Body composition profiles of underweight and obese grade one learners in the North West Province of South Africa: NW-CHILD study

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Previous qualification (not compulsory)

Dissertation submitted in partial fulfillment of the requirements for the degree *Magister Scientiae* in Kinderkinetics at the Potchefstroom Campus of the North-West University

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September 2013

Contribution of authors

This dissertation is presented in article format. The study was planned and completed by four authors. The contribution of each author will be explained in table format, with the explanation of the role of each co-author in the study. The co-authors hereby consent that the articles in this dissertation can be submitted for obtaining a Magister of Science in Kinderkinetics degree.

Name and surname of the author	Role of the author in this study
Me. Gizelle Kruger (GK) (BSc. Honours Kinderkinetics)	GK, AP and DC were responsible for the completion of the study. GK is the first author, AP is the second author and DC is the third author in both the articles.
Prof. Anita E. Pienaar (AP) (PhD. Human Movement Sciences)	AP was the supervisor in the study, and was responsible for all the aspects of the study. AP has contributed significantly in terms of writing the articles.
Dr. Dané Coetzee (DC) (PhD. Human Movement Sciences)	DC was the assistant-supervisor. DC has contributed significantly in terms of writing the articles.
Prof Salomé Kruger (SK) (PhD. Nutrition)	SK was the co-author in the article in chapter 4 because of her expert knowledge in Nutrition.

Affirmation by supervisor and assistant-supervisor

I declare that the articles above have been approved and my role in the study as set out above is correct and reflects my part in the study. I further authorise that the articles, as part of the thesis of Me. Gizelle Kruger may be published.

_____	_____	_____
Prof Anita E. Pienaar	Prof Salomé Kruger	Dr. Dané Coetzee

Preface

All the Glory to Jesus Christ!

"Thank you Lord Jesus for giving me the strength and potential to complete this dissertation. Without You carrying me all the way, I would not have been able to finish it. You are my hope, life and light."

"God is able,
He will never fail,
He is almighty God.

Greater than all we seek,
Greater than all we ask,
He has done great things" - Hillsong

"I can do all things through
Christ who strengthens me"

-Philippians 4:13

I would also like to express my sincere gratitude to the following persons who contributed to this final product.

- **Prof. Anita Pienaar**, my supervisor, for the thorough and patient manner of guidance amidst huge workloads. "Thank you for your support and motivation through my study period. You mean a lot to me."

- **Dr. Dané Coetzee**, my co-supervisor, for her valuable insights, excellent advice and hands-on involvement. "Thank you for always making time to see me, and the exhausting hours of reading all the chapters of the dissertation. I really appreciate all you have done for me."

- **Me. Chanelle Kemp,** my first supervisor, for her guidance and advice with my research proposal last year. “Thank you for your friendly support and helpful advice with the writing of my proposal”.

- **Dr. Trudy Reinhardt (contact number 079 976 6888),** my translator and language editor, for her friendly service with the translation and editing of my dissertation. “Thank you for helping me and making the translation and editing affordable for me. I appreciate everything you have done for me.”

- **My family –** “Thank you for the opportunities you gave me. Your love, support and encouragement with this dissertation means a lot. Thank you for all your prayers. I love you guys.”

For nothing is impossible with God.

Luke 1:37

Summary

BODY COMPOSITION PROFILES OF UNDERWEIGHT AND OBESE GRADE ONE LEARNERS IN THE NORTH WEST PROVINCE OF SOUTH AFRICA: NW-CHILD STUDY

Body composition profiles including stunting, wasting and underweight, overweight and obesity, can all affect the health, motor development and academic achievements of children. South Africa (SA), a developing, middle-income country, with large socio-economic inequalities, is one of the most complex nations with regard to race and ethnicity. It therefor results in different body composition profiles of children and adolescents, where undernutrition and obesity can occur among children and adolescents in the same socio-geographic population in disadvantaged communities, as well as in the same household.

The aim of this study was firstly, to determine the incidence of overweight and obesity among Grade 1-learners in the North West Province of SA and to determine whether this incidence is related to gender, race and the socio-economic circumstances in which these learners live. Secondly, the study aimed to determine the incidence of stunting, wasting and underweight among this group of Grade 1-learners and to determine whether these incidences are related to gender, race and the socio-economic circumstances in which these learners live.

The anthropometric measurements that were used in the study were height (cm), body mass (kg), 3 skinfolds [(sub-scapular, triceps and medial calf)] (mm) and waist circumference (cm). These measurements were taken by trained researchers according to the guidelines International Society for the Advancement of Kinanthropometry (ISAK). Body mass index (BMI) [(body mass (kg)/height $(m)^2$)] was calculated and international age-specific cut-off points for BMI was used to determine whether a learner was overweight or obese. Z-scores of less than -2 standard deviation (SD) for height-for-age and weight-for-age were calculated to determine the prevalence of stunting and underweight, while the Z-scores for wasting was

determined using BMI-for-age, under the 5th percentile from an international reference population.

The Statistica-computer programme (Statsoft, 2011) and AntroPlus software (version 1.0.2) in SAS (Statistical Analysis System) were used to analyse the data. Data were descriptively analysed by using percentages, means ($\bar{x}$), minimum and maximum values and standard deviations (SD). Two-way frequency tables were used to analyse the incidence for overweight, obesity, stunting, wasting and underweight. Pearson Chi Square analysis $p \leq 0,05$ was used to determine statistical significance of differences in stunting, wasting and underweight between school types, race and genders. Practical significance of differences was determined using effect sizes ($d \geq 0,1$ which indicates a small effect, $d \geq 0,3$ indicating a medium effect and $d \geq 0,5$ indicating a large effect). Tukey's Post Hoc tests were used to determine the significance of differences between the groups and genders.

