNP) had a low content of fruit and vegetables intake and unhealthy food items were bought by children from tuck shops and vendors inside and outside the school premises (Faber *et al.*, 2014).Carrying lunch boxes is not common in older children; they bring money to buy food, healthy or unhealthy. The results of the SANHANES also showed that for older children, 10-14 years, more than half (51%) did not use a lunch box but 51.3 % of children indicated taking money to school (Shisana *et al.*, 2014). The types of foods available to children at schools influences the variety and quality of foods they consume (Harrison *et al.*, 2013).

The sale of unhealthy foods by vendors in and around schools in South Africa has been documented by other studies (Abrahams *et al.*, 2011; Feeley *et al.*, 2012; Wiles *et al.*, 2013). This availability of competitive foods from vendors challenges the nutritious selections available in school meals and in lunch boxes (De Villiers *et al.*, 2012; Wiles *et al.*, 2013).

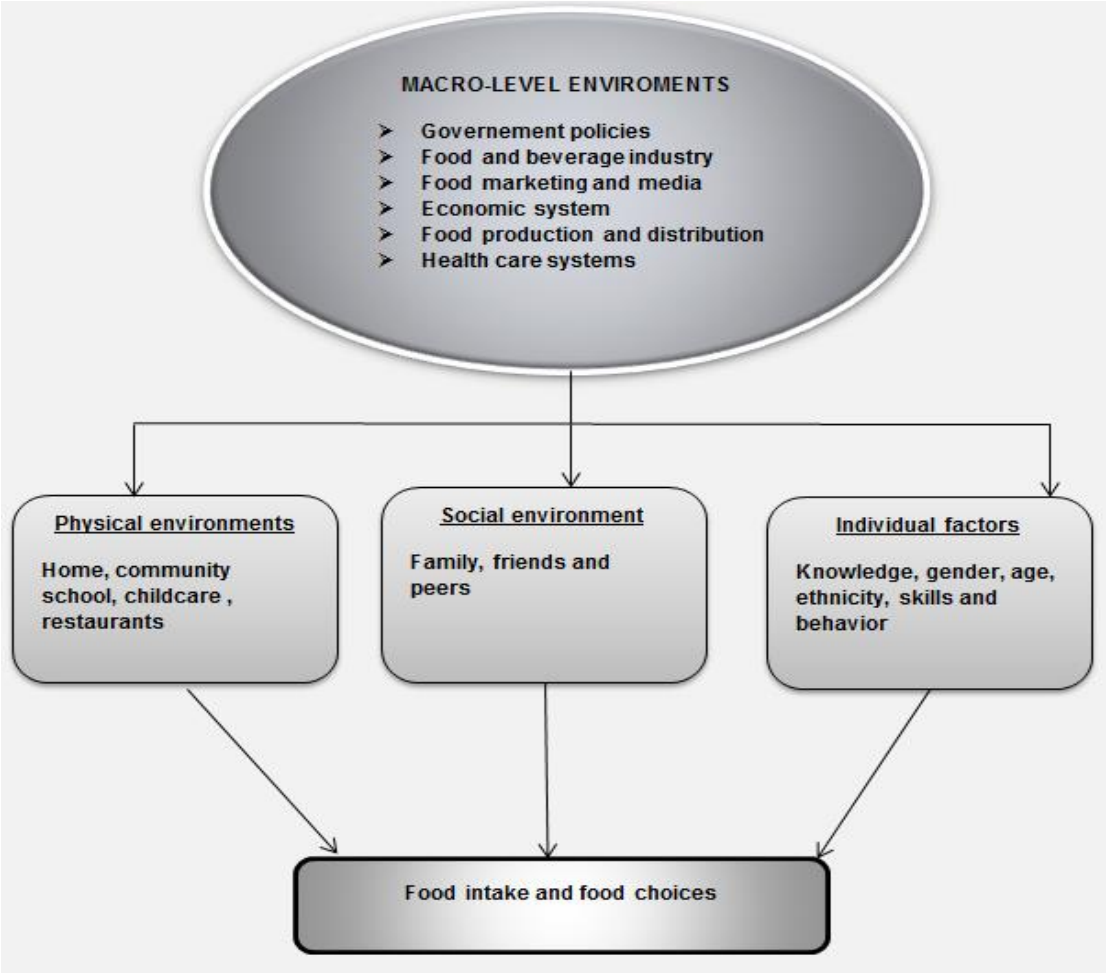

Figure 3-3: Ecological framework on multiple influences on food choices *(adapted from Story et al., 2008)*

Foods available from the vendors are typically energy dense (high in fat and sugar) and low in micronutrients compared to those served through the school lunch programme. In Soweto, most popular tuck shop (food store) purchases were sweets, crisps, sweetened beverages, fried chips and white bread (Feeley *et al.*, 2011). The presence of these alternatives has adverse effects on the quality of foods schoolchildren and adolescents consume. Vendors have difficulty selling healthy foods in and around schools. Their difficulties are encountered when stocking fresh produce, the high cost of healthy foods, children's preference for unhealthy foods and fear of losing income due to selling healthier food items (De Villiers & Faber, 2015; Wiles *et al.*, 2013). Feeley *et al.* (2011) found that the availability of tuck shops and vendors was inversely associated with fruit and vegetable consumption and positively associated with total and saturated fat intake. As the availability of other food provider options increased, fruit consumption decreased. In England, Moore and Tapper (2008) observed that when fruit tuck shops were the only vendors at schools it still did not improve children's fruit consumption patterns at school. However inclusive

of the school regulations on what children could eat at school, positive changes in fruit consumption rates were observed when they were combined with the fruit tuckshops. Faber *et al.* (2014) recommended a comprehensive approach that included classroom curricular, policy and environmental changes, with parental and community support, to create a demand for healthier foods to be sold at school.

2.3.3.2 Community food environments and food intake

The community food environment comprises of fast food and street food. Steyn et al. (2011) described fast food as food that is sold from a formal outlet structure, such as buildings and malls and is frequently operated as a franchise. Street foods conversely are described as foods or beverages that are sold by the informal sector at stands/stalls on the pavement of busy streets in both urban and rural areas (Steyn et al., 2011). Foods sold on the streets include snacks such as crisps or soft drinks, but also cooked foods (Steyn et al., 2011). The availability of convenience stores and fast food outlets close to home usually have a detrimental effect on children's fruit and vegetable intake (Timperio et al., 2008). Low price fast foods are more available and accessible to low income populations (Feeley et al., 2012). Fruit and soft drinks are the most commonly consumed street food among all ethnic groups and ages in South Africa (Steyn et al., 2011). The high prevalence of soft drink consumption is concerning because of its association with obesity and non-communicable diseases (Ogden et al., 2011; Steyn et al., 2011).

2.3.4 Healthy food intake

Healthy foods are defined as foods containing essential nutrients for child growth and general health, namely fruits, vegetables, milk, meat/fish/poultry/eggs (Daboné *et al.*, 2013). South Africa has developed paediatric food-based dietary guidelines (PFBDGs) for infants and young children to address malnutrition, and other nutrition-related public health issues (Vorster *et al.*, 2013). The guidelines recommend that either chicken, fish, meat, milk or eggs can be eaten daily while dry beans, peas, lentils and soya can be eaten regularly (Vorster *et al.*, 2013). Meat is an important part of the human diet and is central to most meals in the middle- and high-income countries (Popkin *et al.*, 2012). South Africa's Food Based Dietary Guidelines (SA FBDGs) recommend eating plenty of fruits and vegetables every day. However, a study in South Africa showed that mainly carbohydrate-rich foods are consumed by primary school children with little animal protein, vegetables or fruits (Nyathela & Oldewage-Theron, 2017). Similar to this finding Mamba *et al.* (2019) reported that in South Africa children 8-11 years consume more cold drinks and snacks and less healthy foods (fruits and vegetables). The recent SANHANES-1 study revealed a low intake of fruits and vegetables (two or fewer portions per day) for 25.6% of South Africans, with the formal urban population appearing to consume the most fruit and vegetables (Shisana *et al.*,

2014). Yoghurt and sour milk consumption has increased dramatically from 1999 to 2012 and some studies have shown that usually children have milk as part of their breakfast in tea and breakfast cereals (Ronquest-Ross *et al.*, 2015; Tee *et al.*, 2015).

2.3.5 Unhealthy food Intake

Unhealthy eating behaviours in children are common even in the low- and middle-income countries, particularly in urban school children (Daboné *et al.*, 2013). Unhealthy foods are foods that provide excessive amounts of energy, sugar, salt and fats, but do not make an important contribution to essential nutrient intake (Lobstein & Davies, 2009; WHO, 2008). The PFBDGs have recommended eating fats and salt sparingly, although studies still indicate increases in fat and oil consumption in South African and other low- and middle-income countries (Bourne *et al.*, 2002; Kearney, 2010; Popkin, 2004; Popkin *et al.*, 2012; Vorster *et al.*, 2013). Euromonitor International Packaged Food and Beverage Consumption (PFBC) data indicated an overall increase in consumption of fat and increased intake of sugar and sweeteners due to their increased use as ingredients in processed foods (Ronquest-Ross *et al.*, 2015). Analysis of international databases, that included the Food and Agriculture Organization of the United Nations Statistics Division (FAOSTAT) food balance sheets and Euromonitor PFBC, showed significant shifts (>30% increases) of sugar sweetened beverages, sauces, dressings and condiments, sweet and savoury snacks, meat, and fats and oils consumed from 1994 to 2012 (Ronquest-Ross *et al.*, 2015). Findings from a systematic review of large cross-sectional studies, and prospective cohort studies with long periods of follow-up, showed positive associations between greater intakes of sugar-sweetened beverages and weight gain and obesity in both children and adults (Malik *et al.*, 2006). Most young people have been reported to be consuming fast foods, cakes, biscuits, sugar sweetened beverages, and sweets at least four days a week (Reddy *et al.*, 2010). Due to the excessive amounts of fat, sugar and salt and limited amount of fibre, fast food intake is associated to poor diet quality and greater weight gain (Larson *et al.*, 2008). The prevalence of obesity increased with an increase in fast food consumption, as concluded by a review on fast food consumption and increased energy intake (Rosenheck, 2008).

2.3.6 Assessment of healthy and unhealthy food intakes

Measuring dietary intake in children is important for the provision of information about nutrition adequacy, nutrients, energy intake, food, and eating habits. Dietary intake assessments in children are performed using different methods such as 24 hr recalls, food records, food frequency questionnaires (FFQs) and diet history interviews (Thompson & Subar, 2017). Validation and reliability studies have shown higher correlation between food recalls and food records than FFQs (McPherson *et al.*, 2000). However, FFQs measure usual food intake are less expensive, easy to

administer and are easily adaptable for population studies (McPherson *et al.*, 2000). Questionnaires are developed based on other similar international or national studies. Parents and caregivers are often used as proxy reporters of young children's dietary intakes because children usually have lower mastery levels hence find it difficult to recall and report portion sizes (Burrows *et al.*, 2010). Table 2-1 shows some studies carried out on children and the dietary assessment tools used.

2.4 Nutrition knowledge

The Social Cognitive Theory (Bandura, 1991) suggests that for someone to perform a certain behaviour they must acknowledge the behaviour and know how to accomplish it. Supporting the theory of knowledge–attitude–behaviour–practice (KAP) implies that knowledge is the foundation of a correct behaviour and positive attitude drives correct behaviour (Sharma *et al.*, 2008). In case of diet according to these theories, if someone must perform positive nutrition behaviour, they must know what the behaviour is (knowledge of the behaviour) and how to accomplish the skill. One has to know what healthy and unhealthy foods are before we ask him/her to eat healthy. Research has also focused on the possible relationship between diet quality and other social and cultural factors, such as nutrition knowledge and beliefs, which are considered important factors in explaining variations in food choices (Sharma *et al.*, 2008; Wardle *et al.*, 2000). Nutrition knowledge, as defined by Worsley (2002), is the knowledge of nutrients, nutrition as well as understanding the risk of unhealthy food choices and the benefits of healthy food choices. Other experts use the term nutrition literacy and define it as the extent to which individuals can attain, process, and understand nutrition information and skills they need to make appropriate nutrition decisions (Zoellner *et al.*, 2009). Nutrition literacy is a distinct form of health literacy that is derived from understanding of health literacy and food knowledge. Good levels of nutrition knowledge will assist individuals to use information that is helpful in achieving good nutrition status by promoting healthy food intake (Grunert *et al.*, 2010).

Table 2-1: Dietary assessment studies in children and tools used

Reference	Study title	Type of study and sample size, age	Dietary assessment tool used/ respondent
Labadarios *et al.* (2001)	The National Food Consumption Survey (NFCS): South Africa, 1999	Cross-sectional survey n=2894 1–9 years	24-hour recall and a food-frequency questionnaire/ Caregivers
Oosthuizen *et al.* (2011)	The impact of a nutrition programme on the dietary intake patterns of primary school children	Experimental study n=172 9-13 years	24-hour recall/ Children
MacKeown *et al.* (2007)	Energy, macro- and micronutrient intake among a true longitudinal group of South African adolescents at two interceptions (2000 and 2003): the Birth-to-Twenty (Bt20) Study	Longitudinal study n=143 10 and 13 years	Semi-quantitative food frequency questionnaire/ Children
Pedro *et al.* (2008)	Variety and total number of food items recorded by a true longitudinal group of urban Black South African children at five interceptions between 1995 and 2003: the Birth-to-Twenty (Bt20) Study	Longitudinal observation study n=143 ages of 5 (1995), 7 (1997), 9 (1999), 10 (2000) and 13 (2003) years,	Semi-quantitative food-frequency questionnaire/ Parents/guardians or the older children
Daboné *et al.* (2013)	Predisposing, facilitating and reinforcing factors of healthy and unhealthy food consumption in schoolchildren: Ouagadougou, Burkina Faso	Cross-sectional survey n=769 mean age 11.7 ± 1.4 years	Food frequency questionnaire/ Children

Maternal nutrition knowledge is likely to be associated with healthy food intake of the family (Asakura *et al.*, 2017; Mcleod *et al.*, 2011; Vereecken & Maes, 2010). Bonaccio *et al.* (2013) also presented findings and concluded that higher nutrition knowledge was associated with healthier food choices. Burchi (2010) reported consistent findings on mothers with better nutrition

knowledge selecting more varied diets for their children than did their lower knowledge counterparts. Vereecken and Maes (2010) established that maternal knowledge is a significant predictor of dietary scores of the children's diets with socio-demographic characteristics mediating this association. However, a study on the effects of maternal nutrition knowledge on children's food intake showed that nutrition education is effective if targeted at mothers with young children, but its influence decreases as the child grows older and start making their own choices (Blaylock et al., 1999).

2.4.1 Sources of nutrition knowledge for children

Health literacy is defined as one's ability to access, understand and use health information; it is identified as an important determinant of health (Berkman *et al.*, 2011). It is important for individuals to have the ability to make decisions about health not only in medical contexts, but in everyday life, whether it be at home, school, work, or within the broader community (Kickbusch, 2009). Children develop their nutrition-related knowledge and skills by relating to many settings and environments surrounding them as they grow (Velardo & Drummond, 2019). Researchers are beginning to recognise children as an important target group for health education initiatives (Velardo & Drummond, 2019). Involving children in the process of developing their own health literacy is crucial to nurture lifelong learning, yet little is known about what health literacy means to them (Okan *et al.*, 2018). Nutrition education for pre-schoolers and children under the age of 10 is usually delivered via the parents and teachers who are considered trustworthy sources of health information by the children (Okan *et al.*, 2018). Research on the qualitative insight of primary school children's nutrition literacy in South Australia showed that children's interactions with nutrition messages and their development of nutrition-related skills were influenced by the combined influence of parents, schools and popular media (Velardo & Drummond, 2019). In South Africa the Curriculum and Assessment Policy Statement (CAPS) places a great emphasis on nutrition and is related to the SA FBDGs (DBE, 2011; Vorster *et al.*, 2013). The media is also perceived as the key provider of messages through interactions with social marketing campaigns, television advertisements and reality cooking shows (Velardo & Drummond, 2019).

2.4.2 Measuring nutrition knowledge

Nutrition knowledge includes assessments of knowledge of dietary guidelines, nutrients in food, diet and health relationships, or of 'best' food/meal choices (Parmenter & Wardle, 1999). Nutrition knowledge forecasts eating behaviour of all foods, henceforth it is an important factor that can drive correct nutrition behaviours (Tan *et al.*, 2010). Nutrition knowledge questionnaires are used to standardise levels of awareness of expert recommendations as well as to assess the effectiveness of nutrition education programmes using a pre-test/post-test method (Parmenter *et*

al., 2000). Although knowledge is not one-dimensional and somewhat structured, questions are posed and the number of correct answers are counted as the nutrition score (Worsley, 2002). Nutrition has various areas and one might know more about some areas but less about others (Worsley, 2002). Poorly developed nutrition knowledge questionnaires have limited the conclusion that can be drawn from research (Trakman *et al.*, 2017). Cross-sectional studies are perhaps the best means by which to investigate the relationship between nutrition knowledge and food intake; this is because in cross sectional studies no specific nutritional requirements and related knowledge are considered (De Vriendt *et al.*, 2009).

2.4.3 Relationship between nutrition knowledge and food intake.

There are arguments that nutrition knowledge is a necessary but an insufficient factor for change in consumer's food behaviours (Grosso *et al.,* 2013; Hirvonen *et al*., 2017; Krešić *et al.*, 2009). The evidence of association between nutrition knowledge and children's diets is not clear, with some studies reporting positive correlations (Fahlman *et al.*, 2008; Gracey *et al.*, 1996; Raby Powers *et al.*, 2005; Shah *et al.*, 2010; Valliant *et al.*, 2012) and others reporting null associations (Hoogenboom *et al.*, 2009; Vereecken & Maes, 2010; Walsh *et al.*, 2011). Intervention studies have generally found that nutrition knowledge and food intake variables are improved in the treatment group after an intervention (Fahlman *et al.*, 2008; Pillai *et al.*, 2016; Powers *et al.*, 2005; Shah *et al.*, 2010). However, at times children's nutrition knowledge may not have great influence on children's food intake at home as their parents influence and control food availability in the home (Webber *et al.*, 2009). Similar correlation results were also observed in studies that involved adults (Rash *et al.*, 2008; Walsh *et al.*, 2011). To conclude on the proposed association, a comparison of studies that use participants with similar characteristics and similar knowledge assessment methodologies should be used, as they may be key in determining the results of the study. Cross-sectional studies have somehow also been able to provide evidence of a correlation between nutrition knowledge and intake of particular foods (Beydoun *et al.*, 2009; Dallongeville *et al.*, 2001; Pieniak *et al.*, 2010; Wardle *et al.*, 2000). Wardle *et al.* (2000) used a larger sample and a valid and reliable nutrition knowledge questionnaire (Parmenter & Wardle, 1999) and provided compelling evidence of a correlation between nutrition knowledge and food intake despite the food intake assessment only assessing frequency of intake and not quantity.

The relationship between nutrition knowledge and food intake is complex and is influenced by the interaction of many demographic and environmental factors (Wardle *et al.*, 2000). Nutrition knowledge and diet quality have both been shown to have a positive correlation with income and education, respectively (Dallongeville *et al.*, 2001; Gracey *et al.*, 1996; Klohe-Lehman *et al.*, 2006). Positive relationships with age and associations with race have also been observed (Klohe-Lehman *et al.*, 2006; Wardle *et al.*, 2000). Therefore, it is possible that the association

between nutrition knowledge and food intake observed in the studies mentioned herein is caused by their association with demographic characteristics, as well as the possibility that nutritional knowledge may have improved as a consequence of an educational intervention designed to improve food intake (Beydoun *et al.*, 2009).

Nutrition knowledge has also been shown to act as an effect modifier and to be a mediator between socioeconomic position and diet quality (Beydoun & Wang, 2008; McLeod *et al.*, 2011). It is recommended that the evaluation of nutrition education programmes should not assume a direct path between knowledge and food choices, but environmental variables should be explored as these may modulate diet quality due to greater knowledge (Tabbakh & Freeland-Graves, 2016). Factors well known to influence nutrition knowledge include age, sex, level of education and socioeconomic status (Wardle *et al.*, 2000). To validate the correlation some studies have used regression models to account for confounding factors (Dallongeville *et al.*, 2001; Rash *et al.*, 2008; Wardle *et al.*, 2000). Rash *et al.* (2008), using simple linear regression, showed a clear indication of the relationship between nutrition knowledge and food intake, while Wardle *et al.* (2000) and Dallongeville *et al.* (2001) provided evidence of a mediation effect of nutrition knowledge on different nutrient intakes. There are many factors besides nutrition knowledge that affect food intake and it is difficult to isolate the influence that nutrition knowledge has on food intake. Confounding factors such as age, food availability and household income must be considered that could also affect the relationships observed in cross-sectional correlational studies.

2.5 Summary

In this literature review, an effort was made to provide an in-depth investigation on childhood obesity determinants with a focus on diet, influences of child food intake and association of nutrition knowledge and food intake. Poor diets are contributing to the burden of chronic disease, including the increasing epidemic of childhood obesity, which is now prevalent even in low-income countries. The significant shift in dietary intakes accompanied by high levels of inactivity have been associated with the development of NCDs. Understanding the determinants of food choices and intake behaviours is critical to the prevention and management of the serious emerging public health problems. The evidence reviewed herein suggests that nutrition knowledge can influence food intake although knowledge is itself linked to other food intake determinants. Nevertheless, these other determinants, such as education level and socio-economic status, are not readily changed, therefore improved nutrition knowledge may be one of the most efficient and cost-effective methods by which to improve food intake. It is therefore the objective of this research to add to the body of evidence by testing the hypothesis that nutrition knowledge is significantly associated to intake of healthy and unhealthy foods in children.

Chapter 3 Methodology

3.1 Introduction

This chapter describes the methods that were used in this study to collect and analyse the data; these include the study design, sample size, inclusion and exclusion criteria, data collection procedures, statistical methods and ethical considerations. This study is affiliated to the Body Composition by Isotope Techniques study (BC-IT, NWU-00025-17-S1), which aims to examine the relationship between objective (stable isotope, bio-electrical impedance analysis (BIA) and indirect (anthropometric variables) measures of BC indices, and objective (accelerometer) and subjective (PAQ-C) measures of physical activity among 6 to 8 year old South African children, and the relationships with other health-related determinant factors (n=400). The BC-IT study received ethical approval (see Annexure B) from the Ethics Committee of the North-West University, Potchefstroom Campus, Faculty of Health Sciences in 2017 and that was when data collection started. The current sub-study received ethical clearance in 2018 (see Annexure C). Figure 3-1 shows how this study is part of the large study.

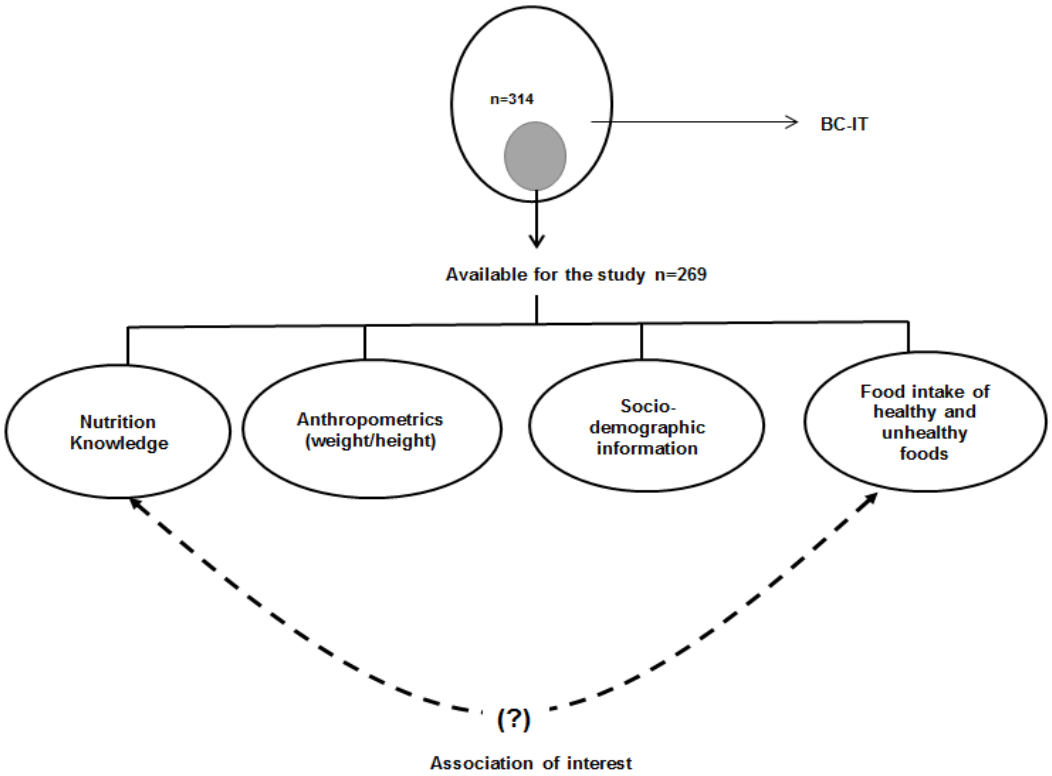

Figure 3-1: Study affiliation to the large study

3.2 Study design

The study has a cross-sectional design. Cross-sectional designs have been selected in a review of correlations of dietary behaviours in children and adolescents, based on the assumptions that then design might be useful in identifying possible theory-based associations (McClain *et al.*, 2009). Cross-sectional designs can result in systematic error and an overestimation of associations between the psychosocial variables and eating behaviours hence it is impossible to make causality conclusions (McClain *et al.*, 2009).

3.3 Population and setting

This cross-sectional study for the BC-IT study was conducted in five schools, selected from 26 primary schools within the Tlokwe municipality area. Permission to conduct the research was obtained from the Department of Education (see Annexure D). The study included quintile 3 and 4 primary schools in urban and township areas, and five schools were randomly selected to be representative. All classrooms with 6-8-year-old children that were present on the day of data collection were given a chance to participate. Children were randomly selected by including every third child on the class list to participate in the study. Interviews and body measurements were taken in a classroom or school hall that was assigned for such duty.

3.4 Recruitment of participants

Recruitment was conducted after advertising the study to the five selected primary schools in Tlokwe municipality area within Dr K Kaunda district. A pamphlet to advertise the study to schools was distributed with details of the principal investigator (PI) to assist parents with any queries. In the selected schools, all children within the ages of 6 to 8 years were informed about the study. Meetings to brief the parents and school authorities were arranged with the selected schools before actual recruitment. The teachers provided objective information to parents and children and managed the informed consent process with the children. The parents had two or more days to decide whether they wanted their children to participate before they signed the informed consent form (see Annexure E). The signed consent form was then returned to school by the child on the day of data collection. The informed consent form had been translated into Setswana and Sesotho, the home languages of the children.

On the day of data collection, the participants whose parents gave consent had the procedures explained to them by the PI, and any questions raised were answered, after which they were required to sign assent forms (Annexure F) before being permitted to participate in the study. The participants were under no obligation to participate in the research and could withdraw at any time during the data collection process.

3.5 Inclusion and exclusion criteria.

3.5.1 Inclusion criteria

Children between 6 to 8 years of age from both sexes could participate in this study. Children were only included if they were healthy on the day of data collection (they were fit to participate in the larger study) and had consent forms from their parents and gave written assent to participate in the study.

3.5.2 Exclusion criteria

Children who were older than 8 years and younger than 6 years were excluded from the study. Those who refused to participate even if their parents had consented were also excluded. Children who had eaten before data was collected and those who participated in high physical activity, according to the BC-IT study selection criteria, could not participate in the study.

3.6 Sample size calculation

The sample size for the BC-IT study was calculated using Open Epi software, Version 3 (Sullivan *et al.*, 2009), in which the Fleiss formulae for cross-sectional studies were applied to determine the appropriate sample size for a power of 0.80 and α-level of 0.05 at confidence interval of 95% (Kelsey et al., 1996). The power calculation for the big study was based on the primary hypothesis of a negative association between percentage body fat (% BF) and physical activity and the odds of having excessive % BF in the inactive group. From this it was found that a minimum sample size of 297 was needed based on an expected prevalence of combined overweight/obesity of 20%, as well as an expected prevalence of 30% inactivity in the children. For simplicity, the number of 297 was rounded up, and calculated that a minimum of 300 children should participate. To allow for parents not giving consent or children not giving assent, or being absent on the study day, 30% oversampling resulted in approximately 400 children being recruited. At the school level, stratified random sampling was used to select children from each age group: six years, seven years and eight years. Furthermore each third child on the class list was randomly selected to participate. A representation ratio of boys to girls as 1:1 was anticipated, based on the distribution of boys and girls in the school (Kigaru *et al.*, 2015). Data of all children who took part in the BC-IT study were available for this study, thus of the 400 recruited children this study aimed to include at least a minimum of 300 children. This number was supported by evidence according to Table 3-1 which shows the sample sizes of similar published studies.

Table 3-1: Sample size of published studies on nutrition knowledge and intake from food groups by primary school children

Authors, year	Title of publication	Objectives	Sample size
Asakura *et. al* 2017	Relationship between nutrition knowledge and dietary intake among primary school children in Japan: Combined effect of children's and guardians' knowledge	Asses the relationship between nutrition knowledge and dietary intake in primary school children	623 lower grades (1-3)
Said and Mohamed. 2017.	Impact of the nutritional educational program to the healthy food behaviour, knowledge, attitude and environment for obese children	Evaluate the healthy food behaviour, attitudes, knowledge and healthy environment of obese school children aged 10-11 years old	287 children 10-11 years
Oldewage-Theron *et al* 2010	Nutrition knowledge and nutrition status of primary school children in QwaQwa	To determine the nutrition knowledge and status of primary school children purposively selected in rural QwaQwa, Free State, South Africa	142 children aged 9-13 years
Vijayapushpam *et al* 2003	A qualitative assessment of nutrition knowledge levels and dietary intake of schoolchildren in Hyderabad	To assess the nutrition knowledge levels and dietary intake pattern of schoolchildren belonging to two groups of different socio-economic status (SES; high income/high SES and low income/low SES).	272 children aged 12-14 years

3.7 Research procedures and data collection

Data collection was done at the children's schools whilst data of the BC-IT study were being collected. Demographic information and anthropometric measurements were collected and some of this information was used as background information of the children in this study.

3.7.1 Demographic questionnaire

Socio-demographic information, including data on personal and family information (i.e. education of the parents, employment, and type of dwelling and household amenities), lifestyle behaviours and self-reported health status, was collected by means of a standard demographic Questionnaire (Annexure G) The questionnaire was sent home for caregivers to assist in providing the required information.

3.7.2 Anthropometric measurements

Anthropometric measures were taken by trained postgraduate students in the Physiology and Human Movement Sciences departments. These measurements, done according to the International Standards for Anthropometric Assessment (ISAK) protocol (Stewart *et al.*, 2011), were height and weight, and recorded on an anthropometry form. Body weight was taken, using a Seca 813 digital scale (Birmingham, United Kingdom), without shoes and with the child dressed in light clothing to the nearest 0.1kg. Height was measured barefoot to the nearest 0.1 cm with a Seca 213 stadiometer (Birmingham, United Kingdom) with a perpendicular board. All measurements were repeated at least twice and recorded. The average of the two closest measurements was calculated and used in data analysis. To ensure privacy, the measurements were taken in separate rooms for boys and girls and parents of selected children were welcome to be present during the measurement periods. We calculated BMI by dividing weight in kilograms by height in meter squared and used the WHO Anthroplus software to calculate BMI z-scores (BMIZ) and to classify the children as underweight (BMIZ <-2), normal weight (BMIZ -2 to +1) and overweight (BMIZ >+1 to +2) or obese (BMIZ >+2) (De Onis, 2006).

3.7.3 Nutrition knowledge questionnaire

A general nutrition knowledge questionnaire was developed by Parmenter and Wardle (1999) and has since been revised, adapted and validated for other populations and ages to suit specific contexts. Kliemann *et al.* reported the validity and reliability of an updated version of the general nutrition knowledge questionnaire, updating it with the current nutritional advice of 2016. Nutrition knowledge includes the assessment of dietary guidelines, nutrients in food, diet and health relationships (Parmenter & Wardle, 1999). The questions are also used to assess food and meal choices in relation to recommended dietary guidelines on the intake for macronutrients (Kliemann *et al.*, 2016). This study used a nutrition knowledge questionnaire adopted by the International Atomic Energy Agency (IAEA) for their studies in Africa (Kigaru et al., 2015)**.** The questionnaire is based on children's basic knowledge of food groups, and diet and health relationships. In the present questionnaire, there are nine nutrition knowledge questions, which assess food group

consumption knowledge, health risks associated with consumption of some foods and the functions of food in the body. The questionnaire was administered directly to children by a trained interviewer who used their mother tongue for easy comprehension. This questionnaire was part of the demographic questionnaire (Annexure G).

3.7.4 Food intake questionnaire

Finding reliable data on the contributions of dietary intake to childhood obesity is a challenge, hence relations between childhood obesity eating patterns and different types of foods consumed must be considered (Rodríguez & Moreno, 2006). A questionnaire to collect data on frequency of intake of healthy and unhealthy food groups was developed for this study and was based on the questionnaire that was used in the WHO Global school-based student health survey (GSHS) (Annexure H). The GSHS questionnaire concentrated on four food groups, fruits, vegetables, carbonated soft drinks and fast foods (WHO, 2008). A similar questionnaire listing five healthy food groups (fruits, vegetables, legumes, fish, meat) and five unhealthy food groups (cold drinks, cookies, cake, candies, 'ice pop') with five different responses of frequency of intake was used to determine intakes of healthy and unhealthy foods of African children in Burkino Faso (Daboné *et al.*, 2013). Our questionnaire to collect data on frequency of intake of healthy and unhealthy food groups was developed based on the questionnaires used in studies performed in Burkino Faso and South Africa (Daboné *et al.*, 2013; Pedro *et al.*, 2008).

The food groups included in this questionnaire are foods generally eaten by South African school children (Feeley *et al.*, 2012; Pedro *et al.*, 2008) and include four groups of healthy foods, namely fruits, vegetables, milk, meat/fish/poultry/eggs and six groups of unhealthy foods, namely hot beverages (tea and coffee) with sugar, cold beverages (sugar sweetened beverages), sweets, salty snacks, cakes and fast foods. Five different responses of frequency of intake were used, namely never, 1-2 days, 3-4 days, 5-6 days, or 7 days per week. The face validity of the questionnaire was assessed among six nutritional scientists with experience in dietary assessment, and they recommended that processed meat be added to the fast food group. This recommendation was implemented in the final questionnaire used in this study. The questionnaire was pilot tested for comprehension in a group of 17 caregivers of 6 to 8 year old children and was found to be easy to understand and complete. Healthy foods were defined as foods containing essential nutrients for child growth and general health, namely fruits, vegetables, milk, meat/fish/poultry/eggs (Daboné *et al.*, 2013). Unhealthy foods were defined as foods that provide energy, sugar, salt and fats, but do not make an important contribution to essential nutrient intake (WHO, 2008). A coloured picture file (Annexure I) with examples of foods from each group was presented together with the questionnaire to facilitate responses. This questionnaire was taken home to be completed by the child with the help of the parent or child's caregiver.

3.8 Data management system

Data was captured and analysed under the management of the principal investigator of the BC-IT study. For this sub-study, data was given to the student upon the approval from the Health Research Ethics Committee. The variables necessary for this study were listed and the dataset was made available for analysis.

3.9 Research monitoring

The principal investigator ensured that monitoring and evaluation was part of the large study from inception to reporting. A monitoring system was put in place to ensure data quality. The PhASReC and HART scientific committees served as the monitoring team in the execution of the project. All fieldworkers were trained to ensure standard data collection. The measuring equipment was calibrated every day before use by weighing a 10kg calibration weight. Data capturing was regularly checked, and the final data set was cleaned by cross checking all the missing data against the questionnaires as well as check captured data randomly for accuracy. Student progress on the study execution (literature review, statistical analysis, and writing up) was monitored by the supervisor and co-supervisors.

3.10 Statistical analysis

Statistical analysis was performed by the supervisor and student. Analysis was performed using SPSS version 25 for Windows (SPSS, Chicago, IL, USA). Descriptive data of demographic information (age, education of caregivers and language), anthropometric information (weight and height), nutrition knowledge and frequency of intakes from food groups were presented. The WHO 2006 growth software (Anthroplus) was used to describe the height-for-age and BMI-for-age z-scores to interpret the children's linear growth and weight status (De Onis, 2006; WHO, 2009). The distribution of data was checked for normality using the Kolmogorov-Smirnov test and QQ plots. Descriptive statistics were reported using median and interquartile ranges for non-normal data, means and standard deviation for normally distributed data, and for categorical characteristics, numbers and percentages were presented. The five different responses of frequency of intake, namely never, 1-2 days, 3-4 days, 5-6 days, or 7 days per week were coded as 0, 1, 3, 5 and 7. To determine the association between nutrition knowledge scores of the children and frequency of intakes from food groups, Spearman correlation coefficients were calculated for non-normally distributed data. A multivariable linear regression model was used to analyse the association between the nutrition knowledge score and frequency of food intake of healthy or unhealthy foods, with adjustment for covariates (children's age, sex, caregiver's age, household income and educational status of the caregiver).

3.11 Data archiving

All data from completed questionnaires of children and parents were computerised into a password protected computer at the North-West University (NWU). Hard copies were kept locked in a cabinet to be stored for seven years, where after they will be destroyed by shredding. Electronic data files of the research project were also kept under password protection on the study supervisor's and project leader's computers and an external hard drive. This ensured that study participants' right to privacy, anonymity and confidentiality was kept.

3.12 Ethical considerations

Before commencement of the larger study, the researchers obtained approval and permission from the Department of Education and Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU-HREC). The parents and caregivers were required to sign informed consent forms for the children, while the children were asked to sign assent forms for their participation in the study. Every participating child was respected by valuing each child's perspective, time and space. Children and their parents were provided with adequate written and verbal information about this study and their role as participants. Parents were invited to the school for a meeting with the principal investigator before data collection. Children were informed about their rights and were not coerced into any situation or behaviour with which they were not comfortable.

Privacy and confidentiality

All participating children had participant numbers and their names were not used. Participant numbers were used in all stages of data collection and no personal information was required from them. Information or conversations between the interviewer and the interviewee were not to be overheard by any other person. For measurements that required the participant to partially undress, two fieldworkers were present in a private room for privacy and security.

3.13 Reporting, dissemination and notification of results

All study results were sent to schools and a meeting was organised for the parents, and the PI explained the results. In addition, letters were written to the parents by the principal with the information on study results. They also received feedback on guidelines for frequency of intake of foods from the healthy and unhealthy food groups, based on the South African Paediatric Food Based Dietary Guidelines.

3.14 Protocol violations

The research team strove to minimise protocol deviations (any measures that could affect the participants rights or integrity and quality of data which were not stated in the original protocol) during the collection of data. The set protocol was not violated.

Chapter 4: Article

The association between nutrition knowledge and intake of healthy and unhealthy foods in 6 to 8 years old children within the Tlokwe municipality of North West Province, South African

(Article to be submitted for publication – formatted as specified by Appetite journal)

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Abstract

Poor dietary habits in children are proposed to be associated with an increased risk of becoming overweight/obese adults, for often these eating habits persist into adulthood. The aim of this study was to assess the association between nutrition knowledge and intake of healthy and unhealthy food groups in 269 children aged 6 to 8 years selected from five schools in Tlokwe City, South Africa. A nutrition knowledge questionnaire adopted from the International Atomic Energy Agency was used to collect information on the children's nutrition knowledge and a short food frequency questionnaire was used to assess food intake from healthy and unhealthy food groups. Height (cm), weight (kg), and socio-demographic information were also collected. The results showed that most of the children had a normal weight, while more children were overweight/obese (12.2%) than underweight (3.0%). The median nutrition knowledge score was 6 (interquartile range was 5–7) out of maximum of 9. The general nutrition knowledge was better than knowledge on the importance of food groups. The median frequency of intake of healthy food groups was 3 days per week, for unhealthy food groups it was 2 days per week, while staple foods were eaten daily. The nutrition knowledge score correlated positively with the frequency of milk group intake. The association between nutrition knowledge and frequency of intakes from the different food groups was assessed in multivariable linear regressions with child age, sex, household income and parental education as covariates. No significant association between nutrition knowledge score and frequency of intake of healthy and unhealthy food groups was found. Only household income was significantly associated with the frequency of intake of healthy food groups, namely fruit (r = 0.22, p = 0.001), animal source protein (r = 0.30, p = 0.001) and milk (r = 0.36, p = 0.001). Findings showed that there is no association between nutrition knowledge and frequency of intake of healthy and unhealthy foods in young children aged 6 to 8 years.

Keywords:

Nutrition knowledge; Nutrition literacy; Nutrition education; South Africa; dietary intake; Food intake; School children; Healthy food; Unhealthy food.

4.1 Introduction

South Africa is a middle-income country regarded as being in the final stage of nutrition transition (Steyn & Mchiza., 2014). Nutrition transition is characterised by the double burden of malnutrition with under and over nutrition occurring in the same population at the same time. Overweight and obesity are a result of several factors, including urbanisation and industrialisation, which have led to poor dietary intake, decreased physical activity and the socioeconomic status of the family (Kruger *et al.*, 2006; Zurita-Ortega *et al.*, 2017). The increasing prevalence of childhood obesity

noted in school-going children has shifted research focus to food intake and dietary quality (Reddy *et al.*, 2009; Reddy *et al.*, 2012; Shisana *et al.*, 2014). Understanding the determinants of food choices and food intake behaviours is critical for the prevention and management of the pandemic of childhood obesity in public health.

Dietary intake is linked directly to obesity, as it may cause increased body mass index (BMI–a proxy measure of fatness) in the absence of a balance between energy intake and energy expenditure (physical activity) (Carnell & Wardle, 2008; Kruger *et al.*, 2006; Sahota *et al.*, 2001; Steyn *et al.*, 2014). During phases of rapid growth (childhood and adolescence), more children are nutritionally vulnerable and at risk of malnutrition as a result of having some of their meals in uncontrolled food environments at school or away from home (McCain *et al.*, 2013). It is therefore important to establish positive nutrition behaviour in young children as it can be effective in positively influencing healthy food choices (Miller & Cassady, 2015). Food intake determinants such as education level and socio-economic status are not readily changed, while improving nutrition knowledge of children has the potential to improve their dietary habits (Grosso *et al.*, 2013). Therefore, understanding what young children know about healthy foods to help them make good food choices in a food environment with a lot of palatable energy dense food is important (Wadden *et al.*, 2002).

Theory of knowledge–attitude–behaviour–practice (KAP) implies that knowledge is the foundation of a correct behaviour and positive attitude drives correct behaviour (Sharma *et al.*, 2008). If someone must perform positive nutrition behaviour, they must know what the behaviour is and how to accomplish it. If we intend to increase intake of healthy foods in children, it is important to assess children's nutrition knowledge and dietary practices to inform nutrition interventions that will address gaps as well as factors that affect healthy food intake. It is therefore, the objective of this research to investigate whether there is an association between nutrition knowledge and the frequency of intake of healthy or unhealthy foods in children between 6 and 8 years.

4.2 Materials and Methods

4.2.1 Participants

This study was affiliated to the Body Composition by Isotope Techniques study (BC-IT), which aims to examine the relationship between body composition and physical activity among 6-8 years old South African children. Five primary schools were randomly selected from 26 primary schools in Tlokwe City, in North West Province, South Africa. A pamphlet with details of the study was used to share information with the school teachers and the parents of the children, and the principals agreed to participate. In the selected schools, all children within the ages of 6 to 8 years

were informed about the study. Every third child on the class list was randomly selected to participate in the study, but only those with parental informed consent forms and those who personally agreed to participate were included.