The results revealed an incidence of 11,6% of overweight and obesity in the group (N=816) of Grade 1-learners. Overweight in the group was 7,8% and overweight was more prevalent in 7 year old learners with 10,5%, compared to 6 year old learners with 6,3%. Obesity (3,8%) showed a lower incidence compared to overweight, were 2,5% learners at 6 years and 0,7% learners at 7 years were obese. The boys showed the highest prevalence for severe obesity at 6 and 7 years (2,4%). White learners showed the highest prevalence for overweight, obesity and severe obesity at 6 and 7 years. The group of Grade 1-learners furthermore showed lower percentages of stunting (4,3%), wasting (7,4%) and underweight (4,3%) compared to overweight and obesity incidences. . A higher prevalence of wasting and underweight were found among the boys (8,4%; 6,0%) compared to the girls (6,3%; 2,5%), although the difference was only significant for underweight ($p=0,02$), while stunting was similar among girls (4,5%) and boys (4,1%; $p>0,05$). Black learners showed the highest incidence for underweight (5,5%; $p<0,01$), while small percentages of underweight were found in the white learners. Only the black learners showed stunting ($p<0,01$), while wasting occurred in black (n=39) and white (n=15) learners. Quintile 1-3 schools had the highest prevalence of underweight (5,1% – 8,2%) and stunting (3,9% – 10,7%), which was significantly higher than in Quintile 4 and 5 schools ($p<0,01$), and agreed with higher prevalences found in rural areas in other South African studies. Knowledge about the body composition profiles of young school beginners is important since extremes such as obesity, stunting and wasting play an important role in the further development and health of children. The results of this study

make a valuable contribution to knowledge that can be used in this regard for preventative purposes.

Key words: Overweight, obesity, undernutrition, stunting, wasting, underweight, children.

Opsomming

LIGGAAMSAMESTELLINGSPROFIELE VAN ONDERGEWIG EN OBESITEIT VAN GRAAD 1-LEERDERS IN DIE NOORDWES PROVINSIE VAN SUID-AFRIKA: NW-CHILD STUDIE

Groei-inperking, ondervoeding en ondergewig, asook oorgewig en obesiteit is almal fasette van liggaamsamestelling wat ŉ effek kan uitoefen op kinders se gesondheid, motoriese ontwikkeling en akademiese prestasies. Suid-Afrika (SA) is een van die mees ras- en etnies komplekse nasies in die wêreld. Hierdie land is ook ŉ ontwikkelende en middel-inkomste land, met sosio-ekonomiese ongelykhede, wat lei tot verskillende profiele in liggaamsamestellings onder kinders en jong volwassenes. In agtergeblewe gemeenskappe in SA kan wanvoeding onder kinders en obesiteit onder adolessente in dieselfde sosio-geografiese populasie, asook in dieselfde gesin voorkom.

Die doelstelling van hierdie studie, was eerstens om vas te stel wat die voorkoms van oorgewig en obesiteit by Graad 1-leerders in die Noordwes Provinsie van SA is, en om te bepaal of hierdie voorkoms verwant is aan sekere geslag, ras of sosio-ekonomiese omstandighede waarin hierdie leerders leef. Die tweede doelstelling was om te bepaal wat die voorkoms van groei-inperking, ondervoeding en ondergewig by Graad 1-leerders in die Noordwes Provinsie van SA is, en om te bepaal of hierdie voorkoms verwant is aan sekere geslag, ras of sosio-ekonomiese omstandighede waarin hierdie leerders leef.

Die antropometriese metings wat in die studie gebruik is, is liggaamslengte (cm), liggaamsmassa (kg), 3 velvoue (subskapulêr, triseps en mediale-kuit) (mm) en middellyfomtrek (cm). Hierdie metings is deur opgeleide navorsers uitgevoer ooreenkomstig aan die protokol van die 'International Society for the Advancement of Kinantropometry' (ISAK). Liggaamsmassa-indeks (LMI) (liggaams-massa (kg)/liggaamslengte (m)^2) is bereken en Internasionale ouderdom-spesifieke afsnypunte vir LMI is gebruik om te bepaal of ŉ

leerder oorgewig of obees was. Z-waardes van minder as -2 standaardafwyking (SA) vir lengte-vir-ouderdom en massa-vir-ouderdom is gebruik om die voorkoms van groei-inperking en ondergewig te bepaal, terwyl z-waardes vir ondervoeding bepaal is deur gebruik te maak van LMI-vir-ouderdom, onder die 5de persentiel van internasionale verwysingsdata.

Die Statistica-rekenaarprogram (Statsoft, 2011) en AntroPlus sagteware (version 1.0.2) in SAS (Statistiese Analiese Sisteem) is gebruik om die data te ontleed. Data is vir beskrywende doeleindes aan die hand van persentasies, rekenkundige gemiddeldes ($\bar{x}$) maksimum en minimum waardes en SA ontleed. Twee-rigting frekwensietabelle is gebruik vir die analisering van die data vir oorgewig, obesiteit, groei-inperking, ondervoeding en ondergewig. Pearson Chi Kwadraat ontledings $p \leq 0,05$ is gebruik om die statistiese betekenisvolheid van verskille in groei-inperking, ondervoeding en ondergewig tussen skooltipes, ras en geslagte te bepaal. Praktiese betekenisvolheid van verskille is bepaal deur effekgroottes ($d \geq 0,1$ dui op 'n klein effek, $d \geq 0,3$ op 'n medium effek en $d \geq 0,5$ op 'n groot effek). Tukey se Post Hoc toetse is gebruik om statistiese betekenisvolle verskille tussen die groepe en geslagte te bepaal.