4.2.2 Sampling

The study had a cross-sectional design. The sample size for the BC-IT study was calculated using Open Epi software, Version 3 (Sullivan *et al.,* 2009). The Fleiss formula for cross-sectional studies was applied to determine the appropriate sample size for a power of 0.80 and α-level of 0.05, at confidence interval of 95% (Kelsey *et al.,* 1996). The power calculation was based on the primary hypothesis of a negative association between percentage body fat and physical activity and the odds of having excessive body fat in the inactive group, based on an expected prevalence of excessive adiposity of 20%, as well as 30% physical inactivity in the children. According to the calculation, a sample size of 300 children should be included in the BC-IT study. This study was to have a minimum of 300 participants, as deduced from the sample sizes of similar published studies on the association between nutrition knowledge and food intake (Oldewage-Theron *et al.,* 2010; Said & Mohamed., 2017; Asakura *et al.,* 2017). From the 314 children who took part in the BC-IT study, 269 children (111 boys, 158 girls) with complete data were included in this study.

4.2.3 Measurements

Demographic questionnaire

Socio-demographic information was collected by means of a standard questionnaire. Data collected focused on personal and family information (i.e. education of the parents, employment, and type of dwelling and household amenities), lifestyle behaviours and self-reported health status. The questionnaire was sent home for parents or caregivers to assist in providing the required information.

Anthropometric measurements

Anthropometric measurements were measured by trained postgraduate students in the Physiology and Human Movement Sciences departments. The measurements were done according to the International Society for the Advancement of Kinanthropometry (ISAK) protocol (Stewart *et al.,* 2014). Body weight was taken without shoes and in light clothing with a Seca 813 digital scale (Birmingham, United Kingdom) to the nearest 0.1kg. Height was measured barefoot to the nearest 0.1cm with a Seca 213 stadiometer (Birmingham, United Kingdom) with a perpendicular board. Subsequently, measurements of weight in kilogram divided by a height in square meter were used to calculate BMI (BMI: kg/m^2).

We used the WHO Anthroplus software to calculate BMI z-scores (BMIZ) and to classify the children as underweight (BMIZ <-2), normal weight (BMIZ -2 to +1) and overweight (BMIZ >+1 to +2) or obese (BMIZ >+2) (De Onis, 2006).

Nutrition knowledge questionnaire

The study used a nutrition knowledge questionnaire that was adopted by the International Atomic Energy Agency (IAEA) for their studies in Africa. The questionnaire was based on children's basic knowledge of food groups, and diet and health relationships (Table 4-1.) The questionnaire had nine nutrition knowledge questions, which assessed knowledge on frequency of food group consumption recommendations, health risks associated with consumption of some foods and the functions of food in the body. The mean nutrition knowledge score was calculated by adding up the number of correct answers for each child out of a total of nine. The questionnaire was administered directly to children by a trained interviewer who used their mother tongue for easy comprehension of the question.

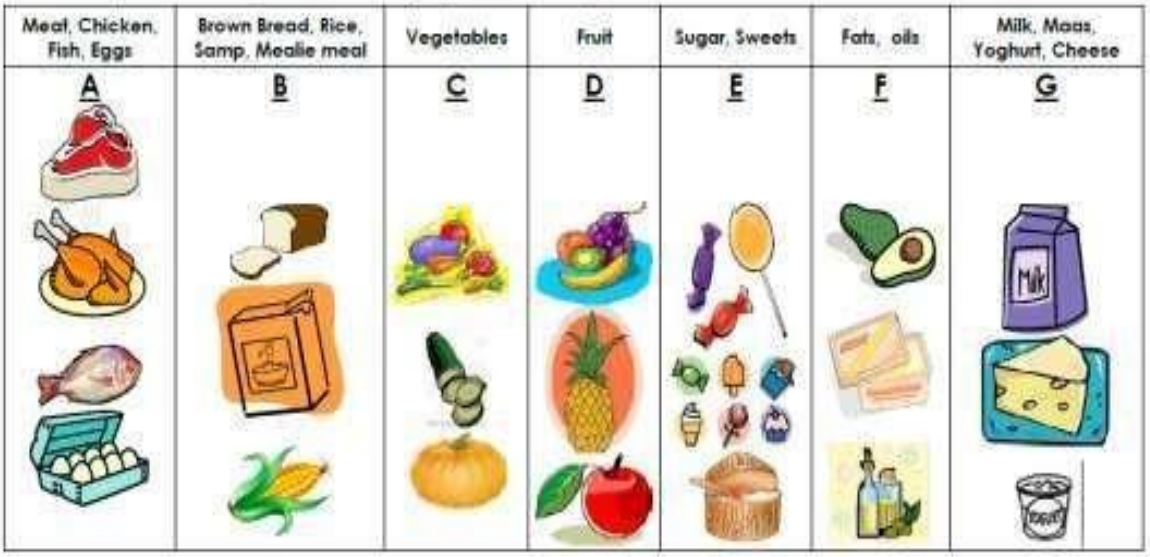
Food intake questionnaire

Children's dietary intake from food groups was measured using a newly developed simplified food frequency questionnaire (FFQ). The questionnaire to collect data on frequency of intake of healthy and unhealthy food groups was developed based on the questionnaires used in the WHO's Global school-based student health survey (GSHS) and studies performed in Burkina Faso and South Africa (Daboné *et al.*, 2013; Pedro *et al.*, 2008). The frequency of food group intakes was recorded as 0, 1-2, 3-4, 5-6, or 7 days per week. The food items included in the questionnaire were foods generally eaten by South African school children (Feeley *et al.*, 2012; Pedro *et al.*, 2008) and included four groups of healthy foods, namely fruits, vegetables, milk, meat/fish/poultry/eggs and six groups of unhealthy foods, namely hot beverages (tea and coffee with sugar), cold drinks (sugar sweetened cold beverages), sweets, salty snacks, cakes and fast foods.

Healthy foods were defined as foods containing essential nutrients for child growth and general health (Daboné et al., 2013). Unhealthy foods were defined as foods that provide energy, sugar, salt and fats, but do not make an important contribution to essential nutrient intake (WHO, 2008). The face validity of the questionnaire was assessed among six nutrition scientists with experience in dietary assessment. They recommended that processed meat be added to the fast food group. This recommendation was implemented in the final questionnaire used in this study. The questionnaire was pilot tested for comprehension in a group of 17 caregivers of 6 - 8 years old children and was found to be easy to understand and complete. A coloured picture file with examples of foods from each group was presented with the questionnaire to facilitate responses.

Table 4-1: Knowledge questions

1	Is eating fruit and vegetables every day good for our bodies to fight against illnesses like colds and flu?	
2	Eating a lot of sugar, sweets and sweet food	2.1 Is good for health?
		2.2 Can make you fat?
		2.3 Is bad for your teeth?
3	Choose the food group that you should eat the MOST of every day	
4	Choose the food group that you should eat the LEAST of every day	
5	Choose the food group that gives your body the best ENERGY	
6	Choose the food group that your BODY uses to BUILD MUSCLES	
7	Choose the food group that best PROTECTS the BODY AGAINST ILLNESSES	



4.2.4 Procedure

Demographic information, anthropometric and nutrition knowledge assessments were carried out at the children's schools. Trained fieldworkers interviewed the children on nutrition knowledge at school on the day of data collection. The socio-demographic questionnaire, the FFQ and coloured picture file, with examples of foods from each group, were taken home for completion by the parent or child's caregiver together with the child participant.

4.2.5 Statistical analysis

Analysis was performed using SPSS version 25 for Windows (SPSS, Chicago, IL, USA). Descriptive data were presented for demographic information (age, education of caregivers and language) and anthropometric information (weight and height). The WHO's 2006 Growth Chart (Anthroplus) software was used to describe BMI-for-age z-scores to interpret the children's weight

status (De Onis, 2006; WHO, 2009). A BMI-for-age z-score of +1 is equivalent to overweight and a z-score of +2 is the cut-off for obesity. The distribution of data was checked for normality using the Kolmogorov-Smirnov test and QQ plots. Descriptive statistics are reported using the median and interquartile range (IQR) for non-normally distributed data, and the mean and standard deviation (SD) for normally distributed data. For categorical variables numbers and percentages are presented. The categories for frequency of intake were recoded to calculate the median (IQR) number of days, using the lowest number of days per category (0 days/week=0, 1-2 days/week=1, 3-4 days/week=3; 5-6 days/week=5, 7 days/week=7). To compare the nutrition knowledge scores of the children in our study according to three age groups (6 years, 7 years, 8 years) the researcher used the Kruskal-Wallis test. To determine the association between nutrition knowledge and frequency of intakes from food groups, Spearman correlation coefficients (*r*) were calculated for non-normally distributed data. A linear regression model was used to analyse the association between nutrition knowledge and frequency of food group intake for healthy or unhealthy foods as a dependent variable, with adjustment for covariates (child age, sex, household income and educational status of the parent, backward regression).

4.2.6 Ethical considerations

Ethical clearance for the study was obtained from the Ethics Committee of the NWU (NWU-00025-17-A1-01; ExAMIN Youth study - NWU-00091-16-A1). Permission was also obtained from the Department of Basic Education of the North West Province (NWP) and the principals from the selected schools. Caregivers for the children signed informed consent forms for the child participants.

4.3 Results

4.3.1 Characteristics of study participants

The characteristics of the study participants are presented in Table 4-2. Most of the participants belonged to low-income families, with 43.2% coming from families who had a household income of less than ZAR 1000 per month. The majority of the children had normal BMI status, while more children were overweight and obese (12.2%) than thin (3.0%).

4.3.2 Nutrition knowledge

Nutritional knowledge was evaluated based on the respondents' knowledge of frequency of consumption recommendations, function of specific food groups, and health risks associated with consumption of some foods. The median nutrition knowledge score was 6 (IQR 5 - 7) out of maximum of 9, and 77% of the children scored 5 or better. The questions in the knowledge

Table 4-2: Characteristics of the study participants (n = 269)

Variable	Median or n	IQR or %
Age (years)	7.93	6.96 - 8.45
Weight (kg)	22.8	20.0 - 26.8
Height (cm)	122.0	115.7 - 126.7
Body mass index z-score	-0.63	-0.77 - 0.62
Body mass index category		
Thin (BMI z-score <-2)	8	3.0
Normal BMI (BMI z-score -2 to +1)	228	84.8
Overweight (BMI z-score >+1 to 2)	20	7.4
Obese (BMI z-score >+2)	13	4.8
School grade		
Grade R	33	12.7
Grade 1	59	22.7
Grade 2	89	34.2
Grade 3	79	30.4
Education level of the parent/caregiver:		
No school education	11	4.4
Primary school	22	8.7
High school	163	64.7
ABET (language, literacy and communication)	11	4.4
College/University/Other tertiary institution	45	17.9
Age of the parent/caregiver (years)	36.0	31.0 – 41.0
Number of household members	4	3 – 4
Number of larger household electric appliances	6	4 - 7
Household income (ZAR / month):		
Less than 1 000	101	43.2
1 000-4 999	83	35.5
5 000-9 999	25	10.7
10 000-20 000	19	8.1
More than 20 000	6	2.6

BMI - Body mass index ABET - Adult Based Education Training IQR – interquartile range 25th and 75th quartile.

questionnaire are listed in Table 4-1 with a picture of the food group options. Figure 4-1 depicts the children's answers to the nutrition knowledge questions. Most children correctly identified the food group that should be consumed most of everyday (62%) and the food group that protects against illness (62%). Only 16% of the children knew the food group that gives the best energy. Although the majority of children (82.2%) correctly answered that eating a lot of sugar, sweets and sweet food was bad for their teeth, only 42.7% showed they knew that this food group was the one that should be consumed the least every day. There was no difference noted between

the nutrition knowledge scores of the children in this study according to age group (6 years, 7years, 8 years, p = 0.28).

4.3.3 Frequency of food intake

Results of the FFQ showed that the frequency of consumption was relatively similar across healthy and unhealthy foods (Figure 4-2). All the listed food groups were consumed by a larger proportion of the children 1-2 days a week, for example fast food and cakes were consumed by 35.3% and 55.9% of children, respectively, on 1-2 days per week. Animal source protein foods were consumed in relatively equal measures (25.1%, 25.1%, 24.7%, and 24.3%) in all the categories (1-2 days, 3-4 days, 5-6 days, 7 days) respectively, showing that at least 24.3% consumed animal source protein every day. The median frequency for intake of healthy foods was 3-4 days per week for fruits and vegetables, while for milk group and animal source protein foods it was 5-6 days; generally, a lower median frequency of intake of unhealthy foods was found based on caregivers' reports (Table 4-3).

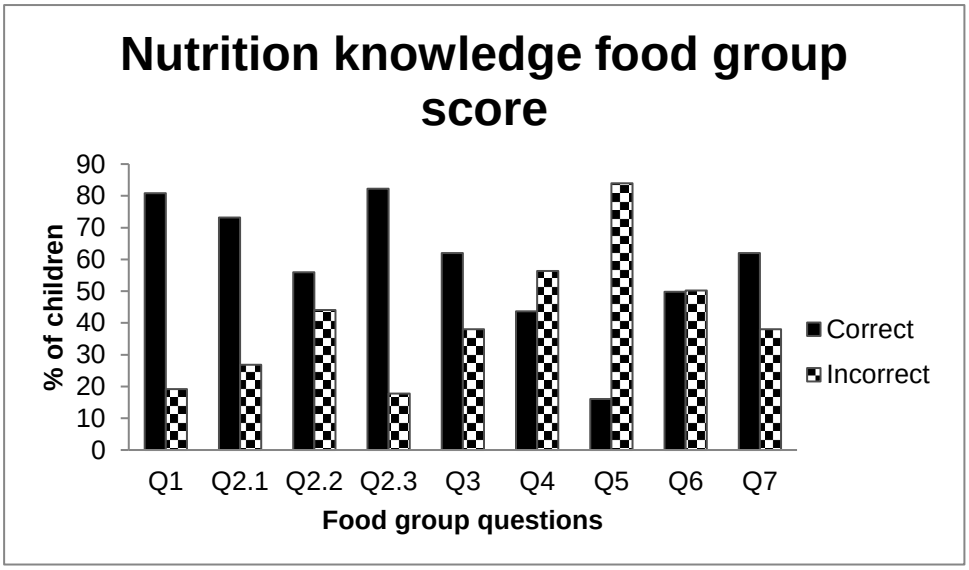
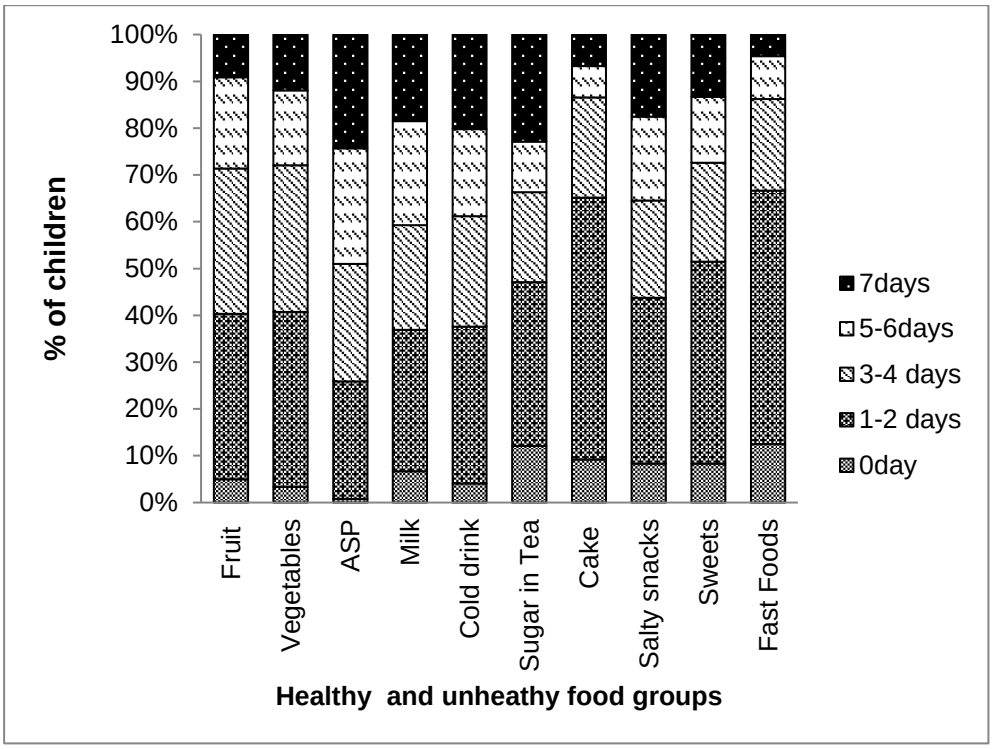


Figure 4-1: Nutrition knowledge for food groups

4.3.4 Association of nutrition knowledge scores, frequency of food intake and socio-demographic variables

The relationships between the nutrition knowledge score and frequency of intakes of healthy and unhealthy food groups are shown in Table 4-3. There was no significant correlation (p>0.05) between nutrition knowledge score and frequency of intake of healthy and unhealthy foods, except for the milk food group. A significant positive, but weak correlation was observed between

nutrition knowledge score and frequency of milk food group intake (r = 0.214, p = 0.006) and household income (r = 0.16, p = 0.04), respectively. Household income in turn correlated positively with the frequency of intake of healthy food groups, namely fruit (r = 0.22, p = 0.001), animal source protein (r = 0.30, p = 0.001) and milk food group (r = 0.36, p = 0.001), but not with vegetable intake. Weaker but significant correlations were also observed among healthy and unhealthy food groups (Table 4-4). Milk food group intake was positively correlated with food groups like fruit (r = 0.158, p = 0.0001) and sugar sweetened cold beverages (r = 0.126, p = 0.0001). Sweets intake was positively correlated with animal source protein foods and all unhealthy food groups; a negative correlation was also noted with vegetable food groups. Salty snack intake was negatively correlated with vegetable intake (r = -0.92, p = 0.0001).



ASP- animal source protein foods Cold drink – sugar sweetened beverages

Figure 4-2: Frequency of intake of healthy and unhealthy foods per week

Sugar sweetened cold beverages was significantly (p=0.01) associated with all food groups except the fruit group, which showed a negative correlation though not significant. Sugar in tea was negatively correlated (p≤0.05) with all unhealthy foods and sugar sweetened cold beverages. A borderline significant positive correlation between nutrition knowledge and the education level of the parents (r = 0.13, p = 0.09) was observed. Parental education was positively correlated

with the household income (r = 0.63, p = 0.001) and correlated with the intake of the animal source protein food group, (r = 0.23, p = 0.001) and milk food group (r = 0.26, p = 0.001).

Table 4-3: The frequency of consumption of specific food groups and their correlation with nutrition knowledge score (n = 269) **

Food group	The frequency of intake from food groups: Days per week Median (IQR)	Correlation with nutrition knowledge score	p-value
Healthy foods			
Fruit	3 (1, 5)	0.121	0.12
Vegetables	3 (1, 5)	-0.013	0.86
ASP	5 (3, 7)	-0.081	0.30
Milk	5 (3, 7)	**0.214**	**0.01**
Unhealthy foods			
Cold drink	5 (1, 7)	0.078	0.32
Cake	1 (1, 3)	-0.53	0.50
Sugar in Tea	3 (1, 7)	-0.021	0.79
Fast Foods	1 (1, 3)	0.123	0.12
Salty snacks	3 (1, 5)	0.097	0.21
Sweets	3 (1, 5)	0.022	0.12

* Spearman correlations; ** Sample size varies due to missing data; ASP - Animal source protein foods; Cold drink – Sugar sweetened cold beverages
The lowest number of days per category was used to calculate the median (IQR) (0 days/week=0, 1-2 days/week=1, 3-4 days/week=3; 5-6 days/week=5, 7 days/week=7).

Further analysis of the relationships between the nutrition knowledge score and frequency of intake of healthy and unhealthy food groups as the dependent variable was conducted adjusting for child age, sex, parental education, parental age and household income using multivariable linear regression models. The low association between nutrition knowledge, as well as the other covariates with frequency of intakes from the food groups is clear and shown by the small-adjusted R square for all the regression models (Table 4-5). Knowledge score was insignificantly associated with frequency of fruit intake (β = 0.121, p = 0.12), but household income was positively associated with frequency of fruit intake (*β* = 0.21, p = 0.015). No variables were associated with frequency of vegetable intake. Children with better nutrition knowledge tended to

Table 4-4: Correlation between frequencies of intake from healthy an unhealthy food groups (n = 269)

Foods groups	Unhealthy foods groups						Healthy foods groups			
	Cold drink	Cake	Fast Foods	Salty snacks	Sweets	Sugar in tea	Fruit	Vegetables	ASP	Milk
Fruit	-0.060	0.017	0.026	-0.005	0.020	-0.080*	-	0.380**	0.156**	0.158**
Vegetables	-0.083*	0.010	-0.036	-0.92*	-0.074*	-0.084*	0.380**	-	0.237**	0.110**
ASP	0.205**	0.034	-0.044	-0.036	0.109**	-0.085*	0.156**	0.237**	-	0.303**
Milk	0.126**	0.014	-0.021	-0.030	0.002	-0.093*	0.158**	0.110**	0.303**	-
Cold drink	-	0.137**	0.125**	0.162**	0.267**	-0.011	-0.060	-0.036	0.205**	0.126 **
Cake	0.137**	-	0.181**	0.308**	0.300**	0.065	0.017	0.010	0.034	0.014
Fast Foods	0.125**	0.181**	-	0.269**	0.214**	0.049	0.026	-0.092**	-0.044	-0.021
Salty snacks	0.162**	0.308**	0.269**	-	0.384**	0.151**	-0.005	-0.92*	-0.036	-0.030
Sweets	0.267**	0.308**	0.214**	0.384**	-	0.106**	0.020	-0.074*	0.109**	0.002
Sugar in tea	-0.011	0.065	0.049	0.151*	0.106*	-	-0.080*	-0.084*	-0.085*	-0.093*

** Spearman correlation, significant at the 0.01 level (2-tailed). *. Spearman correlation, significant at the 0.05 level (2-tailed). ASP- animal source protein foods. Cold drink- sugar sweetened cold beverages

have more frequent intake of milk, though the association was not significant (β= 0.16, p = 0.07). Girls tended to eat cake more frequently than did boys (β = 0.14, p = 0.099), but there were no variables associated with intakes from any of the other food groups.

Table 4-5: Standardised regression coefficients (β) and the p-values for the association between nutrition knowledge and frequency of healthy and unhealthy foods measured with adjustment for covariates

Exposure variable and covariates included in the final regression model for each dependent variable (food group)	β	p-value
Outcome: Frequency of intake from Fruit group		
Knowledge score	.071	.406
Household income	.208	.015
Adjusted R square = 0.037		
Outcome: Frequency of intake from Vegetable group		
Age of the child	.089	.213
Adjusted R square = 0.001		
Outcome: Frequency of intake from Animal source protein food		
Household income	.107	.213
Adjusted R square = 0.004		
Outcome: Frequency of intake from Milk and milk products group		
Knowledge score	.157	.067
Adjusted R square = 0.017		
Outcome: Frequency of intake from Sugar sweetened cold beverages group		
Education of parent	.116	.180
Adjusted R square = 0.006		
Outcome: Frequency of intake from Sugar in tea group		
Household income	.115	.182
Adjusted R square = 0.006		
Outcome: Frequency of intake from Cake group		
Sex (male as reference)	.143	.099
Adjusted R square = 0.013		
Outcome: Frequency of intake from Salty snacks group		
Parental education	.113	.190
Adjusted R square = 0.013		
Outcome: Frequency of intake from Sweets group		
Sex (male as reference)	.133	.124
Adjusted R square = 0.01		
Outcome: Frequency of intake from Fast Foods group		
Parental education	.054	.536
Adjusted R square = -0.005		

4.4 Discussion

This is the first study to the knowledge of the researchers that investigated the association between nutrition knowledge and intake of healthy and unhealthy foods among children of 6-8 years in South Africa. The nutrition knowledge score was positively associated with frequency of milk intake in the children, but not with frequency of intakes from other food groups.

Nutrition knowledge

Knowledge informs decision making in many instances; hence nutrition knowledge has the potential of influencing a child's food choices as well as dietary habits (Asakura *et al.,* 2017). In this study, the children's nutrition knowledge was investigated on the child's ability to know guidelines on food group intake frequency as well as the food group function as descriptors of nutrition knowledge.

The general nutrition knowledge of participants for questions 1 and 2 (role of fruits and vegetables and consequences of consumption of sweets) was relatively good (80% and 82% correct), however they exhibited limited knowledge on the recommendations for frequency of consumption of different food groups and the function of other foods groups in the body. This observation is consistent with that of Oldewage-Theron *et al.* (2015) in older participants (mean age 11.2 years) in QwaQwa, a rural town in South Africa, where the children also showed good basic nutrition knowledge, but with a knowledge gap on the functions of food groups. Kigaru *et al.* (2015) on their study in Kenya study observed moderate nutrition knowledge levels among children aged 8-11 years using the same nutrition knowledge questionnaire as we used. Similar findings about limited nutrition knowledge were also observed in a study in 8-15 years old children from Tshwane Metropole of South Africa (Mamba *et al.*, 2019). According to Oldewage-Theron *et al.* (2015), limited nutrition knowledge in learners may be due to the levels of nutrition knowledge of Life Orientation educators in schools of South Africa. Moderate nutrition knowledge among children in Malaysia, was attributed to insufficient cognitive development since the age group may have been too young for some of the knowledge questions (Koo *et al.*, 2018). The children in our study were only 6-8 years old with a limited number of nutrition lessons and were of low cognition. There was no difference in nutrition knowledge scores of the children according to their age groups. This finding is in contradiction to the findings of Harris (2012) in which nutrition knowledge levels were found to be positively associated with the child's age, as well as the education curriculum adopted by the school. Nguyen *et al.* (2007), found a difference in the nutrition knowledge of 3-year olds compared to 4-year olds, whereas for 4- and 7-year olds there was no difference in their knowledge.

It should also be noted that in the South African studies of Mamba *et al.*, (2019) and Oldewage-Theron *et al.* (2015), participants were adolescents and did not have enough knowledge about food groups. In comparison, this study's participants were much younger, with 35.4% still in pre-school class (grade R) and grade one, levels at which they receive basic non-nutrition specific lessons as evidenced by the Curriculum and Assessment Policy Statement (Caps). CAPS places an emphasis on nutrition and is related to the South African Food Based Dietary Guidelines (DBE, 2011; Vorster *et al.*, 2013). It could then be argued that the children may have been too young for the tested particular nutrition knowledge questions because of the minimal nutrition lessons in school.

Food intake

A food frequency questionnaire was used to investigate how frequently the children consumed both healthy foods (fruits, vegetables, milk and animal source protein) and unhealthy foods (sugar sweetened cold beverages, sweets, cakes, chips, fast foods, tea in sugar) in a week. The median intakes from healthy food groups ranged from 3 - 5 days per week compared to 1 - 3 days per week for unhealthy foods. In a similar study in Tshwane Metropole, South Africa, among 8-15 years old children, Mamba *et al.* (2019) showed that sugar sweetened drinks and snacks were the most frequently consumed food groups, while fruits and vegetables were the least consumed. Contrary to the study in Tshwane, the frequency of intake of healthy foods was more than that of unhealthy foods in our study. More than 20% of the children drank either hot (22.9%) or sugar-sweetened cold beverages (20.2%) daily. The difference between the findings of these two studies can be mainly attributed to the study sites and the different age groups investigated. Children in some South African communities mainly consume plant-based staples and have an inadequate frequency of intake of animal source protein foods, vegetables and fruits (Grobbelaar *et al.*, 2013; Nyathela & Oldewage-Theron, 2017). Although this study did not investigate intakes from the staple group, low intakes were observed of vegetables and fruits (median 3 days/week), which are supposed to be consumed by children daily. Of the sampled children, only 12% ate vegetables and 9% ate fruits daily as recommended by the food-based dietary guidelines (Vorster *et al.*, 2013).

Low intakes of both healthy and unhealthy foods in this study showed there was no replacement in consumption of a food group by another. This is similar to findings of Looney and Raynor (2012), which showed that low intake of snack foods (unhealthy foods) did not result in an automatically higher intake of fruits and vegetables. However, we found a very strong negative correlation of salty snack with vegetable intake (r = -0.92, p = 0.0001). and another negative correlation between the frequency of intake of vegetables and cold drinks and as expected, intake of salty snacks was positively associated with all the unhealthy food groups. Low healthy food

intake could be due to poor availability and accessibility of foods because of the ever-increasing food prices accompanied by the high unemployment rates in low socio-economic settings in South Africa (Labadarios *et al*., 2011; Steyn *et al*., 2011). Low socio-economic status may influence the low intakes of food from all the food groups studied, as it is a major determinant of food availability in the household, in terms of quantity and quality (Jang, 2009). The majority of the households (65%) included in this study, averaging three persons per household, had a monthly income less than ZAR 1000.00 which may not sufficiently sustain healthy food intake, meaning mostly staple foods can be afforded.

Association between nutrition knowledge and food intake

The main findings of this study indicated there was a significant positive correlation between nutrition knowledge and frequency of milk intake on the one side, whilst conversely showing insignificant correlation between nutrition knowledge and intake of other healthy and unhealthy food groups. This null finding was contrary to what has been reported in other studies (Asakura *et al.*, 2017; Bonaccio *et al.*, 2013; Grosso *et al.*, 2013). Grosso *et al.* (2013) have demonstrated that higher quartile of nutrition knowledge score was associated with consumption of healthy foods (pasta/rice, vegetables and fruit) and lower consumption of unhealthy foods (sweets snacks, fried foods and sugary drinks). However, dietary intake was associated with nutrition knowledge, as well as demographic characteristics (higher parental education and income), which could imply that the association between nutrition knowledge and food intake was modified by their individual associations with demographic characteristics (Grosso *et al.*, 2013). These findings were similar to those observed by Shariff *et al*. (2015), which showed that employment status and education levels of the parents or caregivers were essential determinants for better nutrient intakes. A study by Beydoun *et al.* (2009) in adults adds evidence to the association between demographic factors with nutrition knowledge and with food intake. The correlation between nutrition knowledge and food intake persisted after adjustment for confounding factors, contrary to this study where no significant association between nutrition knowledge and food intake was found when covariates were taken into account. Kandiah and Jones (2002) have observed higher consumption of milk, grains, fruit and vegetables, as well as an increase in nutrition knowledge after a nutrition education intervention in 10-years old children.

Finding no association between nutrition knowledge and frequency of intakes from various food groups after adjustment for covariates in this study concurs with the results of other studies (Kandiah, 2002; Oldewage-Theron, 2015; Powers Raby, 2005; Kigaru, 2015). However, their studies considered different age groups to this study and employed different data collection tools. Young children may not have full control over what they eat, but research has shown that some parents allow them to make choices partially (Webber *et al*, 2009; Anliker *et al,* 1992). An

observation of a positive correlation between nutrition knowledge of the children and the education level of the parents, as well as the household income was found in the current study. Similar results were also found by Asakura *et al.* (2017), as they have reported higher vegetable intake in younger children to be correlated with higher knowledge in both children and guardians. This can be interpreted as an indication of more access to resources such as educational materials as well as money to access expensive healthy food groups. This finding indicates that nutrition knowledge can be a mediator between income and intake of healthy foods in an environment that supports healthy eating. This study finding supports the need to target interventions towards parental and educators' nutrition knowledge, as shown by Webb and Block (2004) that parents may also influence their child's nutrition knowledge and not only food availability. School environments also need to be modified in the intervention programmes. Innovative and novel approaches to improve the nutrition knowledge among school-going children in the first few school grades must be implemented.

Limitations

Methods of assessing nutrition knowledge of young children are complex. The limited and mixed findings on developmental differences in nutrition knowledge during early childhood years warrant further research. The main limitation of the study was that the nutrition information that the children received at school or at home was not investigated before developing the questionnaire, and therefore it is recommended that this be done as part of a future study. Caregivers and children together completed the FFQ, which introduced bias, as self-reported intakes may not be accurate. No quantities of the food were recorded, information which could have been used to interpret the physical assessment status. This study also had a relatively small sample size, with only 269 out of the available 314 children having complete data, therefore the study may have been underpowered to determine an association between nutrition knowledge and frequency of intake from food groups. Despite these limitations, the strength of this study was the researcher was able to investigate nutrition knowledge and frequency of food intake from healthy and unhealthy groups for the first time in South African children aged 6 to 8 years.

Conclusion

Nutrition knowledge alone is not automatically associated with practice, as indicated by this study. The nutrition knowledge and food group intakes of children in this study were generally not related. However, in this study the low socio-economic status may be responsible for low frequency of intake for both healthy and unhealthy foods with households relying mainly on staple foods. Investigated nutrition knowledge was limited concerning the frequency of consumption of different food groups. This study has also shown low frequency of intake of important food groups

in this childhood age group (milk, animal source protein, fruits and vegetables) and favourably low intakes of unhealthy snack foods in most children.

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Conflict of interest:

None

Authorship:

PKM and SK conceptualised the study, drafted the manuscript and conducted all the statistical analyses, with input from MF, RK, MAM and TVZ who have made substantial contributions to the drafts and were involved in critically reviewing the manuscript. All the authors have reviewed and approved the final version for publication.

References

Abrahams, Z., De Villiers, A., Steyn, N.P., Fourie, J., Dalais, L., Hill, J., Draper, C.E. & Lambert, E.V. (2011). What's in the lunchbox? Dietary behaviour of learners from disadvantaged schools in the Western Cape, South Africa. *Public Health Nutrition*, 14(10):1752-1758.

Anliker, J.A., Laus, M.J., Samonds, K.W. & Beal, V.A. (1992). Mothers' reports of their three-year-old children's control over foods and involvement in food-related activities. *Journal of Nutrition Education*, 24(6):285-291.

Asakura, K., Todoriki, H. & Sasaki, S. (2017). Relationship between nutrition knowledge and dietary intake among primary school children in Japan: Combined effect of children's and their guardians' knowledge. *Journal of Epidemiology*, 27(10):483-491.

Beydoun, M.A., Powell, L.M. & Wang, Y. (2009). Reduced away-from-home food expenditure and better nutrition knowledge and belief can improve quality of dietary intake among US adults. *Public Health Nutrition*, 12(3):369-381.

Bonaccio, M., Di Castelnuovo, A., Costanzo, S., De Lucia, F., Olivieri, M., Donati, M.B., de Gaetano, G., Iacoviello, L., Bonanni, A. & Investigators, M.-s.P. (2013). Nutrition knowledge is associated with higher adherence to Mediterranean diet and lower prevalence of obesity. Results from the Moli-sani study. *Appetite*, 68:139-146.

Carnell, S. & Wardle, J. (2008). Appetite and adiposity in children: evidence for a behavioral susceptibility theory of obesity. *The American Journal of Clinical Nutrition*, 88(1):22-29.

Daboné, C., Delisle, H. & Receveur, O. (2013). Predisposing, facilitating and reinforcing factors of healthy and unhealthy food consumption in schoolchildren: a study in Ouagadougou, Burkina Faso. *Global Health Promotion*, 20(1):68-77.

South Africa. Department of Basic Education. (2011). Report on the Annual National Assessments of 2011: Pretoria.

De Onis, M. (2006). WHO Child Growth Standards Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age. Methods and Development. World Health Organization

Feeley, A., Musenge, E., Pettifor, J.M. & Norris, S.A. (2012). Changes in dietary habits and eating practices in adolescents living in urban South Africa: The Birth-to-twenty cohort. *Nutrition*, 28(7):e1-e6.

Grobbelaar, H.H., Napier, C. & Oldewage-Theron, W. (2013). Nutritional status and food intake data on children and adolescents in residential care facilities in Durban. *South African Journal of Clinical Nutrition*, 26(1):29-36.

Grosso, G., Mistretta, A., Turconi, G., Cena, H., Roggi, C. & Galvano, F. (2013). Nutrition knowledge and other determinants of food intake and lifestyle habits in children and young adolescents living in a rural area of Sicily, South Italy. *Public Health Nutrition*, 16(10):1827-1836.

Harris, M. (2012). The role of attitude and barriers on the implementation of a nutrition intervention in primary school children. Potchefstroom: NWU. (Thesis - MSc)

Jang, S.Y. (2009). Associations of food insecurity, socioeconomic status, and type 2 diabetes among Mexican Americans and non-hispanic Whites in the United States. Rutgers University-Graduate School-New Brunswick. (Doctoral dissertation, Rutgers University-Graduate School-New Brunswick)

Kandiah, J. & Jones, C. (2002). Nutrition knowledge and food choices of elementary school children. *Early Child Development and Care*, 172(3):269-273.

Kelsey, J.L., Whittemore, A.S., Evans, A.S. & Thompson, W.D. (1996). Methods in observational epidemiology. Vol. 26: Monographs in Epidemiology and Biostatistics

Kigaru, D.M.D., Loechl, C., Moleah, T., Macharia-Mutie, C. & Ndungu, Z.W. (2015). Nutrition knowledge, attitude and practices among urban primary school children in Nairobi City, Kenya: a KAP study. *BioMed Central Nutrition*, 1(1):44.

Koo, H., Lee, C., Hidayah, A.N. & Hazwani, A.N. (2018). Knowledge, attitudes and practices of schoolchildren toward whole grains and nutritional outcomes in Malaysia. *Appetite*, 123:256-263.

Kruger, R., Kruger, H. & Macintyre, U. (2006). The determinants of overweight and obesity among 10 to 15years old schoolchildren in North West Province, South Africa–the THUSA BANA (Transition and Health during Urbanisation of South Africans; BANA, children) study. *Public Health Nutrition*, 9(3):351-358.

Looney, S.M. & Raynor, H.A. (2012). Are changes in consumption of “healthy” foods related to changes in consumption of “unhealthy” foods during pediatric obesity treatment? *International Journal of Environmental Research and Public Health*, 9(4):1368-1378.

Mamba, N.P., Napoles, L. & Mwaka, N.M. (2019). Nutrition knowledge, attitudes and practices of primary school children in Tshwane Metropole, South Africa. *African Journal of Primary Health Care & Family Medicine*, 11(1):1-7.

McCain, M., Mustard, J. & McCuaig, K. (2011). Early years study 3: making decisions, taking action. Toronto, ON: Margaret & Wallace McCain Family Foundation.

Miller, L.M.S. & Cassady, D.L. (2015). The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*, 92:207-216.

Nguyen, S.P. (2007). An apple a day keeps the doctor away: Children's evaluative categories of food. *Appetite*, 48(1):114-118.

Nyathela, T. & Oldewage-Theron, W. (2017). Nutritional status and food consumption patterns of primary school children in Orange Farm. *African Journal of Food, Agriculture, Nutrition and Development*, 17(1):11497-11517.

Oldewage-Theron, W., Egal, A. & Moroka, T. (2015). Nutrition knowledge and dietary intake of adolescents in Cofimvaba, Eastern Cape, South Africa. *Ecology of Food and Nutrition*, 54(2):138-156.

Pedro, T.M., MacKeown, J.M. & Norris, S.A. (2008). Variety and total number of food items recorded by a true longitudinal group of urban Black South African children at five interceptions between 1995 and 2003: the Birth-to-Twenty (Bt20) Study. *Public Health Nutrition*, 11(6):616-623.

Pérez-Rodrigo, C. & Aranceta, J. (2001). School-based nutrition education: lessons learned and new perspectives. *Public Health Nutrition*, 4(1a):131-139.

Powers Raby, Struempler Alicia, Guarino Barbara J, Parmer Anthony & M, S. (2005). Effects of a nutrition education program on the dietary behavior and nutrition knowledge of second-grade and third-grade students. *Journal of School Health*, 75(4):129-133.

Reddy, S., Resnicow, K., James, S., Kambaran, N., Omardien, R. & Mbewu, A. (2009). Underweight, overweight and obesity among South African adolescents: results of the 2002 National Youth Risk Behaviour Survey. *Public Health Nutrition*, 12(2):203-207.

Reddy, S.P., Resnicow, K., James, S., Funani, I.N., Kambaran, N.S., Omardien, R.G., Masuka, P., Sewpaul, R., Vaughan, R.D. & Mbewu, A. (2012). Rapid increases in overweight and obesity among South African adolescents: comparison of data from the South African National Youth Risk Behaviour Survey in 2002 and 2008. *American Journal of Public Health*, 102(2):262-268.

Sahota, P., Rudolf, M.C., Dixey, R., Hill, A.J., Barth, J.H. & Cade, J. (2001). Randomised controlled trial of primary school based intervention to reduce risk factors for obesity. *British Medical Journal.* 323(7320):1029.

Sharma, S.V., Gernand, A.D. & Day, R.S. (2008). Nutrition knowledge predicts eating behavior of all food groups except fruits and vegetables among adults in the Paso del Norte region: Qué Sabrosa Vida. *Journal of Nutrition Education and Behavior*, 40(6):361-368.

Shariff, M.Z., Lin, K.G., Sariman, S., Lee, H.S., Siew, C.Y., Yusof, M., Nisak, B., Mun, C.Y. & Mohamad, M. (2015). The relationship between household income and dietary intakes of 1-10 year old urban Malaysian. *Nutrition research and practice*, 9(3):278-287.

Stewart, A., Marfell-Jones, M., Olds, T. & De Ridder, H. (2011). International standards for anthropometric assessment (ISAK). *New Zealand: Lower Hutt*.

Steyn, N.P., Mchiza, Z., Hill, J., Davids, Y.D., Venter, I., Hinrichsen, E., Opperman, M., Rumbelow, J. & Jacobs, P. (2014). Nutritional contribution of street foods to the diet of people in developing countries: a systematic review. *Public Health Nutrition*, 17(6):1363-1374.

Sullivan, K.M., Dean, A. & Soe, M.M. (2009). On Academics: OpenEpi: A Web-Based Epidemiologic and Statistical Calculator for Public Health. *Public Health Reports*, 124(3):471-474.

Tee, L., Laubscher, R., Botha, C. & Jerling, J. (2015). The intake and quality of breakfast consumption in adolescents attending public secondary schools in North West province, South Africa. *South African Journal of Clinical Nutrition*, 28(2):81-88.

Vereecken, C. & Maes, L. (2010). Young children's dietary habits and associations with the mothers' nutritional knowledge and attitudes. *Appetite*, 54(1):44-51.

Vorster, H.H., Badham, J. & Venter, C. (2013). An introduction to the revised food-based dietary guidelines for South Africa. *South African Journal of Clinical Nutrition*, 26(3):S5-S12.

World Health Organization, (2006). WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. WHO

World Health Organization, (2009). Growth Reference Data for Children from 5 to 19 Years, Geneva*: www. who. int/growthref/en/.*

Wadden, T.A., Brownell, K.D. & Foster, G.D. (2002). Obesity: responding to the global epidemic. *Journal of Consulting and Clinical Psychology*, 70(3):510.

Webb, P. & Block, S. (2004). Nutrition information and formal schooling as inputs to child nutrition. *Economic Development and Cultural Change*, 52(4):801-820.

Webber, L., Hill, C., Saxton, J., Van Jaarsveld, C. & Wardle, J. (2009). Eating behaviour and weight in children. *International Journal of Obesity*, 33(1):21.