Die resultate van die studie dui 'n voorkoms van 11,6% vir oorgewig en obesiteit by die Graad 1-leerders aan. Oorgewig in die groep was 7,8% en oorgewig was hoër by die 7 jarige leerders met 10,5% in vergelyking met die 6 jariges met 6,3%. Obesiteit (3,8%) het 'n laer voorkoms as oorgewig getoon, waar 2,5% leerders van 6 jaar en 0,7% leerders van 7 jaar obees was. Die seuns het die hoogste voorkoms van ernstige obesiteit by 6- en 7 jaar (2,4%) getoon. Blanke leerders het die hoogste voorkoms van oorgewig, obesiteit en ernstige obesiteit getoon by 6- en 7 jaar. Die groep Graad 1-leerders het verder laer persentasies van oorgewig en obesiteit getoon vir groei-inperking (4,3%), ondervoeding (7,4%) en ondergewig (4,3%). 'n Hoër voorkoms van ondervoeding en ondergewig het by die seuns (8,4%; 6,0%) teenoor die dogters (6,3%; 2,5%) voorgekom, alhoewel hierdie verskille slegs betekenisvol vir ondergewig was ($p=0,02$). Die voorkoms van groei-inperking was baie soortgelyk by dogters (4,5%) en seuns (4,1%; $p>0,05$). Swart leerders het die hoogste voorkoms vir ondergewig (5,5%; $p<0,01$) getoon, met klein persentasies van ondergewig onder die blanke leerders. Slegs swart leerders het groei-inperking getoon ($p<0,01$), terwyl swart leerders ($n=39$) en blanke leerders ($n=15$) ondervoed was. Kwintiel 1-3 skole het die hoogste voorkoms vir ondergewig (5,1%-8,2%) en groei-inperking (3,9%-10,7%) getoon, en was

betekenisvol hoër as in Kwintiel 4 en 5 skole ($p<0,01$). Hierdie resultate stem ooreen met ander studies in SA, waar ŉ hoër voorkoms van wanvoeding ook in landelike gebiede gerapporteer was. Inligting rakende die liggaamsamestellingsprofiele van jong skoolbeginners is belangrik, omrede uiterstes soos obesiteit, groei-inperking en ondervoeding ŉ belangrike rol in die toekomstige ontwikkeling en gesondheid van kinders speel. Hierdie studie se resultate lewer ŉ aansienlike bydrae tot omvattende kennis wat gebruik kan word vir gesondheidsvoorkomingsdoeleindes.

Sleutelwoorde: Oorgewig, obesiteit, wanvoeding, groei-inperking, ondervoeding, ondergewig, kinders.

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List of abbreviations

UNICEF	United Nations Children's Fund
WHO	World Health Organization
NWU	North-West University
SA	South Africa
BMI	Body Mass Index
NHANNES	The Third National Health and Nutrition Examination Survey
MABC	Movement Assessment Battery for Children
DCD	Developmental Coordination Disorder
WAZ	Weight-for-age
HAZ	Height-for-age
WHZ	Weight-for-height
US	United States
ISAK	International Society for the Advancement of Kinanthropometry
NWP	North West Province
CHILD	Health-Integrated-Learning and Development
CDC	Center of Disease Control
IOTF	International Obesity Taskforce

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CHAPTER 1

CHAPTER 1

Introduction, problem statement and objective of the study

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1.1 Introduction

Stunting, wasting and underweight, as well as overweight and obesity, are all facets of body composition that can affect the health (Torpy *et al.*, 2004:648; Daniels *et al.*, 2005:2000), motor development (Mendez & Adair, 1999:1555; Cawley & Spiess, 2008:388) and academic achievement of children (Cawley & Spiess, 2008:388). Afolayan (2004:9) found that on a world-wide scale, South Africa (SA) is one of the most complex populations with regard to race and ethnicity. South Africa also has a diverse population regarding income and nutritional status (Jinabhai *et al.*, 2003:363), resulting in differences in the body composition of children and young adults (Popkin, 1994:285). Apart from this complexity, SA is classified as a developing and middle-income country, with socio-economic inequalities (46,3% of the population live in low socio-economic circumstances and 53,7% in middle to high socio-economic circumstances) (Zere & McIntyre, 2003:8-9).

Kimani-Murage *et al*. (2010:158) and Vorster (2010:2) report that in disadvantaged communities in SA, undernutrition and obesity can occur among children and adolescents in the same socio-geographic group, as well as in the same family (Vorster, 2010:2).

Improvement in the social, cultural and economic environment is therefore needed to counteract the increases in overweight, obesity and undernutrition. This can only be achieved through the combined efforts of the food industry, the media, communities and on an individual level (WHO, 1997). Researchers can also make a contribution by making more information available about the nature and incidence of these kinds of problems among young developing children.

1.2 Problem statement

The World Health Organization (WHO) (WHO, 2011b) defines overweight and obesity as abnormal or excessive accumulation of body fat. Nutritional status reflects growth in children, thus abnormalities in growth can be used as an indicator of undernutrition (Robinson *et al.*, 2001:287). Mild forms of undernutrition is characterised by stunting, wasting and underweight (Tharakan & Suchindran, 1999:843). Stunting is defined as insufficient height-for-age and wasting or thinness as insufficient mass-for-height (Victoria, 1991:1105). Underweight and stunting is mainly the result of an insufficient diet and regular infections, which lead to a shortage of calories, proteins, vitamins and minerals (WHO, 2011b).

Overweight and obesity have become a global epidemic (Craeynest *et al.*, 2006:347) which, according to the WHO, affects more than 1 billion people in both developed and developing countries (WHO, 2011b). Various factors contribute to overweight and obesity, which include genetics (Martínez-Hernández *et al.*, 2007:1138), ethnicity (Ramos & Caughey, 2005:1089), diet (Walker *et al.*, 2001:369), physical inactivity (Finkelstein *et al.*, 2003:225) and socio-economic status (Monteiro *et al.*, 2004:940). Researchers report increases in the incidence of overweight and obesity among children (Lobstein *et al.*, 2004:4; Ogden *et al.*, 2010:244), and these increases are one of the most important current health concerns worldwide (Daniels *et al*., 2005:2000). In 2010, approximately 43 million children under the age of 5 years worldwide were overweight (WHO, 2011b).

The WHO (2011b) recently acknowledged obesity as a chronic illness, and South African statistics indicate that this country is not excluded from this problem (Van der Merwe & Pepper, 2006:315). The past decades indicated a progressive increase in the incidence of obesity in SA, especially among women and children (Labadarios *et al.*, 2005:104-105). A

study undertaken by Armstrong *et al.* (2006:439) on 6 to 13 year old children in SA, found that 14% boys and 17,9% girls were overweight, while 3,2% boys and 4,9% girls were obese. According to the "National Food Consumption Survey" (Labadarios *et al.*, 2005:104), one out of thirteen, 1 to 9 year old children who participated in the study, was overweight. An increase in the socio-economic status, urbanisation and a decrease in physical activity have led to certain areas in SA being more affected by overweight and obesity (Walker *et al.*, 2001:368). A larger number of South Africans in urban and rural areas also find themselves in a phase of food-transition due to changes in economic, social, demographic and health factors (Popkin, 1993:138). These changes contribute to an increase in the incidence of overweight and obesity (Drewnowski & Popkin, 1997:31).

Furthermore, obesity and overweight are linked to serious medical complications during childhood (Must & Strauss, 1999:2) and these children have a higher risk of becoming obese adults, with the possibility of poor health and premature death (Guo *et al.*, 1994:818). Child obesity is associated with numerous health problems which include sleep apnoea, hypertension, cardiovascular complications, metabolic syndrome and Type 2 diabetes (Daniels *et al.*, 2005:2000). Obesity is also associated with impairment in cognitive and psychological development, poorer verbal, social and gross motor skills, as well as impairment in daily activities (Mond *et al.*, 2007:1069; Cawley & Spiess, 2008:388). A study of Grade 1-learners in the Cologne district of Germany found a link between obesity and poorer motor development in both boys and girls (Graft *et al.*, 2004:26). Research by D'Hondt *et al.* (2009:21) found that the general level of motor co-ordination in obese children is lower when compared to that of children with normal weight. Obese children are also less active and prefer a more sedentary lifestyle than non-obese children (Zhu *et al.*, 2011:801). Lowered physical activity levels lead to lower energy expenditure and increases the risk of obesity later in life (Zhu *et al.*, 2011:801).

Undernutrition contributes to various body composition profiles such as stunting (insufficient height-for-age), wasting (insufficient mass-for-height) and underweight, which is also linked to various developmental problems in children. According to the United Nations International Children's Fund (UNICEF, 1990), all people have the right to be free of hunger. Despite this basic human right, approximately 150 million under the age of 5 years suffer from serious undernutrition (UNICEF, 2012). The WHO (WHO, 2011a) defines undernutrition as a cellular imbalance between the supply of nutrients and energy and the

body's ability to utilise it for growth and specific functions. Undernutrition is globally considered to be the most important risk factor for illness and mortality (WHO, 2000) and was the cause of 54% of child deaths worldwide in 2010 (WHO, 2011a). It is reported that 1 out of every 3 children is affected by undernutrition worldwide (UNICEF, 2012). Stunting is furthermore wide-spread in Africa and affects 1 out of every 3 children (Fleshman, 2002:2).

An anthropometric status study in 2005 on children between the ages of 1 and 9 years in SA, indicates that 20,7% of the children were stunted, 8,1% were underweight and 5,8% were wasted (Kruger *et al*., 2005:594). A study in the magisterial district of KwaZulu-Natal of 579 primary school children between the ages of 8 and 10, found that 7,3% of the children who participated in the study, suffered from stunting (Jinabhai *et al*., 2001:50).

The causes of undernutrition range from biological, social, cultural and economic factors and include: age, birth weight, period of breastfeeding, gender of the head of the family, type of dwelling, toilet facilities, education of parents, intake levels of milk, milk products, staple food, as well as the incidence of coughing and diarrhoea (Tharakan & Suchindran, 1999:843). Undernutrition affects almost every organ system in the human body (Shashidhar & Grigsby, 2009:1) and undernourished children are more susceptible to illnesses, because their bodies cannot ward off infections (Torpy *et al.*, 2004:648). Children suffering from chronic undernutrition exhibit behavioural changes and appear irritated, apathetic, attention deficient, anxious and have a lowered social response (Shashidhar & Grigsby, 2009:4). Undernutrition further causes impairment of physical, motor and mental development (UNICEF, 2012), academic underachievement (Mendez & Adair, 1999:1555), as well as impairment of physical, cognitive and psychological functions (Shashidhar & Grigsby, 2009:1). Chopra and Sharma (1992:9) also found that undernutrition negatively influences children's speed, fine motor skills and co-ordination.

From the aforementioned literature it appears that overweight and obesity, as well as undernutrition, is a health concern among children worldwide. The total well-being of children is however essential for healthy development. A young child has comprehensive developmental needs, with the main areas being motor and physical development (Pienaar, 2009:49). However, the problem is that achievement of motor milestones, as well as motor and physical development, are affected negatively by overweight, obesity and undernutrition (Cawley & Spiess, 2008:388; UNICEF, 2012). Kain *et al*. (2003:S85) state that the incidence

of overweight and obesity among pre-school children is low, but increases dramatically in schoolchildren. Fatal and infant nutritional conditions (stunting), education and socio-economic circumstances, dietary changes (especially increased total energy intake), and physical inactivity are some of the reasons for this increase in overweight and obesity once children start school (Kain *et al*. 2003:S77). Little information is however available regarding the body composition profiles of the school beginner in SA. It is, therefore, important to obtain more information about the body composition profiles of young school beginners, since it plays an important role in the further development of children, as indicated in the preceding problem statement.

The research questions that arise as a result of the foregoing are firstly, what is the incidence of overweight and obesity among Grade 1-learners in the North West Province of SA and whether this incidence is related to gender, race and the socio-economic circumstances which these learners are exposed to. Secondly, what is the incidence of stunting, wasting and underweight among Grade 1-learners in the North West Province of SA, and whether this incidence is related to gender, race and the socio-economic circumstances which these learners are exposed to. Answering these questions will provide an extensive profile of various body compositions of school beginners that might influence their health and development negatively.