World Health Organization, W.H.O. (2008). Chronic diseases and health promotion: Global school-based student health survey (GSHS) purpose and methodology. Switzerland: WHO

Wenhold, F.; Muehlhoff, E. & Kruger, H.S. (2015) Nutrition for school aged children. In Community Nutrition for Developing Countries; Temple, N., Steyn, N.P., Eds.; AU Press, Athabasca University: Edmonton, AB, Canada; UNISA: Pretoria, South Africa.

Zurita-Ortega, F., Castro-Sanchez, M., Rodriguez-Fernandez, S., Cofre-Bolados, C., Chacon-Cuberos, R., Martinez-Martinez, A. & Muros-Molina, J. (2017). Physical activity, obesity and self-esteem in Chilean schoolchildren. *Revista Medica de Chile*, 145(3):299-308.

Chapter 5 Conclusions and Recommendations

5.1 Introduction

Several factors influence food intake in children and are mutually interrelated (Scaglioni *et al.*, 2018). Research in intervention studies have shown that nutrition knowledge may contribute to improving frequency of food intake from healthy food groups (Asakura *et al.*, 2017; Pérez-Rodrigo & Aranceta, 2001). The overall aim of this study was to determine the association between the nutrition knowledge of food groups (meats, cereals, fruits, vegetables, sweets, fats and milk), and frequency of intake of healthy and unhealthy foods by children aged 6-8 years in Tlokwe City, South Africa. More specifically the study aimed to describe children's knowledge of food group consumption and the frequency of intake of healthy and unhealthy food groups by children. It also aimed to determine the association between knowledge and frequency of intake of healthy and unhealthy food groups with adjustment for possible covariates. The purpose of this chapter was to summarise the main findings of the study based on the analysis of data, present the limitations of the study methodology and recommendations for future research.

5.2 Main findings

It was hypothesised that there was no significant association between nutrition knowledge and the frequency of intake of healthy and unhealthy food groups among children aged 6 to 8 years. Children of this age group had better nutrition knowledge in terms of food groups than about the recommendations on frequency of consumption of different food groups and their roles in the body. Frequency of intake of the healthy food groups was lower than the recommendations of eating fruits and vegetables every day (7 days a week). The median frequency of intake of most unhealthy food groups ranged between 1-2 days and 3-4 days per week, which was lower than in other studies of children in South Africa (Mamba *et al.*, 2019). These unhealthy foods are low in key nutrients for child growth and development (Daboné *et al.*, 2013). Nutrition knowledge was only associated with frequency of intake of milk and milk products and not associated with the consumption of other healthy and unhealthy foods groups. Nutrition knowledge was also positively associated with household income and parental education. Household income was positively associated with parental age and parental education as well as with frequency of intake of fruits, milk and animal source protein foods (healthy foods). These associations persisted after adjustments were made for possible covariates like children's age, sex, parental age, household income and educational status of the parent or caregiver. Even though nutritional knowledge was fair the frequency of intakes from healthy food groups remained low, suggesting there were other factors besides nutritional knowledge that influences food group intake. Children have no full

control over their dietary intake, for intakes of most food groups were correlated to parental age and education, and household income which portrays the influence of food accessibility and availability. The association of sociodemographic factors (household income, parental education and age) with the intake of healthy foods and their association with nutrition knowledge suggest that nutrition knowledge may play a mediation role in the intake of healthy foods. Based on these results this study accepts the null hypothesis that there was no association between nutrition knowledge and frequency of healthy and unhealthy foods intake in children aged 6 to 8 years.

5.3 Conclusion

It can be concluded that there was no association between nutrition knowledge and frequency of intakes from food groups in children 6 to 8 years old. It was also observed that nutrition knowledge is complex to measure precisely in this age group. However, we have found good general nutrition knowledge of food group function and consequences of excessive intakes, but limited knowledge on the guidelines recommending frequency of consumption of food groups and their roles. Generally low frequency of intake of both healthy and unhealthy foods was observed in the children. In summary, there is no association between nutrition knowledge and frequency of intake of healthy and unhealthy foods in young children aged 6 to 8 years.

5.4 Limitations

Assessing nutrition knowledge in young children is complex. A serious limitation of this study was that the nutrition information that the children received at school or at home was not investigated before developing the nutrition knowledge questionnaire. Instead a nutrition knowledge questionnaire that has been adopted by the International Atomic Energy Agency (IAEA) for their studies in Africa was used (Kigaru *et al.*, 2015) (Addendum F)**.** Caregivers and children together completed the short food group questionnaire which may have introduced bias as self-reported intakes may not be accurate. The FFQ did not provide food quantities and may also not have provided a clearer pattern of the food group intake. This study also had a relatively small sample size, with only 269 out of the available 314 children having complete data. Therefore, the study may have been underpowered to determine an association between nutrition knowledge and frequency of intake from food groups.

5.5 Recommendations

The following recommendations are proposed for further research based on this study's main findings:

(i) The environment and nutrition knowledge sources should be examined before the knowledge questionnaire or tool is developed. This will determine the nutrition content for the specific age group, the type of nutrition education covered, and the approaches used for the delivery of nutrition messages.

(ii) More research on developmental differences in nutrition knowledge during early childhood should be carried out for the development of suitable appropriate nutrition knowledge assessment tools.

(iii) More cross-sectional research focusing on nutrition knowledge and dietary intake of the same age group need to be carried out. The research must include bigger sample sizes (nationally representative), different ethnicities for heterogeneity of food intake and should be carried out in various settings (rural, township and urban).

The following recommendations are proposed for implementation in schools based on the findings:

(a) It is recommended to strengthen nutrition education in schools specifically with more focus on delivery methods and age specific content in the first few school grades.

References

Abrahams, Z., De Villiers, A., Steyn, N.P., Fourie, J., Dalais, L., Hill, J., Draper, C.E. & Lambert, E.V. 2011. What's in the lunchbox? Dietary behaviour of learners from disadvantaged schools in the Western Cape, South Africa. *Public health nutrition*, 14(10):1752-1758.

Anliker, J.A., Laus, M.J., Samonds, K.W. & Beal, V.A. 1992. Mothers' reports of their three-year-old children's control over foods and involvement in food-related activities. *Journal of nutrition education*, 24(6):285-291.

Anzman, S.L., Rollins, B.Y. & Birch, L.L. 2010. Parental influence on children's early eating environments and obesity risk: implications for prevention. *International journal of obesity*, 34(7):1116.

Asakura, K., Todoriki, H. & Sasaki, S. 2017. Relationship between nutrition knowledge and dietary intake among primary school children in Japan: Combined effect of children's and their guardians' knowledge. *Journal of epidemiology*, 27(10):483-491.

Atay, Z. & Bereket, A. 2016. Current status on obesity in childhood and adolescence: Prevalence, etiology, co-morbidities and management. *Obesity medicine*, 3:1-9.

Bandura, A. 1991. Social cognitive theory of self-regulation. *Organizational behavior and human decision processes*, 50(2):248-287.

Berkman, N.D., Sheridan, S.L., Donahue, K.E., Halpern, D.J. & Crotty, K. 2011. Low health literacy and health outcomes: an updated systematic review. *Annals of internal medicine*, 155(2):97-107.

Beydoun, M.A. & Wang, Y. 2008. Do nutrition knowledge and beliefs modify the association of socio-economic factors and diet quality among US adults? *Preventive medicine*, 46(2):145-153.

Beydoun, M.A., Powell, L.M. & Wang, Y. 2009. Reduced away-from-home food expenditure and better nutrition knowledge and belief can improve quality of dietary intake among US adults. *Public health nutrition*, 12(3):369-381.

Black, R.E., Victora, C.G., Walker, S.P., Bhutta, Z.A., Christian, P., De Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J. & Martorell, R. 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, 382(9890):427-451.

Blaylock, J., Variyam, J.N. & Lin, B.-H. 1999. Maternal nutrition knowledge and children's diet quality and nutrient intakes: US Department of Agriculture, ERS.

Bonaccio, M., Di Castelnuovo, A., Costanzo, S., De Lucia, F., Olivieri, M., Donati, M.B., de Gaetano, G., Iacoviello, L., Bonanni, A. & Investigators, M.-s.P. 2013. Nutrition knowledge is associated with higher adherence to Mediterranean diet and lower prevalence of obesity. Results from the Moli-sani study. *Appetite*, 68:139-146.

Bourne, L.T., Lambert, E.V. & Steyn, K. 2002. Where does the Black population of South Africa stand on the nutrition transition? *Public health nutrition*, 5(1a):157-162.

Burchi, F. 2010. Child nutrition in Mozambique in 2003: the role of mother's schooling and nutrition knowledge. *Economics & human biology*, 8(3):331-345.

Burrows, T.L., Martin, R.J. & Collins, C.E. 2010. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. *Journal of the American dietetic association*, 110(10):1501-1510.

Campbell, K.J., Abbott, G., Spence, A.C., Crawford, D.A., McNaughton, S.A. & Ball, K. 2013. Home food availability mediates associations between mothers' nutrition knowledge and child diet. *Appetite*, 71:1-6.

Caprio, S., Daniels, S.R., Drewnowski, A., Kaufman, F.R., Palinkas, L.A., Rosenbloom, A.L., Schwimmer, J.B. & Kirkman, M.S. 2008. Influence of race, ethnicity, and culture on childhood obesity: implications for prevention and treatment. *Obesity*, 16(12):2566-2577.

Carnell, S. & Wardle, J. 2008. Appetite and adiposity in children: evidence for a behavioral susceptibility theory of obesity. *The American journal of clinical nutrition*, 88(1):22-29.

Chaput, J.P., Klingenberg, L., Astrup, A. & Sjödin, A.M. 2011. Modern sedentary activities promote overconsumption of food in our current obesogenic environment. *Obesity reviews*, 12(5):e12-e20.

Covic, T., Roufeil, L. & Dziurawiec, S. 2007. Community beliefs about childhood obesity: its causes, consequences and potential solutions. *Journal of public health*, 29(2):123-131.

Daboné, C., Delisle, H. & Receveur, O. 2013. Predisposing, facilitating and reinforcing factors of healthy and unhealthy food consumption in schoolchildren: a study in Ouagadougou, Burkina Faso. *Global health promotion*, 20(1):68-77.

Dallongeville, J., Marécaux, N., Cottel, D., Bingham, A. & Amouyel, P. 2001. Association between nutrition knowledge and nutritional intake in middle-aged men from Northern France. *Public health nutrition*, 4(1):27-33.

Department of Basic Education, D.o.B. 2011. Report on the annual national assessments of 2011. DBE Pretoria

De Onis, M. 2006. WHO Child Growth Standards Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age. Methods and development. World Health Organization.

De Onis, M. 2009. Growth curves for school-age children and adolescents. *Indian pediatrics*, 46(6):463.

De Villiers, A. & Faber, M. 2015. The school food environment: shaping the future health of the nation: guest editorial. *South African journal of clinical nutrition*, 28(1):4-5.

De Villiers, A., Steyn, N.P., Draper, C.E., Fourie, J.M., Barkhuizen, G., Lombard, C.J., Dalais, L., Abrahams, Z. & Lambert, E.V. 2012. "HealthKick:" Formative assessment of the health environment in low-resource primary schools in the Western Cape Province of South Africa. *Biomed central public health*, 12(1):794.

De Vriendt, T., Matthys, C., Verbeke, W., Pynaert, I. & De Henauw, S. 2009. Determinants of nutrition knowledge in young and middle-aged Belgian women and the association with their dietary behaviour. *Appetite*, 52(3):788-792.

DeCosta, P., Møller, P., Frøst, M.B. & Olsen, A. 2017. Changing children's eating behaviour-A review of experimental research. *Appetite*, 113:327-357.

DeJesus, J.M., Du, K.M., Shutts, K. & Kinzler, K.D. 2019. How information about what is "healthy" versus "unhealthy" impacts children's consumption of otherwise identical foods. *Journal of experimental psychology: general*.

Dovey, T.M., Staples, P.A., Gibson, E.L. & Halford, J.C. 2008. Food neophobia and 'picky/fussy'eating in children: a review. *Appetite*, 50(2-3):181-193.

Ebbeling, C.B., Feldman, H.A., Osganian, S.K., Chomitz, V.R., Ellenbogen, S.J. & Ludwig, D.S. 2006. Effects of decreasing sugar-sweetened beverage consumption on body weight in adolescents: a randomized, controlled pilot study. *Pediatrics*, 117(3):673-680.

Faber, M., Laurie, S., Maduna, M., Magudulela, T. & Muehlhoff, E. 2014. Is the school food environment conducive to healthy eating in poorly resourced South African schools? *Public health nutrition*, 17(6):1214-1223.

Fahlman, M.M., Dake, J.A., McCaughtry, N. & Martin, J. 2008. A pilot study to examine the effects of a nutrition intervention on nutrition knowledge, behaviors, and efficacy expectations in middle school children. *Journal of school health*, 78(4):216-222.

Falciglia, G.A., Couch, S.C., Gribble, L.S., Pabst, S.M. & Frank, R. 2000. Food neophobia in childhood affects dietary variety. *Journal of the American dietetic association*, 100(12):1474-1481.

Feeley, A., Musenge, E., Pettifor, J.M. & Norris, S.A. 2012. Changes in dietary habits and eating practices in adolescents living in urban South Africa: The birth-to-twenty cohort. *Nutrition*, 28(7):e1-e6.

Feeley, A.B.B., Kahn, K., Twine, R. & Norris, S. 2011. Exploratory survey of informal vendor-sold fast food in rural South Africa. *South African journal of clinical nutrition*, 24(4):199-201.

Garver, W.S., Newman, S.B., Gonzales-Pacheco, D.M., Castillo, J.J., Jelinek, D., Heidenreich, R.A. & Orlando, R.A. 2013. The genetics of childhood obesity and interaction with dietary macronutrients. *Genes & nutrition*, 8(3):271-287.

Golan, M. & Crow, S. 2004. Parents are key players in the prevention and treatment of weight-related problems. *Nutrition reviews*, 62(1):39-50.

Gracey, D., Stanley, N., Burke, V., Corti, B. & Beilin, L. 1996. Nutritional knowledge, beliefs and behaviours in teenage school students. *Health education research*, 11(2):187-204.

Green, H., Siwajek, P. & Roulin, A. 2017. Use of nutrient profiling to identify healthy versus unhealthy snack foods and whether they can be part of a healthy menu plan. *Journal of nutrition & intermediary metabolism*, 9:1-5.

Grobbelaar, H.H., Napier, C. & Oldewage-Theron, W. 2013. Nutritional status and food intake data on children and adolescents in residential care facilities in Durban. *South African journal of clinical nutrition*, 26(1):29-36.

Grosso, G., Mistretta, A., Turconi, G., Cena, H., Roggi, C. & Galvano, F. 2013. Nutrition knowledge and other determinants of food intake and lifestyle habits in children and young adolescents living in a rural area of Sicily, South Italy. *Public health nutrition*, 16(10):1827-1836.

Grunert, K.G., Wills, J.M. & Fernández-Celemín, L. 2010. Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK. *Appetite*, 55(2):177-189.

Gupta, N., Goel, K., Shah, P. & Misra, A. 2012. Childhood obesity in developing countries: epidemiology, determinants, and prevention. *Endocrine reviews*, 33(1):48-70.

Harris, J.L., Bargh, J.A. & Brownell, K.D. 2009. Priming effects of television food advertising on eating behavior. *Health psychology*, 28(4):404.

Harris, M. 2012. The role of attitude and barriers on the implementation of a nutrition intervention in primary school children. Potchefstroom: NWU. (Thesis - MSc)

Harrison, F., Jennings, A., Jones, A., Welch, A., van Sluijs, E., Griffin, S. & Cassidy, A. 2013. Food and drink consumption at school lunchtime: the impact of lunch type and contribution to overall intake in British 9–10-year-old children. *Public health nutrition*, 16(6):1132-1139.

Hawkes, C., Smith, T.G., Jewell, J., Wardle, J., Hammond, R.A., Friel, S., Thow, A.M. & Kain, J. 2015. Smart food policies for obesity prevention. *The Lancet*, 385(9985):2410-2421.

Hoogenboom, B.J., Morris, J., Morris, C. & Schaefer, K. 2009. Nutritional knowledge and eating behaviors of female, collegiate swimmers. *North American journal of sports physical therapy*, 4(3):139.

Horgen, K., Choate, M. & Brownell, K. 2001. Television and children's nutrition. *Handbook of children and the media*:447-461.

Igumbor, E.U., Sanders, D., Puoane, T.R., Tsolekile, L., Schwarz, C., Purdy, C., Swart, R., Durão, S. & Hawkes, C. 2012. "Big food," the consumer food environment, health, and the policy response in South Africa. *PLoS medicine*, 9(7):e1001253.

Jang, S.Y. 2009. Associations of food insecurity, socioeconomic status, and type 2 diabetes among Mexican Americans and non-hispanic Whites in the United States. Rutgers University-Graduate School-New Brunswick. (Doctoral dissertation, Rutgers University-Graduate School-New Brunswick)

Kandiah, J. & Jones, C. 2002. Nutrition knowledge and food choices of elementary school children. *Early child development and care*, 172(3):269-273.

Kaphingst, K.M. & French, S. 2006. The role of schools in obesity prevention. *The future of children*, 16(1):109-142.

Kazianga, H., de Walque, D. & Alderman, H. 2014. School feeding programs, intrahousehold allocation and the nutrition of siblings: evidence from a randomized trial in rural Burkina Faso. *Journal of Development Economics*, 106:15-34.

Kearney, J. 2010. Food consumption trends and drivers. *Philosophical transactions of the royal society b: biological sciences*, 365(1554):2793-2807.

Keino, S., Plasqui, G., Ettyang, G. & van den Borne, B. 2014. Determinants of stunting and overweight among young children and adolescents in sub-Saharan Africa. *Food and nutrition bulletin*, 35(2):167-178.

Kelly, B., Halford, J.C., Boyland, E.J., Chapman, K., Bautista-Castaño, I., Berg, C., Caroli, M., Cook, B., Coutinho, J.G. & Effertz, T. 2010. Television food advertising to children: a global perspective. *American journal of public health*, 100(9):1730-1736.

Kelsey, J.L., Whittemore, A.S., Evans, A.S. & Thompson, W.D. 1996. Methods in observational epidemiology. Vol. 26: Monographs in Epidemiology and Biostatistics

Kelsey, M.M., Zaepfel, A., Bjornstad, P. & Nadeau, K.J. 2014. Age-related consequences of childhood obesity. *Gerontology*, 60(3):222-228.

Kickbusch, I. 2009. Health literacy: engaging in a political debate. *International journal of public health*, 54(3):131-132.

Kigaru, D.M.D., Loechl, C., Moleah, T., Macharia-Mutie, C. & Ndungu, Z.W. 2015. Nutrition knowledge, attitude and practices among urban primary school children in Nairobi City, Kenya: a KAP study. *BioMed central nutrition*, 1(1):44.

Kliemann, N., Wardle, J., Johnson, F. & Croker, H. 2016. Reliability and validity of a revised version of the General Nutrition Knowledge Questionnaire. *European journal of clinical nutrition*, 70(10):1174.

Klohe-Lehman, D.M., Freeland-Graves, J., Anderson, E.R., McDowell, T., Clarke, K.K., Hanss-Nuss, H., Cai, G., Puri, D. & Milani, T.J. 2006. Nutrition knowledge is associated with greater weight loss in obese and overweight low-income mothers. *Journal of the american dietetic association*, 106(1):65-75.

Koo, H., Lee, C., Hidayah, A.N. & Hazwani, A.N. 2018. Knowledge, attitudes and practices of schoolchildren toward whole grains and nutritional outcomes in Malaysia. *Appetite*, 123:256-263.

Kraak, V.I., Gootman, J.A. & McGinnis, J.M. 2006. Food marketing to children and youth: threat or opportunity?: *National academies press*.

Krebs, N.F., Himes, J.H., Jacobson, D., Nicklas, T.A., Guilday, P. & Styne, D. 2007. Assessment of child and adolescent overweight and obesity. *Pediatrics*, 120(Supplement 4):S193-S228.

Krešić, G., Kenđel Jovanović, G., Pavičić Žeželj, S., Cvijanović, O. & Ivezić, G. 2009. The effect of nutrition knowledge on dietary intake among Croatian university students. *Collegium antropologicum*, 33(4):1047-1056.

Kruger, H.S., Puoane, T., Senekal, M. & Van Der Merwe, M.-T. 2005. Obesity in South Africa: challenges for government and health professionals. *Public health nutrition*, 8(5):491-500.

Kruger, R., Kruger, H. & Macintyre, U. 2006. The determinants of overweight and obesity among 10-to 15-year-old schoolchildren in the North West Province, South Africa–the THUSA BANA (Transition and Health during Urbanisation of South Africans; BANA, children) study. *Public health nutrition*, 9(3):351-358.

Labadarios, D., Steyn, N., Maunder, E., MacIntyre, U. & Swart, R. 2001. The National Food Consumption Survey (NFCS)--children aged 1-9 years South Africa 1999. *South African journal of clinical nutrition*, 14(2):16.

Larson, N.I., Neumark-Sztainer, D.R., Story, M.T., Wall, M.M., Harnack, L.J. & Eisenberg, M.E. 2008. Fast food intake: longitudinal trends during the transition to young adulthood and correlates of intake. *Journal of adolescent health*, 43(1):79-86.

Laureati, M., Bergamaschi, V. & Pagliarini, E. 2014. School-based intervention with children. Peer-modeling, reward and repeated exposure reduce food neophobia and increase liking of fruits and vegetables. *Appetite*, 83:26-32.

Lobstein, T. & Davies, S. 2009. Defining and labelling 'healthy'and 'unhealthy'food. *Public health nutrition*, 12(3):331-340.

Lobstein, T. & Jackson-Leach, R. 2016. Planning for the worst: estimates of obesity and comorbidities in school-age children in 2025. *Pediatric obesity*, 11(5):321-325.

Lobstein, T., Jackson-Leach, R., Moodie, M.L., Hall, K.D., Gortmaker, S.L., Swinburn, B.A., James, W.P.T., Wang, Y. & McPherson, K. 2015. Child and adolescent obesity: part of a bigger picture. *The Lancet*, 385(9986):2510-2520.

Looney, S.M. & Raynor, H.A. 2012. Are changes in consumption of "healthy" foods related to changes in consumption of "unhealthy" foods during pediatric obesity treatment? *International journal of environmental research and public health*, 9(4):1368-1378.

Lwin, M.O., Shin, W., Yee, A.Z. & Wardoyo, R.J. 2017. A parental health education model of children's food consumption: Influence on children's attitudes, intention, and consumption of healthy and unhealthy foods. *Journal of health communication*, 22(5):403-412.

MacKeown, J.M., Pedro, T.M. & Norris, S.A. 2007. Energy, macro-and micronutrient intake among a true longitudinal group of South African adolescents at two interceptions (2000 and 2003): the Birth-to-Twenty (Bt20) Study. *Public health nutrition*, 10(6):635-643.

Maimaran, M. & Fishbach, A. 2014. If it's useful and you know it, do you eat? Preschoolers refrain from instrumental food. *Journal of consumer research*, 41(3):642-655.

Malik, V.S., Schulze, M.B. & Hu, F.B. 2006. Intake of sugar-sweetened beverages and weight gain: a systematic review–. *The American journal of clinical nutrition*, 84(2):274-288.

Mamba, N.P., Napoles, L. & Mwaka, N.M. 2019. Nutrition knowledge, attitudes and practices of primary school children in Tshwane Metropole, South Africa. *African journal of primary health care & family medicine*, 11(1):1-7.

McCain, M., Mustard, J. & McCuaig, K. 2011. Early years study 3: making decisions, taking action. Toronto, ON: *Margaret & Wallace McCain Family Foundation*;

McClain, A.D., Chappuis, C., Nguyen-Rodriguez, S.T., Yaroch, A.L. & Spruijt-Metz, D. 2009. Psychosocial correlates of eating behavior in children and adolescents: A review. *International journal of behavioral nutrition and physical activity*, 6(1):54.

Mchiza, Z. & Maunder, E. 2013. Fighting childhood obesity. *South African journal of clinical nutrition*, 26(3):100-102.

Mchiza, Z.J., Goedecke, J.H. & Lambert, E.V. 2011. Intra-familial and ethnic effects on attitudinal and perceptual body image: a cohort of South African mother-daughter dyads. *Biomed central public health,* 11(1):433.

Mchiza, Z.J., Temple, N.J., Steyn, N.P., Abrahams, Z. & Clayford, M. 2013. Content analysis of television food advertisements aimed at adults and children in South Africa. *Public health nutrition*, 16(12):2213-2220.

McLeod, E.R., Campbell, K.J. & Hesketh, K.D. 2011. Nutrition knowledge: a mediator between socioeconomic position and diet quality in Australian first-time mothers. *Journal of the American dietetic association*, 111(5):696-704.

McPherson, R.S., Hoelscher, D.M., Alexander, M., Scanlon, K.S. & Serdula, M.K. 2000. Dietary assessment methods among school-aged children: validity and reliability. *Preventive medicine*, 31(2):S11-S33.

Miller, L.M.S. & Cassady, D.L. 2015. The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*, 92:207-216.

Moore, L. & Tapper, K. 2008. The impact of school fruit tuck shops and school food policies on children's fruit consumption: a cluster randomised trial of schools in deprived areas. *Journal of epidemiology & community health*, 62(10):926-931.

Neumark-Sztainer, D., Croll, J., Story, M., Hannan, P.J., French, S.A. & Perry, C. 2002. Ethnic/racial differences in weight-related concerns and behaviors among adolescent girls and boys: findings from Project EAT. *Journal of psychosomatic research*, 53(5):963-974.

Nguyen, S.P. 2007. An apple a day keeps the doctor away: Children's evaluative categories of food. *Appetite*, 48(1):114-118.

Nicklas, T.A., Baranowski, T., Cullen, K.W. & Berenson, G. 2001. Eating Patterns, Dietary Quality and Obesity. *Journal of the American college of nutrition*, 20(6):599-608.

Nyathela, T. & Oldewage-Theron, W. 2017. Nutritional status and food consumption patterns of primary school children in Orange Farm. *African journal of food, agriculture, nutrition and development*, 17(1):11497-11517.

Ogden, C., Carroll, M.D., Curtin, L.R., Lamb, M.M. & Flegal, K.M. 2010. About childhood obesity. *The journal of the American medical association*, 303(3):242-249.

Ogden, C.L., Kit, B.K., Carroll, M.D. and Park, S., 2011. Consumption of sugar drinks in the United States, 2005-2008 (p. 71). Hyattsville, MD: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics.

Okan, O., Lopes, E., Bollweg, T.M., Bröder, J., Messer, M., Bruland, D., Bond, E., Carvalho, G.S., Sørensen, K. & Saboga-Nunes, L. 2018. Generic health literacy measurement instruments for children and adolescents: a systematic review of the literature. *BioMed central public health*, 18(1):166.

Oldewage-Theron, W., Egal, A. & Moroka, T. 2015. Nutrition knowledge and dietary intake of adolescents in Cofimvaba, Eastern Cape, South Africa. *Ecology of food and nutrition*, 54(2):138-156.

Oldewage-Theron, W.H. & Egal, A.A. 2010. Nutrition knowledge and nutritional status of primary school children in QwaQwa. *South African journal of clinical nutrition*, 23(3).

Oosthuizen, D., Oldewage-Theron, W.H. & Napier, C. 2011. Impact of a nutrition education programme on the nutrition knowledge of primary school children: nutrition and health. *African journal for physical health education, recreation and dance*, 17(1):141-155.

Papoutsi, G.S., Drichoutis, A.C. & Nayga Jr, R.M. 2013. The causes of childhood obesity: A survey. *Journal of economic surveys*, 27(4):743-767.

Parmenter, K. & Wardle, J. 1999. Development of a general nutrition knowledge questionnaire for adults. *European journal of clinical nutrition*, 53(4):298.

Parmenter, K., Waller, J. & Wardle, J. 2000. Demographic variation in nutrition knowledge in England. *Health education research*, 15(2):163-174.

Patrick, H. & Nicklas, T.A. 2005. A review of family and social determinants of children's eating patterns and diet quality. *Journal of the American college of nutrition*, 24(2):83-92.

Pearson, N. & Biddle, S.J. 2011. Sedentary behavior and dietary intake in children, adolescents, and adults: a systematic review. *American Journal of preventive medicine*, 41(2):178-188.

Pedro, T.M., MacKeown, J.M. & Norris, S.A. 2008. Variety and total number of food items recorded by a true longitudinal group of urban Black South African children at five interceptions between 1995 and 2003: the Birth-to-Twenty (Bt20) Study. *Public health nutrition*, 11(6):616-623.

Pérez-Rodrigo, C. & Aranceta, J. 2001. School-based nutrition education: lessons learned and new perspectives. *Public health nutrition*, 4(1a):131-139.

Pienaar, A.E. 2015. Prevalence of overweight and obesity among primary school children in a developing country: NW-CHILD longitudinal data of 6–9-yr-old children in South Africa. *Biomed central obesity*, 2(1):2.

Pieniak, Z., Verbeke, W. & Scholderer, J. 2010. Health-related beliefs and consumer knowledge as determinants of fish consumption. *Journal of human nutrition and dietetics*, 23(5):480-488.

Pillai, A., Kinabo, J. & Krawinkel, M.B. 2016. Effect of nutrition education on the knowledge scores of urban households with home gardens in Morogoro, Tanzania. *Agriculture & food security*, 5(1):22.

Popkin, B.M. 2004. The nutrition transition: an overview of world patterns of change. *Nutrition reviews*, 62(suppl_2):S140-S143.

Popkin, B.M. 2011. Contemporary nutritional transition: determinants of diet and its impact on body composition. *Proceedings of the Nutrition Society*, 70(1):82-91.

Popkin, B.M., Adair, L.S. & Ng, S.W. 2012. Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition reviews*, 70(1):3-21.

Poskitt, E.M.E. 2014. Childhood obesity in low- and middle-income countries. *Paediatrics and international child health*, 34(4):239-249.

Powers Raby, Struempler Alicia, Guarino Barbara J, Parmer Anthony & M, S. 2005. Effects of a nutrition education program on the dietary behavior and nutrition knowledge of second-grade and third-grade students. *Journal of school health*, 75(4):129-133.

Punyanitya, M. & Clark, P.R. 2015. Translational Research Methods for Diabetes, Obesity and Cardiometabolic Drug Development. Springer. p. 139-167.

Rankin, J., Matthews, L., Cobley, S., Han, A., Sanders, R., Wiltshire, H.D. & Baker, J.S. 2016. Psychological consequences of childhood obesity: psychiatric comorbidity and prevention. *Adolescent health, medicine and therapeutics,* 7:125.

Rash, C.L., Malinauskas, B.M., Duffrin, M.W., Barber-Heidal, K. & Overton, R.F. 2008. Nutrition-related knowledge, attitude, and dietary intake of college track athletes. *Sport journal*, 11(1):48-55.

Reddy, S., Panday, S., Swart, D., Jinabhai, C., Amosun, S., James, S., Monyeki, K., Stevens, G., Morejele, N. & Kambaran, N. 2010. Umthenthe uhlaba usamila–The South African Youth Risk Behaviour survey 2002. Cape Town: South African Medical Research Council, 20.

Reddy, S., Resnicow, K., James, S., Kambaran, N., Omardien, R. & Mbewu, A. 2009. Underweight, overweight and obesity among South African adolescents: results of the 2002 National Youth Risk Behaviour Survey. *Public health nutrition*, 12(2):203-207.

Reddy, S.P., Resnicow, K., James, S., Funani, I.N., Kambaran, N.S., Omardien, R.G., Masuka, P., Sewpaul, R., Vaughan, R.D. & Mbewu, A. 2012. Rapid increases in overweight and obesity among South African adolescents: comparison of data from the South African National Youth Risk Behaviour Survey in 2002 and 2008. *American journal of public health*, 102(2):262-268.

Rodríguez, G. & Moreno, L.A. 2006. Is dietary intake able to explain differences in body fatness in children and adolescents? *Nutrition, metabolism and cardiovascular diseases*, 16(4):294-301.

Rolland-Cachera, M.F. 2011. Childhood obesity: current definitions and recommendations for their use. *International journal of pediatric obesity*, 6(5-6):325-331.

Ronquest-Ross, L.-C., Vink, N. & Sigge, G.O. 2015. Food consumption changes in South Africa since 1994. *South African journal of science*, 111(9-10):01-12.

Rosenheck, R. 2008. Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk. *Obesity reviews*, 9(6):535-547.

Sahoo, K., Sahoo, B., Choudhury, A.K., Sofi, N.Y., Kumar, R. & Bhadoria, A.S. 2015. Childhood obesity: causes and consequences. *Journal of family medicine and primary care*, 4(2):187.

Sahota, P., Rudolf, M.C., Dixey, R., Hill, A.J., Barth, J.H. & Cade, J. 2001. Randomised controlled trial of primary school based intervention to reduce risk factors for obesity. *British medical journal.* 323(7320):1029.

Said, N. & Mohamed, R. 2017. Impact of the nutritional educational program to the healthy food behaviour, knowledge, attitude and environment for obese children. *Environment-behaviour proceedings journal*, 2(5):1-7.

Savage, J.S., Fisher, J.O. & Birch, L.L. 2007. Parental influence on eating behavior: conception to adolescence. *The Journal of law, medicine & ethics*, 35(1):22-34.

Scaglioni, S., De Cosmi, V., Ciappolino, V., Parazzini, F., Brambilla, P. & Agostoni, C. 2018. Factors influencing children's eating behaviours. *Nutrients*, 10(6):706.

Shah, P., Misra, A., Gupta, N., Hazra, D.K., Gupta, R., Seth, P., Agarwal, A., Gupta, A.K., Jain, A. & Kulshreshta, A. 2010. Improvement in nutrition-related knowledge and behaviour of urban Asian Indian school children: findings from the 'Medical education for children/Adolescents for Realistic prevention of obesity and diabetes and for healthy aGeing'(MARG) intervention study. *British journal of nutrition*, 104(3):427-436.

Shariff, M.Z., Lin, K.G., Sariman, S., Lee, H.S., Siew, C.Y., Yusof, M., Nisak, B., Mun, C.Y. & Mohamad, M. 2015. The relationship between household income and dietary intakes of 1-10 year old urban Malaysian. *Nutrition research and practice*, 9(3):278-287.

Sharma, S.V., Gernand, A.D. & Day, R.S. 2008. Nutrition knowledge predicts eating behavior of all food groups except fruits and vegetables among adults in the Paso del Norte region: Qué Sabrosa Vida. *Journal of nutrition education and behavior*, 40(6):361-368.

Simmonds, M., Llewellyn, A., Owen, C. & Woolacott, N. 2016. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obesity reviews*, 17(2):95-107.

Singh, A.S., Mulder, C., Twisk, J.W., Van Mechelen, W. & Chinapaw, M.J. 2008. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obesity reviews*, 9(5):474-488.

South Africa. Department of Basic Education. 2011. Report on the Annual National Assessments of 2011: Pretoria.

Stewart, A., Marfell-Jones, M., Olds, T. & 7 De Ridder, H. 2011. International Standards for Anthropometric Assessment. (ISAK). New Zealand*: Lower Hutt*.

Steyn, N.P., Labadarios, D. & Nel, J.H. 2011. Factors which influence the consumption of street foods and fast foods in South Africa - a national survey. *Nutrition journal*, 10(1):104.

Steyn, N.P., Mchiza, Z., Hill, J., Davids, Y.D., Venter, I., Hinrichsen, E., Opperman, M., Rumbelow, J. & Jacobs, P. 2014. Nutritional contribution of street foods to the diet of people in developing countries: a systematic review. *Public health nutrition*, 17(6):1363-1374.

St-Onge, M.-P., Keller, K.L. & Heymsfield, S.B. 2003. Changes in childhood food consumption patterns: a cause for concern in light of increasing body weights. *The American journal of clinical nutrition*, 78(6):1068-1073.

Story, M., Kaphingst, K.M., Robinson-O'Brien, R. & Glanz, K. 2008. Creating healthy food and eating environments: policy and environmental approaches. Annual Review*. Public health*, 29:253-272.

Sullivan, K.M., Dean, A. & Soe, M.M. 2009. On Academics: OpenEpi: A Web-Based Epidemiologic and Statistical Calculator for Public Health. *Public health reports*, 124(3):471-474.

Swinburn, B.A., Kraak, V.I., Allender, S., Atkins, V.J., Baker, P.I., Bogard, J.R., Brinsden, H., Calvillo, A., De Schutter, O. & Devarajan, R. 2019. The global syndemic of obesity, undernutrition, and climate change: The Lancet Commission report. *The Lancet*, 393(10173):791-846.

Swinburn, B.A., Sacks, G., Hall, K.D., McPherson, K., Finegood, D.T., Moodie, M.L. & Gortmaker, S.L. 2011. The global obesity pandemic: shaped by global drivers and local environments. *The Lancet*, 378(9793):804-814.

Tabbakh, T. & Freeland-Graves, J.H. 2016. The home environment: A mediator of nutrition knowledge and diet quality in adolescents. *Appetite*, 105:46-52.

Taljaard, C., Covic, N.M., Van Graan, A.E., Kruger, H.S., Smuts, C.M., Baumgartner, J., Kvalsvig, J.D., Wright, H.H., Van Stuijvenberg, M.E. & Jerling, J.C. 2013. Effects of a multi-micronutrient-fortified beverage, with and without sugar, on growth and cognition in South African schoolchildren: a randomised, double-blind, controlled intervention. *British journal of nutrition*, 110(12):2271-2284.

Talma, H., Chinapaw, M.J., Bakker, B., HiraSing, R.A., Terwee, C.B. & Altenburg, T.M. 2013. Bioelectrical impedance analysis to estimate body composition in children and adolescents: a systematic review and evidence appraisal of validity, responsiveness, reliability and measurement error. *Obesity reviews*, 14(11):895-905.

Tan, C., Luo, J., Zong, R., Fu, C., Zhang, L., Mou, J. & Duan, D. 2010. Nutrition knowledge, attitudes, behaviours and the influencing factors among non-parent caregivers of rural left-behind children under 7 years old in China. *Public health nutrition*, 13(10):1663-1668.

Tee, L., Laubscher, R., Botha, C. & Jerling, J. 2015. The intake and quality of breakfast consumption in adolescents attending public secondary schools in the North West Province, South Africa. *South African journal of clinical nutrition*, 28(2):81-88.

Temple, N.J. & Steyn, N.P. 2009. Food prices and energy density as barriers to healthy food patterns in Cape Town, South Africa. *Journal of hunger & environmental nutrition*, 4(2):203-213.

Temple, N.J. & Steyn, N.P. 2011. The cost of a healthy diet: A South African perspective. *Nutrition*, 27(5):505-508.

Thompson, F.E. & Subar, A.F. 2017. Nutrition in the Prevention and Treatment of Disease. *Elsevier*. p. 5-48.

Timperio, A., Ball, K., Roberts, R., Campbell, K., Andrianopoulos, N. & Crawford, D. 2008. Children's fruit and vegetable intake: associations with the neighbourhood food environment. *Preventive medicine*, 46(4):331-335.

Trakman, G.L., Forsyth, A., Hoye, R. & Belski, R. 2017. Developing and validating a nutrition knowledge questionnaire: Key methods and considerations. *Public health nutrition*, 20(15):2670-2679.

Vaitkevičiūtė, J. & Petrauskienė, A. 2019. The Associations between body mass index of seven- and eight-year-old children, dietary behaviour and nutrition-related parenting practices. *Medicina*, 55(1):24.

Valliant, M.W., Pittman Emplaincourt, H., Kieckhaefer Wenzel, R. & Garner, B.H. 2012. Nutrition education by a registered dietitian improves dietary intake and nutrition knowledge of a NCAA female volleyball team. *Nutrients*, 4(6):506-516.

Variyam, J.N., Blaylock, J.R., Smallwood, D.M. and Basiotis, P.P., 1998. *USDA's healthy eating index and nutrition information* (No. 1488-2016-124554).

Velardo, S. and Drummond, M., 2019. Qualitative insight into primary school children's nutrition literacy. *Health education*, 119(2):98-114.

Ventura, A.K. & Mennella, J.A. 2011. Innate and learned preferences for sweet taste during childhood. *Current opinion in clinical nutrition & metabolic care*, 14(4):379-384.

Vereecken, C. & Maes, L. 2010. Young children's dietary habits and associations with the mothers' nutritional knowledge and attitudes. *Appetite*, 54(1):44-51.

Vijayapushpam, T., Menon, K.K., Rao, D.R. and Antony, G.M., 2003. A qualitative assessment of nutrition knowledge levels and dietary intake of schoolchildren in Hyderabad. *Public health nutrition*, *6*(7), pp.683-688.

Vorster, H.H. 2010. The link between poverty and malnutrition: A South African perspective. *Health SA Gesondheid*, 15(1).

Vorster, H.H., Badham, J. & Venter, C. 2013. An introduction to the revised food-based dietary guidelines for South Africa. *South African journal of clinical nutrition*, 26(3):S5-S12.

Wadden, T.A., Brownell, K.D. & Foster, G.D. 2000. Obesity: responding to the global epidemic. *Journal of consulting and clinical psychology*, 70(3):510.

Walsh, M., Cartwright, L., Corish, C., Sugrue, S. & Wood-Martin, R. 2011. The body composition, nutritional knowledge, attitudes, behaviors, and future education needs of senior schoolboy rugby players in Ireland. *International journal of sport nutrition and exercise metabolism*, 21(5):365-376.

Wang, Y. & Lim, H. 2012. The global childhood obesity epidemic and the association between socio-economic status and childhood obesity: Taylor & Francis.

Wang, Y. & Lobstein, T. 2006. Worldwide trends in childhood overweight and obesity. *International journal of pediatric obesity*, 1(1):11-25.

Wang, Y.C., Bleich, S.N. & Gortmaker, S.L. 2008. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988–2004. *Pediatrics*, 121(6):e1604-e1614.

Wardle, J., Parmenter, K. & Waller, J. 2000. Nutrition knowledge and food intake. *Appetite*, 34(3):269-275.

WCRF. 2007. Food, nutrition, physical activity, and the prevention of cancer: a global perspective. (0972252223).

Webb, P. & Block, S. 2004. Nutrition information and formal schooling as inputs to child nutrition. *Economic development and cultural change*, 52(4):801-820.

Webber, L., Hill, C., Saxton, J., Van Jaarsveld, C. & Wardle, J. 2009. Eating behaviour and weight in children. *International journal of obesity*, 33(1):21.

Wells, J. & Fewtrell, M. 2006. Measuring body composition. *Archives of disease in childhood*, 91(7):612-617.

Wells, J., Fewtrell, M., Williams, J., Haroun, D., Lawson, M. & Cole, T. 2006. Body composition in normal weight, overweight and obese children: matched case–control analyses of total and regional tissue masses, and body composition trends in relation to relative weight. *International journal of obesity*, 30(10):1506.

Wen, L.M., Rissel, C. & He, G. 2017. The Effect of Early Life Factors and Early Interventions on Childhood Overweight and Obesity 2016. *Journal of Obesity*, 2017.

Wenhold, F.; Muehlhoff, E. & Kruger, H.S. 2015 Nutrition for school aged children. In Community Nutrition for Developing Countries; Temple, N., Steyn, N.P., Eds.; AU Press, Athabasca University: Edmonton, AB, Canada; UNISA: Pretoria, South Africa.

Wiles, N., Green, J. & Veldman, F. 2013. Tuck-shop purchasing practices of Grade 4 learners in Pietermaritzburg and childhood overweight and obesity. *South African journal of clinical nutrition*, 26(1):37-42.