1.3 Objectives

The objectives of the study are:

1.3.1 To determine the incidence of overweight and obesity among Grade 1-learners in the North West Province of SA, and to determine whether this incidence is related to gender, race and the socio-economic circumstances which these learners are exposed to.

1.3.2 To determine the incidence of stunting, wasting and underweight among Grade 1-learners in the North West Province of SA, and to determine whether this incidence is related to gender, race and the socio-economic circumstances which these learners are exposed to.

1.4 Hypothesis

This study is based on the following hypotheses:

1.4.1 An incidence of more than 10% of overweight and obesity will be found among Grade 1-learners in the North West Province of SA, and White girls who are exposed to better socio-economic conditions will show the highest incidence.

1.4.2 An incidence of more than 10% of stunting, wasting and underweight will be found among Grade 1-learners in the North West Province of SA, and Black boys who are exposed to poorer socio-economic conditions will show the highest incidence.

1.5 Structure of dissertation

This dissertation is presented in article format. The structure of the dissertation is as follows:

1.5.1 Chapter 1 provides the problem statement and objectives of the study. Citations used in this chapter, follow at the end of the chapter in the modified Harvard-style, as required by the North-West University.

1.5.2 Chapter 2 provides a literature overview of the nature of different body composition profiles including overweight, obesity and undernutrition and an overview of the health and developmental consequences of these conditions for children. Citations used in this chapter will follow at the end of the chapter in the modified Harvard-style, as required by the North-West University.

1.5.3 Chapter 3 will be presented in article format. The title of the article is: The prevalence of overweight and obesity in Grade 1-learners in the North West Province of South Africa: The NW-CHILD Study. The article was prepared according to the guidelines of the '***South African Journal of Sports Medicine***'. The author guidelines of this journal are placed in Appendix B. The citations that were used in this chapter were inserted in the text as superscript numbers and all the citations that were used in the text, were listed at the end of the article in numerical order of appearance as required by the Vancouver style of referencing. For uniformity and technical purposes of the

dissertation, some changes were made to the guidelines of the journal. The line spacing of the article was adjusted to be the same as the rest of the dissertation, which is one and a half spacing. This change makes the dissertation easier to read and fits in with the rest of the structure of the dissertation.

1.5.4 Chapter 4 is also presented in article format. The title of the article is: The prevalence of stunting, wasting and underweight in Grade 1-learners in the North West Province of South Africa: The NW-CHILD Study. The article which was prepared according to the guidelines of the ***'SA Health/SA Gesondheid'***. The author guidelines of this journal are placed in Appendix C. For uniformity and technical purposes of the dissertation, some changes were made to the guidelines of the journal. The tables were inserted as part of the text and not at the end of the article, as required by the journal guidelines. The alignment, line spacing, font and font size of the article were adjusted to be the same as the rest of the dissertation, which are justified, one and a half spacing, Times New Romans and 12 font size. These changes make the dissertation easier to read and fits in with the rest of the structure of the dissertation.

1.5.5 Chapter 5 provides the summary, conclusions and recommendations of the study.

Subsequently, Chapter 2 will provide an overview discussion of the nature of the body composition profiles of children and the effect thereof on the development and health of children.

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CHAPTER 2

CHAPTER 2

LITERATURE OVERVIEW: BODY COMPOSITION PROFILES AND THE DEVELOPMENTAL AND HEALTH IMPLICATIONS FOR CHILDREN

Table of Content

2.1 INTRODUCTION

Body composition of which underweight, stunting, overweight and obesity are all facets, can have an effect on children's health (Torpy *et al.*, 2004:648; Daniels *et al.*, 2005:2000), motor development (Mendez & Adair, 1999:1555; Cawley & Spiess, 2008:388) and academic achievements (Cawley & Spiess, 2008:388).

As a result of SA's diversity in income and nutritional status, several variations occur in the body composition of children and young adults (Popkin, 1994:285; Jinabhai *et al.*, 2003:363). For example, undernutrition can occur among children and obesity among adolescents in the same population group (Kimani-Murage *et al.*, 2010:158) and family (Vorster, 2010:2) in disadvantaged areas.

The World Health Organisation (WHO, 2011b) reports that more than 1 billion people in both developed and developing countries are influenced by overweight and obesity. Approximately 43 million children, under the age of 5 years, were overweight in 2010

(WHO, 2011b). Compared to this, the statistics for undernutrition are even higher. According to the United Nations Children's Fund (UNICEF) (2012:20), 150 million children under the age of 5 years suffer from serious undernutrition. In 2001, undernutrition was responsible for 54% of all child deaths (WHO, 2011a).

The purpose of this study is to determine the incidence of overweight and obesity, as well as die incidence of stunting, wasting and underweight in Grade 1-learners in die North West Province (NWP) of SA (SA). With these objectives in mind, it is thus important to reflect on the findings of relevant literature. Firstly, a literature overview is provided regarding the diversity of the South African population in order to understand the incidence of child obesity and stunting among South African children. Secondly, the classification of overweight and obesity among children, the incidence of overweight and obesity, the effect of overweight and obesity on child development, as well as the health risks of overweight and obesity are discussed. Thirdly, the classification of stunting, wasting and underweight among children, the incidence of stunting, wasting and underweight, the effect of stunting, wasting and underweight on child development, as well as the health risks of stunting, wasting and underweight, are discussed. This literature overview is concluded with a discussion of the possible relationship between stunting and overweight in children.

2.2 SOUTH AFRICA: A DIVERSE NATION

South Africa is a diverse nation with a population of over 50 million people which include a variety of cultures, languages and religions (Statistics SA, 2011). Following is a discussion of the population size, population demographics and socio-economic conditions in SA.

2.2.1 Population size

According to the mid-year predictions for 2011 by Statistics SA, the South African population stands at 50,5 million people. This figure has increased since the 2001 census survey, when the population numbers were 44,8 million (Statistics SA, 2011). Almost one-third of the population (31,3%) is under the age of 15 years (Statistics SA, 2011). According to the “South African Child Gauge” 2008/2009 (2009:71), statistics indicate that there are 18,3 million children under the age of 18 in SA. Children in SA represent approximately 40% of the population.