World Health Organization 2018. World health statistics 2018: Monitoring health for the SDGs sustainable development goals: World Health Organization Geneva.

World Health Organization, 2006. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. World Health Organization Switzerland.

World Health Organization, 2008. Chronic diseases and health promotion: Global school-based student health survey (GSHS) purpose and methodology. World Health Organization Switzerland.

World Health Organization, 2009. Growth Reference Data for Children from 5 to 19 Years, Geneva*: www. who. int/growthref/en/.*

World Health Organization, 2008. Chronic diseases and health promotion: Global school-based student health survey (GSHS) purpose and methodology. World Health Organization Switzerland.

World Health Organization. 2016. Consideration of the evidence on childhood obesity for the Commission on Ending Childhood Obesity: report of the ad hoc working group on science and evidence for ending childhood obesity, Geneva, Switzerland.

Worsley, A. 2002. Nutrition knowledge and food consumption: can nutrition knowledge change food behaviour? *Asia Pacific journal of clinical nutrition*, 11(s3).

Yavuz, H.M., van Ijzendoorn, M.H., Mesman, J. & van der Veek, S. 2015. Interventions aimed at reducing obesity in early childhood: a meta-analysis of programs that involve parents. *Journal of child psychology and psychiatry*, 56(6):677-692.

Zhao, J. & Grant, S.F. 2011. Genetics of childhood obesity. *Journal of obesity*, 2011.

Zlatevska, N., Dubelaar, C. & Holden, S.S. 2014. Sizing up the effect of portion size on consumption: a meta-analytic review. *Journal of marketing*, 78(3):140-154.

Zoellner, J., Connell, C., Bounds, W., Crook, L. & Yadrick, K. 2009. Peer reviewed: nutrition literacy status and preferred nutrition communication channels among adults in the lower Mississippi Delta. *Preventing chronic disease*, 6(4).

Zurita-Ortega, F., Castro-Sanchez, M., Rodriguez-Fernandez, S., Cofre-Bolados, C., Chacon-Cuberos, R., Martinez-Martinez, A. & Muros-Molina, J. (2017). Physical activity, obesity and self-esteem in Chilean schoolchildren. *Revista medica de chile*, 145(3):299-308.

Annexures

Annexure A: Language editing certificate

Gill Smithies

Proofreading & Language Editing Services

59, Lewis Drive, Amanzimtoti, 4126, Kwazulu Natal

Cell: 071 352 5410 E-mail: moramist@vodamail.co.za

Work Certificate

To	P. Makore
Address	Centre of Excellence for Nutrition, North West University, Private Bag X6001, Potchefstroom.
Date	30/11/2019
Subject	Dissertation: The association between nutrition knowledge and intake of healthy and unhealthy foods in 6 to 8 years old South African children
Ref	GS/PM /01

I, Gill Smithies, certify that I have proofed the following for language, grammar and style,

Chapters 1 -5: The association between nutrition knowledge and intake of healthy and unhealthy foods in 6 to 8 years old South African children, by P. Makore

to the standard as required by NWU, Potchefstroom Campus.

Gill Smithies

Annexure B: BC-IT ethical approval

Private Bag X6001, Potchefstroom,
South Africa, 2520

Tel: (018) 299-4900
Faks: (018) 299-4910
Web: http://www.nwu.ac.za

Research Ethics Regulatory Committee
Tel: +27 18 299 4849

Email : Ethics@nwu.ac.za

ETHICS APPROVAL CERTIFICATE OF STUDY

Based on approval by **Health Research Ethics Committee (HREC)** on **22/02/2018**, the North-West University Research Ethics Regulatory Committee (NWU-RERC) hereby **approves** your study as indicated below. This implies that the NWU-RERC grants its permission that provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Body composition by isotope techniques and objectively assessed physical activity in 6–8 year-old children: BC-IT study

Study Leader: Prof MA Monyeki

Ethics number: N W U - 0 0 0 2 5 - 1 7 - A 1

Institution | Study Number | Year | Status

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application Type: Larger study

Commencement date: 19/04/2017 **Risk:** 2

Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special conditions of the approval (if applicable):

- Please provide the HREC with permission letters from the school governing bodies and the principals of the schools still outstanding, for approval before recruitment can begin.

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- *The study leader (principle investigator) must report in the prescribed format to the NWU-RERC via HREC:*
  - *annually (or as otherwise requested) on the monitoring of the study, and upon completion of the study*
  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any changes to the proposal be deemed necessary during the course of the study, the study leader must apply for approval of these amendments at the HREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility the NWU-RERC and HREC retains the right to:*
  - *request access to any information or data at any time during the course or after completion of the study;*
  - *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.*
  - *withdraw or postpone approval if:*
    - *any unethical principles or practices of the study are revealed or suspected,*
    - *it becomes apparent that any relevant information was withheld from the HREC or that information has been false or misrepresented,*
    - *the required amendments, annual (or otherwise stipulated) report and reporting of adverse events or incidents was not done in a timely manner and accurately,*
    - *new institutional rules, national legislation or international conventions deem it necessary.*
- *HREC can be contacted for further information or any report templates via Ethics-HRECApply@nwu.ac.za or 018 299 1206.*

The RERC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the RERC or HREC for any further enquiries or requests for assistance.

Yours sincerely

Prof. Refilwe Phaswana-Mafuya
Chair NWU Research Ethics Regulatory Committee (RERC)

Annexure C: Sub-Study ethical approval

Private Bag X1290, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Fax: 018 299-4910
Web: http://www.nwu.ac.za

Research Ethics Regulatory Committee
Tel: 018 299-4849
Email: nkosinathi.machine@nwu.ac.za

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the North West University Health Research Ethics Committee (NWU-HREC) on 22/11/2018, the NWU Health Research Ethics Committee hereby approves your study as indicated below. This implies that the North-West University Research Ethics Regulatory Committee (NWU-RERC) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: The association between nutrition knowledge and intake of healthy and unhealthy foods in 6-8 year-old South African children.
Study Leader/Supervisor (Principal Investigator)/Researcher: Prof HS Kruger
Student: PK Makore

Ethics number: N W U - 0 0 0 2 5 - 1 7 - A 1 - 0 1
Institution Study Number Year Status
Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application Type: Sub study
Commencement date: 2018/11/22 **Risk:** **Minimal**
Expiry date: 2019/11/30
Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of an annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special in process conditions of the research for approval (if applicable): None

General conditions:
While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:

- *The study leader/supervisor (principle investigator)/researcher must report in the prescribed format to the NWU-HREC:*
  - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*
  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the NWU-HREC, prior to*

1

implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.

- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility the NWU-RERC and NWU-HREC reserves the right to:*
  - *request access to any information or data at any time during the course or after completion of the study;*
  - *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
  - *withdraw or postpone approval if:*
    - *any unethical principles or practices of the study are revealed or suspected;*
    - *it becomes apparent that any relevant information was withheld from the NWU-HREC or that information has been false or misrepresented;*
    - *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
    - *new institutional rules, national legislation or international conventions deem it necessary.*
- *NWU-HREC can be contacted for further information or any report templates via Ethics-HRECApply@nwu.ac.za or 018 299 1206.*

The NWU-HREC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the NWU-HREC or the NWU-RERC for any further enquiries or requests for assistance.

Yours sincerely

Digitally signed by Wayne Towers
Date: 2018.12.04
18:13:14 +02'00'

Prof Wayne Towers
Chair NWU Health Research Ethics Committee

Current details: (22361930) M:\DSS1\8533\Monitoring and Reporting Cluster\Ethics\Certificates\Templates\Research Ethics Approval Letters\9.1.5.4.2 HREC Ethical Approval Letter.docm
3 December 2018

File reference: 9.1.5.4.2

Annexure D: District Education Department Research Approval

Education and Sport Development
Department of Education and Sport Development
Departement van Onderwys en Sport Ontwikkeling
Lefapha la Thuto le Tlhabololo ya Metshameko
NORTH WEST PROVINCE

8 O.R. Tambo Street, Potchefstroom
Private Bag X1256,
Potchefstroom 2520
Tel.: (018) 299-8216
Fax: (018) 294-8234
Enquiries: Mr H. Motara
e-mail: hmotara@nwpg.gov.za

DR KENNETH KAUNDA DISTRICT

OFFICE OF THE DISTRICT DIRECTOR

Enquiries: Mpiliso Tyatya	Tel:(018) 299 8307/ e-mail : ptyatya@nwpg.gov.za	Contact 082 317 4656

27 June 2017

To: **University of the North West**
Faculty of Health & Science
Physical Activity Sport & Recreation

Attention: **Prof. M. Monyeki (Principal Investigator)**
Prof. H. Moss (Director – PhASRec)

From: **Mr. H. Motara**
District Director

PERMISSION TO CONDUCT RESEARCH:
"Body Composition by Isotope Techniques and Objectively Assessed Physical Activity in 6 – 8 Year old Children: BC–IT Study."

We refer to your e-mailed correspondence regarding your request for permission to conduct research under the above-stated topic in primary schools around Dr. Kenneth Kaunda District.

Accordingly, permission is hereby granted for you to conduct the research as per your request, subject to the following provisions.

- That the onus to contact your target schools about your request and this subsequent letter of permission rests with your good self. Your Target Schools are: Dan Tlome, Pudulogo, Tshupane, Lesego, Potch and Keotshepile Primary Schools
- A parent-consent seeking process must be undertaken via the School Governing Bodies of affected schools, for learners identified to participate in the research.
- Considering that the research work will involve learners, it is requested that you ensure that the general functionality of affected schools is not compromised by the research project, or alternatively, a recovery plan be developed to recoup lost teaching time.
- Your research findings must be made available to the Department of Education & Sport Development in Dr. Kenneth Kaunda District upon request.
- The principle of confidentiality will be observed in its strictest terms in relation to information sourced from the research work conducted.

Thanking you

.....

Mr. H. Motara
District Director
Dr. Kenneth Kaunda District

2030 NDP

"Towards Excellence in Education and Sport Development"

Annexure E Parental Consent form

FORM 5

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

Health Research Ethics Committee
Faculty of Health Sciences
NORTH-WEST University
(Potchefstroom Campus)
2017 -09- 08

HREC Stamp

PARENTAL PERMISSION FORM FOR PARTICIPATION OF MY CHILD
My child is _____ years of age.

TITLE OF THE RESEARCH PROJECT: The Exercise, Arterial Modulation and Nutrition in Youth South Africa (ExAMIN Youth SA) study

REFERENCE NUMBERS: NWU-00091-16-A1

PRINCIPAL INVESTIGATOR: Prof Ruan Kruger

ADDRESS: North-West University, Hypertension in Africa Research Team (HART), Private Bag X6001, Potchefstroom, 2520

CONTACT NUMBER: 018 299 2904

Your child is being invited to take part in a research project investigating physical activity, nutrition and blood vessel health in children at the North-West University (Potchefstroom campus). Please take some time to read the information presented here, which will explain the details of this project. Please ask me any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how your child

could be involved. Also, your child's participation is entirely voluntary and he/she will be free to decline to participate. If you say no to your child's possible participation, this will not affect you or your child negatively in any way. Your child will are also be free to withdraw from the study at any point, even if your child had initially agreed to take part.

This study has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU-00091-16-A1) and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee members or relevant authorities to inspect the research records.

What is this research study all about?

- The ExAMIN Youth SA study is designed to explore the health of the blood vessels and how it is influenced by what your child eats and how active he/she is. This study has two phases:
  (i) baseline and
  (ii) follow-up after 4 years.
- In South Africa it is known that heart disease is a big problem and we would like to understand more about heart and blood vessel complications by using your child's data to contribute in our understanding of early changes that contribute to this health problem in our country.
- This study will be conducted in 1200 children (6-8 years of age) at the schools in a private room and will involve health tests of the heart and blood vessels, physical activity tests, questionnaires as well as urine and saliva sampling.
- Health researchers, trained in heart and blood vessel health, nutrition, physical activity and biomarkers will perform these non-invasive and painless measurements.

<u>What test will be done</u>?

- Body composition
  i. we will measure your child's height, weight, waist, hip and neck circumference in minimal clothing to not add more weight
  ii. we will measure the thickness of your child's skin on the back of the upper arm and the shoulder blade
  iii. we will attach four stickers (two on the hand and the other two on the foot), which will be linked to a tester to indicate how much water and fat is in your child's body
  iv. we will provide a small bottle of water that contains a safe tracer that can be picked up in saliva. Your child will be asked to provide a saliva sample to determine how much of the tracer was absorbed.

- Blood pressure will be measured on the right arm with a sleeve around the upper arm which inflates and detects the pressure in your child's blood vessels.
- Blood vessel health:
  i. We will test how stiff your child's blood vessels are with another cuff on the upper arm that will detect the speed blood travels.
  ii. We will take two photos of both your child's eyes to look at the blood vessels in the back of the eye.
- We will collect a urine (only once in the morning before participation in the privacy of your home) and saliva (once in the morning before 08:00 and also before and after the physical activity tests) sample to detect biochemical markers (biomarkers) relating to heart and blood vessel function and others markers related to diet and health to support the measurements described above.
- We will ask you to complete questionnaires on behalf of your child about your family (such as education of parents, employment, type of dwelling, etc.) and health behaviours (exercise and outdoor activities), also about the healthy and unhealthy foods your child eats, and stress exposure.
- We will also ask your child to do a few physical exercises in order to see how fit he/she is. These exercises include:
  i. two running tests to test speed and endurance
  ii. jumping sideward to test coordination and hand-ball coordination
  iii. balancing backwards test on 3m long beam
  iv. standing broad jump to test strength
- We will also give your child a small device to wear for seven days that will monitor his/her activity for a week, after which we will take the device and download the data.

The objectives of this research are:
We aim to investigate the links between blood vessel function, nutrition and physical fitness in 6–8-year-old children.

Objectives:

- To assess physical activity, nutrition and vascular phenotypes (the set of observable characteristics of an individual) in primary school children at baseline and after 4 years follow-up
- To investigate and compare the associations of physical activity, urinary biomarkers and 24-hour dietary recall with macro- and microvascular physiology (structure and function of big and small blood vessels)
- To determine if psychological stress also contribute to changes in nutrition behaviours, physical activity and blood vessel health

Your child has been invited as he/she:
- is between the ages of 6 and 8 years
- stays in Potchefstroom or surrounding areas

What will your child's responsibilities be?

Your child will be expected:

- To provide a urine sample (the first morning excretion) in the privacy of your own home and we will provide a small container and cooler bag in which we will collect the sample. We would be grateful if the urine sample could be sent to school in the morning of the day your child will be examined. We will collect the sample from school in the least inconvenient way by having the sample dropped off at the school offices.
- To not eat or drink anything (except water) on the day of participation. A meal will be provided after we have collected the saliva samples.
- To provide saliva into a small bottle three times. Once before 8am and then once before the physical activity tests and once after.
- To remove his/her shoes, socks and jacket for the body composition measurements. We will also measure the skinfolds of the upper arm and your child may need to remove his/her shirt. All these measurements may take about 10 minutes.
- We will also give your child a specific labelled water after which a saliva sample will be collected to test the absorption of the label in the water. This takes about 15 minutes and after 2 hours we will collect a saliva sample.
- We will attached an inflatable cuff on your child's arm to measure blood pressure and the stiffness of the blood vessels. All these measurements will take about 25 minutes.
- We will also take a picture of the blood vessels of the eye with an eye camera and may take about 7 minutes.
- Physical activity tests will be done as a group activity to test speed, flexibility, endurance, strength, coordination and balance. These tests will be done on Fridays and take about an hour to complete. They will receive a meal on this day also.
- Parents will be asked to complete various surveys for completeness of data.
- After 4 years, we would like to invite your child again to do all the same measurements again. This is to see if there have been any changes during the course of 4 years. We therefore, would like to keep in contact with you (via email, SMS or phone calls) during the waiting period of three years.

Will your child benefit from taking part in this research?

- There will be no direct benefits for your child to participate. However, the results of the study could provide new knowledge in an attempt to improve the heart and blood vessel health of children in South Africa.

- Your child will receive a free detailed health assessment including feedback in the form of a short report and direct referral to your nearest hospital, clinic or physician in the case of any incidental findings.
- Your child will also receive a meal when participating on his/her days of measurements.

Are there risks involved in your taking part in his research?

- The risks to you and your child in this study are minimal, but your child may feel uncomfortable giving a urine or saliva sample, but they will do this in their own privacy.
- There are more gains for your child in joining this study than there are risks.
- None of the measurements are painful, but your child will be requested to sit still while some of the measurements are being taken.

What will happen in the unlikely event of some form of discomfort occurring as a direct result of your taking part in this research study?

Should your child experience any distress, your child will be given the opportunity to either withdraw from the study or to take time out. You will also immediately be informed should your child be referred for assistance due to his/her distress.

Who will have access to the data?

- Your privacy will be respected by performing all the measurements in a private room and your data will be securely stored with only a number linked to your name.
- Your results will be kept confidential by keeping all data locked away in a strictly accessed controlled room, your data will also be kept saved with passwords on a computer which can only be accessed by the Data Manager of the study. Only the researchers and the Data Manager will have access to your coded data. The Principle Investigator will have the full detail in order to ensure follow-up communication to the research participant.
- Findings will be kept safe by locking hard copies in locked cupboards in the researcher's office and for electronic data it will be password protected. Data will be stored for 8 years.

What will happen with the data/samples?

- All documents with your data will be securely stored and urine/saliva samples will be stored in biofreezers for safekeeping until we can analyse the biomarkers.

- Biomarkers related to cardiovascular health will be analysed in the HART laboratory or overseas if we do not have the equipment to do so.
- In the event that urine or saliva samples need to be shipped abroad (this will be done only when facilities are not available in South Africa), the Principle Investigator will follow the correct procedure from the ethics office, Department of Health and all other relevant (legal) entities before this may occur.

Will you be paid to take part in this study and are there any costs involved?
No, your child will not be paid to take part in the study, and there will also be no costs involved for you either. I will provide refreshments after all the tests.

Is there anything else that you should know or do?

- You can contact Prof Ruan Kruger at 018 299 2904 (ruan.kruger@nwu.ac.za) if you have any further questions or have any problems.
- You can also contact the Health Research Ethics Committee via Mrs Carolien van Zyl at 018 299 1206 or carolien.vanzyl@nwu.ac.za if you have any concerns that were not answered about the research or if you have complaints about the research.
- You will receive a copy of this information and consent form for your own purposes.

How will you know about the findings?

- We will give you the results of this research when the study completes the first year's measurements by providing a health report for each participant.
- The findings of the research will be shared with you by means of a short feedback report including a summary of your individual measurements. The research publications obtained from the anonymous data will also be available on request.
- You will be informed of any new relevant findings by being contacted by our Research Nurse if there is any health concern.

Declaration by parent

By signing below, I ..... agree that my adolescent child may take part in a research study:

I declare that:

- I have read this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions to both the person obtaining consent, as well as the researcher and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and my child have not been pressurised to take part.
- My child may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- My child may be asked to leave the study before it has finished, if the researcher feels it is in my child's best interests, or if I or my child do not follow the study plan, as agreed to.

Signed at (*place*) ..... on (*date*) ..... 20....

.....	.....
Signature of parent	**Signature of witness**

Declaration by person obtaining parental permission

I *(name)* ..... declare that:

- I explained the information in this document to .....
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter.

Signed at (*place*) ..... on (*date*) ..... 20....

....

Signature of person obtaining permission **Signature of witness**

PLEASE TICK HERE indicating that verbal assent was obtained from the child (below 7years of age: | YES | NO |

Declaration by researcher

I *(name)* ..... declare that:

- I explained the information in this document to .....
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) ..... on (*date*) ..... 20....

.....	.....
Signature of researcher	**Signature of witness**

Annexure F: Child assent form

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

Health Research Ethics Committee
Faculty of Health Sciences
NORTH-WEST University
(Potchefstroom Campus)
2017 -09- 08

HREC Stamp

INFORMED WRITTEN ASSENT DOCUMENTATION FOR: The research participant (CHILD) between the ages of 7–8 years old

TITLE OF THE RESEARCH STUDY: The Exercise, Arterial Modulation and Nutrition in Youth South Africa (ExAMIN Youth SA) study

ETHICS REFERENCE NUMBERS: NWU-00091-16-A1

PRINCIPAL INVESTIGATOR: Prof Ruan Kruger

ADDRESS: North-West University
Hypertension in Africa Research Team (HART)
Private Bag X6001
Potchefstroom
2520

CONTACT NUMBER: 018 299 2904

You are being invited to take part in a **research study** that looks at exercise, healthy and unhealthy foods that you eat and health of the tubes in your body that carries blood in children. Please take some time to read this letter, which will explain everything about this study. Please ask the researcher or person explaining the research to you any questions about any part of this study that you do not understand. It is very important that you understand what this study is about and how you could be involved. Also remember that taking part in the study is up to you, which means that you choose to take part or not. If you do not want to take part, you do not have to. You should also know that you can leave the study at any time, even if you say now that you want to take part.

This **Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU-00091-16-A1) said that this study could take place and it will follow the rules that the country and the rest of the world says it must follow to protect you and what we collect today.** (Ethics in Health Research: Principles, Processes and Structures (DoH, 2015). This means that you will be treated

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with respect and we will keep you as safe as possible. What we collect today may be looked at by the people who said the study could take place (research ethics committee) or people who are allowed by the government to look at it.

What is this study all about?

- This study is wants to look at how healthy the tubes are in your body that carry your blood and how what you eat and how much exercise you do changes that. This study has two phases: (i) baseline (now) and (ii) follow-up after 4 years.
- There will be 1200 children (6-8 years of age) in the study.
- It will take place at the schools in a private room and we will do certain health tests of your heart and the tubes that carry your blood (like when you go to the doctor), tests to see how much you exercise, a list of questions about your life and we will ask you to give us some of your urine (pee) and saliva (spit).
- The people that will do all these tests have learnt how to do these tests at a university.

What test will be done?