2.2.2 Population demographics

The South African population is composed of various racial groups. Table 2.1 reflects the main racial groups of SA, as well as the 2001 mid-year predictions of the percentage of the various groups in the total population.

Table 2.1: Mid-year population predictions in 2011 (Statistics SA, 2011)

Population group	Amount	% of total
Black	40 206 275	79,5%
White	4 565 825	9,0%
Mixed ancestry	4 539 790	9,0%
Indian/Asian	1 274 867	2,5%
Total	**50 586 757**	**100%**

2.2.3 Socio-economic conditions

SA has a vast, diverse population regarding income and nutritional status (Jinabhai *et al.*, 2003:363), which leads to different variations in the physical composition among children and young adults (Popkin, 1994:285). The degree of poverty in the Black population is more than 60%, compared to the less than 5% of the Indian and White populations (Coutsoudis & Coovadia, 2001:459). Poverty, in the past was especially rife in the non-urban areas, where the figure was 73,7% (Coutsoudis & Coovadia, 2001:459). SA is a developing, middle income country, with socio-economic inequalities (46,3% in low socio-economic conditions and 53,7% in middle to high socio-economic conditions) (Zere & McIntyre, 2003:8-9). The inequalities in socio-economic status are reflected in the nutritional status of South Africans; on the one hand there is the occurrence of underweight among children, opposed to obesity among adults with the risk of chronic diseases as a result of lifestyle choices (Coutsoudis & Coovadia, 2001:459).

2.3 OVERWEIGHT AND OBESITY

2.3.1 Definition and classification of overweight and obesity

The WHO (2011b) defines overweight and obesity as abnormal or excessive accumulation of body fat which is the result of an imbalance between energy absorption and energy consumption (Daniels *et al*., 2005:2002). In adults, the body mass index (BMI) is used to determine overweight and obesity. BMI is defined by dividing mass into kilogram by height in square metre (kg/m²). A BMI between 25 and 29,9 is classified as overweight and a BMI of 30 or higher as obese (Flegal *et al*., 2010:235). Since the BMI of children change constantly as they grow older, Cole and co-workers (2000:1240) determined age-specific BMI cut-off points to identify overweight and obesity in growing children (See Table 2.2 for the cut-off points for children between the ages of 6 and 8 that fall within the focus of this study). According to Cole and co-workers (2000:1245) children have a risk for obesity and overweight if their BMI is respectively between the 85th and 95th percentile and higher than the 95th percentile for age and gender.

Table 2.2: Age-specific cut-off points for overweight and obesity (Cole *et al*., 2000:1243)

	Body mass index 25kg/m²		**Body mass index 30kg/m²**	
Age (years)	**Boys**	**Girls**	**Boys**	**Girls**
6	17,55	17,34	19,78	19,65
6,5	17,71	17,53	20,23	20,08
7	17,92	17,75	20,63	20,51
7,5	18,16	18,03	21,09	21,01

2.4 THE OCCURRENCE OF OVERWEIGHT AND OBESITY

Overweight and obesity have become a global epidemic (Craeynest *et al.*, 2006:347; Wang & Lobstein, 2006:11). The WHO (WHO, 2011b) further predicts that by 2015 approximately 23 million adults will be overweight, while more than 700 million will be obese. The overweight and obesity epidemic among children is especially a concern (Hills *et al*., 2007:533). Recent reports stress the seriousness of obesity in children with this statement: *"Today's generation of children will be the first for over a century for whom life expectancy falls"* (Hills *et al*., 2007:533). Davison and Birch (2001:159) report that the incidence of overweight in children has doubled over the past 2 decades. In the year 2000 overweight and obesity led to

approximately 36 504 deaths in SA (Steyn & Labadarios, 2008:304). In the following section, worldwide statistics of overweight and obese children will firstly be considered, followed by a closer examination of South African statistics.

2.4.1 Worldwide statistics

In America 1 of every 7 children and adolescents are obese (Schwimmer *et al.,* 2003:1813). Approximately 25% of American children between the ages of 6 and 17 years are overweight or run the risk of becoming overweight (Troiano & Flegal, 1998:497). During the period 1999-2002, 31% of children between the ages of 6 to 19 years were at risk to become overweight and 16% were overweight (Hedley *et al*., 2004:2847). According to Goran *et al.* (2002:1417) the annual cost of hospitalisation for children and adolescents with obesity-related illnesses in America has increased to 127 million dollars. In addition, the incidence of obesity has escalated in Latin America, especially over the past 10 to 15 years (Kain *et al*., 2003:S77). Kain *et al*. (2003:S85) state that the incidence among pre-school children is low, but increases dramatically among school children. The reasons for this increase in obesity in school children are fatal and infant nutritional conditions (stunting), education and socio-economic conditions, dietary changes (especially increased total energy intake), and physical inactivity (Kain *et al.* 2003:S77). Studies in Canada, Norway and America among children in the 6 to 11 year age group, found that the incidence of overweight and obesity in these 3 countries was 6,3%, 16,1% and 20,7% respectively (Phipps *et al*., 2006:7).

The incidence of overweight and obesity in European countries is also increasing drastically (Jackson-Leach & Lobstein, 2006:26). A study by Lobstein and Frelut (2003:195) indicates a high incidence of overweight in children in especially western and southern Europe. Studies found overweight among school-going children to be as high as 35% in parts of Europe and the rate of increase escalates annually (Jackson-Leach & Lobstein, 2006:26). In France, a study of 1 582 children between the ages of 7 to 9 years, found 20,6% of the children to be overweight and 6,4% to be obese (Rolland-Cachera *et al*., 2002:1610). Padez *et al.* (2004:670) undertook a study of 7 to 9 year old Portuguese children and the results indicated that 31,5% of the children were overweight and obese (20,3% overweight; 11,3% obese). The same study was undertaken in other Mediterranean countries and similar tendencies were reported among children of the same age group: Spain (30%), Greece (31%) and Italy (36%) (Padez *et al*., 2004:670).