- Body composition
  - i. we will measure how tall you are, how much you weigh, we will also measure your waist, hips and neck. We will ask you to take off your jacket, jersey or hat to measure you.
  - ii. we will measure the thickness of your skin on the back of the upper arm and the shoulder blade
  - iii. we will attach four stickers (two on your hand and the other two on your foot), which will be linked to a tester to indicate how much water and fat is in your body
  - iv. we will ask you to drink a small bottle of special water that contains an invisible dye that we will measure in your saliva (spit). You will be asked to give a saliva (spit) sample for us to measure how much of the dye was taken up in your body. This dye is completely safe.
- We will measure how hard your blood is pumping by putting a sleeve around your right upper arm.
- Health of the tubes that carry your blood:
  - i. We will test how stiff these tubes are with another cuff on your upper arm that will work out how fast your blood is pumping.
  - ii. We will take two photos of each of your eyes to look at the blood tubes in the back of your eyes.
- We will collect a urine (pee) and saliva (spit) sample to detect many things in your blood (called biochemical markers) that will tell us how healthy you are and what you have been eating.
- We will ask your parents to complete a set of questions about your family (such as where they went to school, their jobs and where they live, etc.) and what you eat or the type of exercises you do.
- We will also ask you to do some exercises for us to see how fit you are. These exercises include:
  - i. two running tests
  - ii. jumping sideward and playing with a ball
  - iii. balancing backwards on a 3m long beam
  - iv. standing broad jump to test how strong you are

  We will also give you a small machine to wear for seven days that will tell us how much move throughout the day.

What are we going to do with your test results?
Everything we collect will be kept in a locked cupboard or on a computer with a special password. Your name will also not be on anything we collect. We will rather use a special number that we will give you when we start the study. We want to just look at how what you eat and the amount of exercise you had affects the tubes that carry your blood through your body.

Why have you been invited to take part?

- You are 6, 7 or 8 years old.
- You live in or near Potchefstroom.

What will we want you to do?

- We will ask you to give us some of your urine (wee) from the first time you have a wee in the morning in a small cup, before you eat or drink anything. We will give you a bottle and a cooler box so that you can do this at home. You will then bring it with you to school when you come to take part in the study. We will get it from you at the school
- We also ask that you please not eat or drink anything (except water) on the day you will take part in the study. We will give you some food after we have collected your saliva (spit).
- We will ask you to give some spit in a small bottle three times during the day This will be once before 8 o'clock in the morning and then once before the exercise tests and once after.
- We will ask you to take off your shoes, socks and jacket when we measure how tall you are and how much you weigh. We will also measure your skin on your upper arms and you may need to take off your shirt. We will do this in a separate room and your mom and dad can sit in with us if they want.
- We will also give you a special kind of water to drink and then we will ask you to give us some of your saliva (spit) to test how much of the water your body took up.
- We will put a cuff (sling) on your right arm to measure how strong your blood is flowing and how stiff the tubes are that carry your blood.
- We will also take a pictures of your eyes to see the blood vessels in your eyes with a special eye camera.
- We will ask you to do exercise tests in a group to test how fast you can run, how long you can run, how strong you are and if you have good balance.
- We will ask your parents to complete various questions about your family and your health.
- After 4 years, we would like to invite you again to do all the same tests again. This is to see if there have been any changes over 4 years. We therefore, would like to keep in contact with you during the waiting period of three years.

Will you benefit from taking part in this research?

- If you take part in this study you will get a free check-up like when you go to the doctor.
- You will help us to find out how we can make children in South Africa healthier especially their hearts.
- You will also receive a meal and juice box when take part on your day of measurements.

Are there any bad things that can happen while taking part in this research and what will be done to prevent them?

- There are very few bad things that might happen, but you might feel uncomfortable when you give us some urine (pee) or saliva (spit)
- There are more good things for you in joining this study than there are bad things.
- None of the tests are sore, but you will be asked to sit still while some of the measurements are being taken.

How will we protect your results and who will see your data?

- We will give you a specific number so that no one can tell that the data came from you.
- Your privacy will be respected by doing all the tests in a private room and your data will be stored with only a number linked to your name.
- Your results will be kept private by keeping all data locked away in a locked room and kept safe with passwords on a computer which can only be accessed by the Data Manager of the study. Only the researchers and the Data Manager will have access to your data. The Principle Investigator will have the full detail in order to communicate with you for the 4 year follow-up study.
- Your data will be stored for 8 years.

What will happen with the findings or samples?

- The findings of this study will be used in future research of postgraduate students projects, as well as when we collect the follow-up data in 4 years.
- The Health Research Ethics Committee of the university will have to say if other studies can take place with what we find in this study, before data may be used.
- Your information will be stored and urine (pee) /saliva (spit) samples will be stored in biofreezers for safekeeping until we can analyse the biomarkers.
- Biomarkers of your heart and tubes carrying your blood will be tested for in the HART laboratory or in another country, if we do not have the equipment to do so.
- In the event that urine (wee) or saliva (spit) samples need to be sent overseas, the Principle Investigator will follow the correct procedure from the ethics office, Department of Health and all other relevant (legal) entities before this may happen.

How will you know about the results of this research?

- We will give you the results of this research when the study completes the first year's measurements by providing a health report.
- The findings of the study will be shared with you by means of a short feedback report including a summary of your individual measurements. The research publications obtained from the anonymous data will also be available on request.
- You will be informed of any new relevant findings by being contacted by our Research Nurse if there is any health concern.

Will you be paid to take part in this study and are there any costs for you?

No you will not be paid to take part in the study because there is no direct cost to you involved to take part in the study.

Is there anything else that you should know or do?

- You can phone Prof Ruan Kruger at 018 299 2904 (ruan.kruger@nwu.ac.za) if you have any questions or have any problems.
- You can also phone the Health Research Ethics Committee via Mrs Carolien van Zyl at 018 299 1206 or carolien.vanzyl@nwu.ac.za if you have any problems about the research.
- You will receive a copy of this form.

Declaration by participant (above 7 years)

By signing below, I ..... agree to take part in the research study titled: The Exercise, Arterial Modulation and Nutrition in Youth South Africa (ExAMIN Youth SA) study

I declare that:

- I have read this information/it was explained to me by a trusted person in a language with which I am fluent and comfortable.
- The research was clearly explained to me.
- I have had a chance to ask questions to both the person getting the consent from me, as well as the researcher and all my questions have been answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be handled in a negative way if I do so.
- I may be asked to leave the study before it has finished, if the researcher feels it is in the best interest, or if I do not follow the study plan, as agreed to.
- I agree that my urine and saliva samples can be stored and analysed and also be sent abroad for analyses that cannot be performed in South Africa.

Signed at (*place*) ..... on (*date*) ..... 20....

.....	.....
Signature of participant	**Signature of witness**

Assent by participant (younger than 7 years)

Write your name below if you agree to take part in the Exercise, Arterial Modulation and Nutrition in Youth South Africa (ExAMIN Youth SA) study

I declare that:

1. **I understand what this study is about and know how to contact the investigators if I want to.**
2. **I understand that body fluids (urine (wee) and saliva (spit)) will be collected from me and that tests will be done.**
3. **I understand that all the information given to the investigators and all test results will be kept private and confidential.**
4. **I understand that I will not get any money from this study apart from money for the transport on the days that I take part in the study.**
5. **I understand that I am free to withdraw myself from this study if I want to.**
6. **I may be contacted to participate after 4 years for the follow up study.**

.....

Tick the option you choose:

I agree that my urine can be stored after the project is completed, but it is anonymised with all possible links to my identity removed. I also agree that the researchers may sent my urine to laboratories in South Africa or internationally for additional research in this or a related field.	**Yes**	**No**

Please let the child choose by crossing their option below:

How I feel about the study	Description	My choice is:
	YES, I really want to take part in this study and understand all the information explained to me by my parents and the researchers.	
	I DON'T KNOW, I am not sure if I want to take part because I still have questions and want to learn more about the study before I decide.	
	NO, I do not like this study and wish to not take part in this study.	

Signed at (*place*) ..... on (*date*) .....20.....

....

Name of participant **Signature of witness**

Declaration by person obtaining consent

I *(name)* ..... declare that:

- I clearly and in detail explained the information in this document to

  .....
- I did/did not use an interpreter.
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I gave him/her time to discuss it with others if he/she wished to do so.
- I give permission for my child to participate in this study.

Signed at (*place*) ..... on (*date*) ..... 20....

.....	.....
Signature of person obtaining consent	**Signature of witness**

PLEASE TICK HERE indicating that verbal assent was obtained from the child (below 7years of age: | YES | NO |

Declaration by researcher

I *(name)* ..... state that:

- I had the information in this document explained by .... who I trained for this purpose.
- I did/did not use an interpreter
- I was available should he/she want to ask any further questions.
- The informed consent was obtained by an independent person.
- I am satisfied that he/she adequately understands all aspects of the research, as described above.
- I am satisfied that he/she had time to discuss it with others if he/she wished to do so.

Signed at (*place*) ..... on (*date*) ..... 20....

.....	.....
Signature of researcher	**Signature of witness**

Annexure G: Demographic and Nutrition Knowledge Questionnaire

BC-IT STUDY DEMOGRAPHIC INFORMATION, DIETARY QUESTIONNAIRE AND KNOWLEDGE ON FOOD

Country _____ Country code _____

Name of school _____ School Number _____

Name of interviewer _____ Date_____(dd/mm/yyyy)

Questionnaire 4-digit ID _____ Class/Grade _____

Section A: Tell us about you and your family

We would like to learn more about you and your family. Please answer all questions. Remember that there are no right or wrong answers, and that every person is different. We will not share any of your personal information with anyone else, and all of your answers will remain private.

1. Participant number: _____

(Write your name in full, do not use abbreviations)

2. Are you a boy or a girl? (tick one) ☐ Boy ☐ Girl
3. How old are you? _____ Years
4. Including yourself, how many people currently live in your home? _____
5. 5. How many rooms are there in your house? _____ rooms

(Including rooms like the kitchen, lounge/sitting room, bedrooms and any outside structures; do not include bathrooms)

6. In your home, what is the main source of water? (tick one)

☐ Indoor tap water

☐ Outside tap water

☐ Other water source

7. What kind of toilet do you usually use at home?

☐ Flush toilet inside the house

☐ Flush toilet outside the house

☐ Pit latrine/bucket

☐ Other type, Specify _____

8. Tick all items that you have in your home now?

Household items	✓ if Yes
Electricity	
Television	
Radio	
Car/motorbike	
Bicycle	
Fridge/refrigerator	
Washing machine	
Telephone/Cell phone	
Computer	
Satellite dish/cable	
Microwave oven	

9. What is used for cooking in your home? **You can circle more than one.**

- ☐ Gas
- ☐ Electricity
- ☐ Wood
- ☐ Charcoal
- ☐ Paraffin stove
- ☐ Other, specify _____

b) Does your mother/guardian work? ☐ Yes ☐ No
If yes, what type of work does she do? _____

c) Does your father/guardian work? ☐ Yes ☐ No
If yes, what type of work does he do? _____

Section B. Healthy habits

d) When you eat too much fat you can become fat

1. Agree
2. Neutral

3. Disagree

e) Fruits are a healthy snack

1. Agree
2. Neutral
3. Disagree

f) I do not have to worry about the kind of foods I eat because I am still young

1. Agree
2. Neutral
3. Disagree

g) I do not like sport/physical activity/conducting chores around the house

1. Agree
2. Neutral
3. Disagree

h) It is important to do sport/exercise every day in order to keep your body healthy

1. Agree
2. Neutral
3. Disagree

Lifestyle and Health

1. In the last 7 days, did you eat in front of the television/computer?

Yes		No		Sometimes (2-3 times per week)	

2. In the last 7 days did you eat your main meal with your family?

Yes		No		Sometimes (2-3 times per week)	

3. In the past 7 days did you eat breakfast before school?

Yes		No		Sometimes (2-3 times per week)	

If no, is it difficult for you to eat breakfast at home because:

3.1 the people at home do not eat breakfast?

Yes		No	

3.2 there is no food in the house to eat for breakfast?

Yes		No	

4. In the past 7 days did you bring a lunchbox to school?

Yes		No		Sometimes (2-3 times per week)	Not allowed lunchboxes at school

4.1 Is it difficult for you to take a lunchbox to school because other children will want your food?

Yes		No		Sometimes (2-3 times per week)	

4.2 Is it difficult for you to take a lunchbox to school because there is nothing at home to put in your lunchbox?

Yes		No		Sometimes (2-3 times per week)	

4.3 Is it difficult for you to take a lunchbox to school because no one at home can help you to make a lunchbox?

Yes		No		Sometimes (2-3 times per week)	

4.4 Do you share or exchange what you have in your lunchbox with friends?

Yes		No		Sometimes (2-3 times per week)	

5. How many days in the last 7 days do you bring money to school?

Every day (5 days)		2-3 times/wk	Never

6. In the past 7 days did you buy anything from the tuck shop/school canteen/vendor?

Yes		No		Sometimes (2-3 times per week)	

7. Do you participate in the school feeding scheme?/Do you receive lunch (a meal) from your school every day?

Yes		No		Sometimes (2-3 times per week)	

8. In the past 7 days did you eat fruit?

Yes		No	

9. If you do eat fruit, why do you eat them?

9.1 because you like the taste?

_____

Yes		No		Sometimes (2-3 times per week)	

9.2 because people at home eat fruit

Yes		No		Sometimes (2-3 times per week)	

9.3 because you are told to eat them

Yes		No		Sometimes (2-3 times per week)	

10. In the past 7 days did you eat vegetables?

Yes		No		Sometimes (2-3 times per week)	

If you do eat vegetables, why do you eat them?

10.1 Because you like the taste

Yes		No		Sometimes (2-3 times per week)	

10.2 because people at home eat vegetables

Yes		No		Sometimes (2-3 times per week)	

10.3 because you are told to eat them

Yes		No		Sometimes (2-3 times per week)	

11. When you feel like a snack, what do you eat?

11.1Chips

Yes		No		Sometimes (2-3 times per week)	

11.2 Sweets/Candy

Yes		No		Sometimes (2-3 times per week)	

11.3 Fruit

Yes		No		Sometimes (2-3 times per week)	

11.4 Sandwich or cereal

Yes		No		Sometimes (2-3 times per week)	

11.5 Chocolate

Yes		No		Sometimes (2-3 times per week)	

Other : .....

Yes No Sometimes (2-3 times per week)

12. In the past 7 days, did you consume sweetened beverages (cold drinks, fizzy drinks, squash, soda, sweet drink)?

Yes(everyday)		No		Sometimes (2-3 times per week)	

13. In the past 7 days have you eaten fast foods (e.g hot chips, French fries, burger, hotdog, pizza, shawarma, ikota/Gatsby/rolex)?

Yes		No		Sometimes (2-3 times per week)	

14. In the last 7 days have you ever gone to bed hungry because there was no food? How many times

Never		1-2 days		>3 days	

Knowledge

1. Do you have school lessons where you talk about healthy eating?

Yes		No	

2. Is eating fruit and vegetables every day good for our bodies to fight against illnesses like colds and flu

Yes		No		I don_t know	

3. Eating a lot of sugar, sweets and sweet food…

3.1 Is good for health

Yes		No		I don_t know	

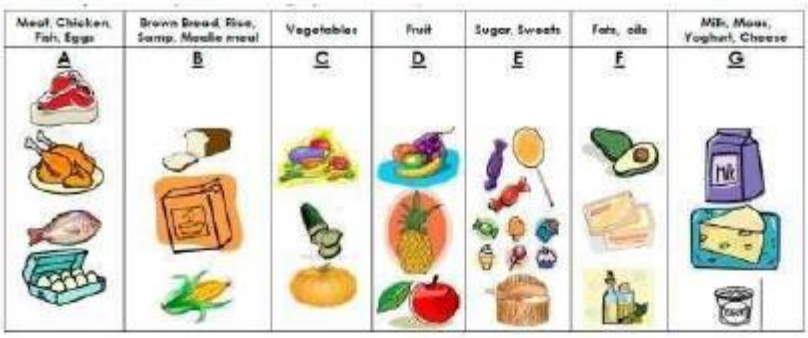
3.2 Can make you fat

Yes		No		I don_t know	

3.3 Is bad for your teeth

Yes		No		I don_t know	

4. Look at the following pictures and fill in the LETTER (A, B, C, D, E, F or G) of the food group you think best fits the answer to the questions below (You can choose a group more than once)



a Choose the food group that you should eat the MOST of every day ☐

b Choose the food group that you should eat the LEAST of every day ☐

c Choose the food group that gives your body the best ENERGY ☐

d Choose the food group that your BODY uses to BUILD MUSCLES ☐

e Choose the food group that best PROTECTS THE BODY AGAINST ILLNESSES ☐

The correct answers are the following and the child will get 1 mark for the correct answer and 0 for an incorrect answer:

2 Yes
3.1 No
3.2 Yes
3.3 Yes
4 a: B or C or D
4 b: E
4 c: F or B
4 d: A or G
4 e: C or D
The maximum knowledge score will be 9.

Annexure H: Food group intake questionnaire

Healthy and unhealthy food intake survey **Participant nr:…**

Dear Parent or Caregiver

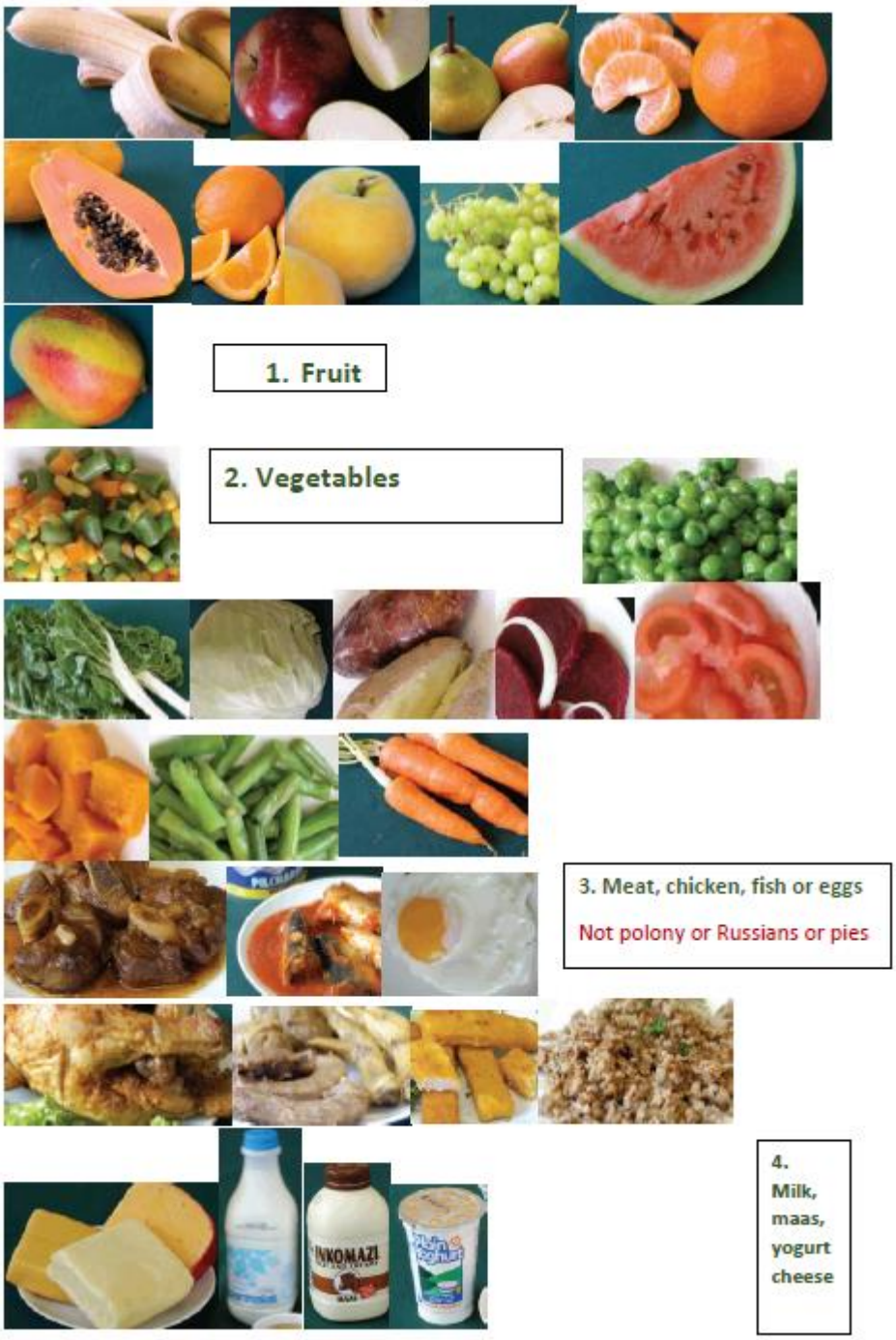
How many times per week does your child take the following foods or drinks?

Please look at the pictures attached to this questionnaire to see examples of the 10 groups of foods and drinks that you must tick in the following list.

Please also remember to fill in **how many teaspoons of sugar** the child takes in his/her tea or coffee.

Food group		**Frequency of intake per week**				
		0 days	1-2 days	3-4 days	5-6 days	7 days
1	Fruits (excluding canned fruit)					
2	Vegetables					
3	Meat, chicken, eggs or fish					
4	Milk, maas (inkhomazi), plain yogurt					
5	Cold drinks (fizzy drinks or cordials)					
6	Sugar in tea (….teaspoons sugar/cup)					
7	Cookies or cake					
8	Chips (Simba type) or cheese puffs					
9	Sweets or chocolates					
10	Fast foods (Fried chicken, Russians, Viennas, polony, hamburger, chips, pie, pizza)					

Annexure I: Food group picture pamphlet



5. Cold drinks

6. Sugar in tea and coffee

7. Cakes, cookies

8. Chips, cheese puffs, niknaks

9. Sweets, chocolates

10. Fast foods