Forty one studies were undertaken in Australia during the period 1985-2008 to investigate the weight status of children and to determine the incidence of overweight and obesity among children. These studies included 264 905 subjects between the ages of 2 to 18 years and data of 70 758 children were available to establish the incidence. Between 21% and 25% of the boys and girls were overweight and 5-6% were obese (Olds *et al.*, 2010:57).

A discussion of overweight and obesity among different racial groups follows. A study in America reports that the incidence of obesity differs with regard to race and ethnicity. The study found the highest incidence of obesity to be among American-Indian children, where obesity was double that of non-Hispanic White or Asian children (Anderson & Whitaker, 2009:344). Another study undertaken by Whitaker and Orzol (2006:578) on American pre-school children found a higher incidence of obesity among Black children (16,2%) as opposed to White children (14,8%). Daniels *et al.* (1997:804) found that racial differences occurred in the waist-hip measurement variables, where it was higher among White than Black boys and according to these researchers the percentage body mass depends on sexual maturity, gender (girls have more body mass than boys) and waist-hip width (Daniels *et al*., 1997:804). Race and ethnic differences in lifestyle behaviour and economic status can be sources of certain racial differences found in obesity-related diseases and outcomes (Cossrow & Falknet, 2004:2590).

2.4.2 South African statistics

Improvement in socio-economic status, urbanisation and a decrease of physical activity contribute to the fact that some parts of SA are more affected by overweight and obesity (Walker *et al.*, 2001:368). Changes in diet (higher fat intake) and activity patterns, as well as lower physical activity participation, are all contributory factors to the higher incidence of obesity in SA (Kruger *et al*., 2005:491). In SA, overweight and obesity in children are on the increase, but the prevalence varies with age, gender and population group (Rossouw *et al*., 2012:1).

Armstrong *et al.* (2006:439) conducted a study on 6 to 13 year old children of different races in SA and found that 14% boys and 17,9% girls were overweight and 3,2% boys and 4,9% girls were obese. The results of the study further indicated that White boys and girls had the highest BMI values and that these BMI values start changing in girls from the age of 11 years

(Armstrong *et al*., 2006:442). Armstrong *et al.* (2006:441) further reports that the lowest BMI values were found among Black children. However, Moneyki *et al.* (1999:287) found that very few Black children living in rural areas (0-2,5% boys and 0-4,3% girls) when reaching the age of 7 years, are above the NHANNES III (The Third National Health And Nutrition Examination Survey) 85th percentile for BMI.

A study of 579 primary school children between the ages of 8 and 10 years of age in the rural magisterial district of KwaZulu-Natal found that 3,1% of the children who participated in the study were obese (Jinabhai *et al*., 2001:50). Another study by Jinabhai *et al*. (2003:358) in KwaZulu-Natal of 802 Black children between the ages of 8 to 11 years, found that the incidence of overweight varied between 0,4% and 13,3% and obesity between 0,1% and 3,7% according to the WHO standards. Kemp *et al.* (2011:19) report an incidence of overweight and obesity among 7 year old children (N=816) in the NWP of 11,6% (7,8% overweight and 3,8% obese) and that the incidence was higher among girls. Another study in the NWP among 10 to 12 year-old girls found that 16,5% girls were overweight and 4,9% obese (Pienaar *et al*., 2007:221). One out of 5 children was found to be overweight or obese in a study done by Truter *et al.* (2010:227), and the incidence of overweight and obesity was double among girls than among boys. During the National Food Consumption Survey (NFCS) in 1999, Steyn *et al.* (2005:5) conducted a national study of 2 894 children between the ages of 1 and 8 years of age. This study was undertaken in 156 areas in SA, in which 82 rural and 74 urban areas were represented. The results of the study indicated that 17,1% of the children had a BMI value of at least 25 kg/m². These research results further indicated that 6,7% children could be classified as overweight and 3,7% as obese and that urban areas had the highest incidence (Steyn *et al*., 2005:8). Somers *et al.* (2006:11) studied the incidence of overweight and obesity among 10 to 16 year-old children in the rural area of the Western Province and found 15,7% to be overweight and 6,2% to be obese.

Race and gender differences also play a role in overweight and obesity among children in SA. Studies report a higher incidence of overweight and obesity among girls than among boys (Jinabhai *et al*. 2003:358; Kruger *et al.* 2006:351). Regarding race, Kruger *et al.* (2006:351) found that White children aged between 10 and 15 years, have a higher incidence of overweight and obesity (White 14,2%, Black 7,1%, Indian 6,4% and Mixed ancestry 2,9%). Pienaar *et al*. (2007:221) reported that 21,3% White girls, 15,8% Black, 9,1% Mixed ancestry and 17,4% Indian girls were overweight in their study of 10 to 12 year olds, while obesity

were also found among the girls, where 8,5% White, 4,4% Black, 0% Mixed ancestry and 8,7% Indian girls were obese. Research done by Reddy *et al.* (2008:206) found similar results and indicated a higher incidence of overweight and obesity among White boys and girls. Kruger *et al.* (2006:351) also found a higher incidence of overweight and obesity in urban areas and smaller households.

It can be concluded that the incidence of overweight and obesity in SA is high and differs between rural and urban areas. Several researchers found the incidence to be lower in rural areas (Moneyki *et al.,* 1999:287; Steyn *et al*., 2005:9). Researchers further report that overweight and obesity are more prevalent among the White racial group (Armstrong *et al*., 2006:442; Kruger *et al*., 2006:351; Kemp *et al*., 2011:119), and that the incidence is lower in Black populations compared to White populations (Jinabhai *et al*., 2003:358; Reddy *et al*., 2008:206). Few research results are, however available relating to Mixed ancestry and Indian populations and the incidence of overweight and obesity in these racial groups. Several studies were done on wide-spread age groups (3-13 years) to determine the incidence of overweight and obesity. Very little research has been done to determine the overweight and obesity status of school beginners, which are approximately 7 year old children.

2.5 THE EFFECT OF OVERWEIGHT AND OBESITY ON CHILD DEVELOPMENT

2.5.1 Gross and fine motor development

Motor competency is defined as a person's quality of movement coordination while he/she participates in different motor skills that include gross and fine motor skills (D'Hondt *et al*., 2009:22).

Obese children and adults are reported to be less active and prefer a more sedentary lifestyle than non-obese children and adults (Zhu *et al.,* 2011:801). Lowered physical activity levels lead to lower energy usage and increases the risk of obesity and poor health later in life (Zhu *et al.,* 2011:801). According to Deforche *et al*. (2003:434) obese children with poor motor coordination are less physically fit than typical developing children and experience more problems with weight-bearing exercises than non-obese children. Truter *et al*. (2010:227) report in this regard that physical fitness in children is important for improved health.

Graft *et al.* (2004:22) completed a study of Grade 1-learners in the Cologne region in Germany and found that overweight and obese children had poorer gross motor development and endurance performance than children who have normal weight. Another study of children between the ages of 4,4 – 8,6 years in Lower Bavaria, Germany, found that obese boys, but not obese girls, have a bigger chance of gross motor deficiency (Mond *et al*., 2007:1068). Research by D'Hondt *et al.* (2009:21) found that the general level of motor coordination in obese children is lower when compared to that of children with normal weight.

Some studies further indicate that overweight and obese children have poorer loco-motor skills, i.e. jumping and kicking. They also lag behind their normal weight classmates in athletic items like relay and 30 metre sprints (Graft *et al.*, 2004:25; Okely *et al*., 2004:238). Deforche *et al.* (2009:175) report that overweight boys, who have not yet reached puberty, showed poorer gross motor skills, as well as lower static and dynamic balance skills and posture as opposed to girls. Furthermore, obese children proved to have poorer ball sense than normal weight children when their motor skills were evaluated by the "Movement Assessment Battery for Children" (MABC) test battery (D'Hondt *et al*., 2009:32). Ball skills, such as throwing and catching, require well-balanced posture, balance and hand-eye coordination, which are the reasons given why obese and overweight children have poorer ball skills (D'Hondt *et al*., 2009:32; Zhu *et al*., 2011:805). In a study by D'Hondt *et al*. (2009:32) more than a quarter of the obese children who participated in the study (26,5%) were under the 5^{th} percentile of the MABC test battery and possibly had developmental coordination disorder (DCD). When the relationship between DCD, overweight and obesity is discussed, there is the assumption that DCD or poor motor coordination skills can lead to lowered participation in physical activity (Bouffard *et al*., 1996:61; Wrotniak *et al*., 2006:e1758), which increases the risk of obesity and overweight (Faught *et al*., 2005:376).

The physical fitness of children is negatively influenced by overweight and obesity (Truter *et al*., 2010:227). Physical fitness is determined by cardiovascular endurance, body composition, muscular strength, muscular endurance and flexibility (Truter *et al*., 2010:227). Results of the study by Truter *et al.* (2010:232) report that children with normal weight have higher cardiovascular fitness levels than overweight or obese boys and girls who were found to have lower cardiovascular fitness levels. Truter *et al*. (2010:232) further indicated that overweight and obesity are associated with lower muscular strength, especially in the legs.

Muscle endurance also decreased in the study with an increase in BMI (Truter *et al*., 2010:232).

D'Hondt *et al.* (2009:33) further found that child obesity and overweight have a negative influence on children's fine motor skills. It would appear that posture control and balance have an effect on fine motor achievement (Zhu *et al*., 2011:805). Assessment of balance stability indicated that higher body weight is associated with poorer posture stability (D'Hondt *et al*., 2009:33). Child obesity and overweight are associated with lowered control of posture stability which, in effect, place limitations on the execution of other motor skills (D'Hondt *et al*., 2008:72). According to D'Hondt *et al.* (2008:74), obese children did not perform as well in fine motor skill tests, where they had to place a peg in a peg-board, because their posture control was weak.

2.5.2 Psychosocial development

With the dramatic increase in child obesity and overweight during the past two decades, more studies have been done to understand the impact of obesity on children's psychosocial development and functioning (Dreyer & Egan, 2008:159). Due to child development being influenced by numerous factors, it is recommended that the psychosocial effects of child obesity be studied; not only with regard to children's individual functioning, but also in the context of children's relationships with classmates, family and community functioning (Davison & Birch, 2001:168).

On an individual level psychosocial functioning can be negatively influenced by obesity and overweight, since it might lead to low self-confidence and depression. Research on the psychosocial functioning of obese and overweight youths indicate constant areas of lowered functioning, such as lowered health-related quality of life (Dreyer & Egan, 2008:160). Social support and social skills can play an important role in the development and prevention of these problems. Both these concepts are theoretically linked. Social skills are essential to begin and maintain social relationships. By using social skills, social support is mobilised and negative aspects of social relationships or interactions are lowered (Dierk *et al*., 2006:219-220).

Obesity is a visible condition where everyone can assess the individual's weight status and remark on it (Warschburger, 2005:S127). As a result, obese children have a higher risk of becoming victims of weight-based stigmatisation by their peer group (Gray *et al.*, 2009:720). According to Gray *et al.* (2009:722) weight-based stigmatisation and injustice during childhood can have a negative influence on children's psychosocial and social adaptation. Teasing is defined as personal communication, directly from a specific person to a specific target, with combined components of aggression, humour and ambiguity (Shapiro *et al*., 1991:459).

Research by Faith *et al.* (2002:e23) shows that children who are the targets of criticism about their weight, do not only have negative attitudes towards participation in sport, but also have lower physical activity levels. For example, specific teasing during participation in physical activity is linked with lower physical activity participation patterns and lower enjoyment during sport participation (Faith *et al.*, 2002:e23). Research about the incidence of general psychopathology among obese children is limited, while more research is reported where specific areas of psychosocial functioning was studied. These areas will now be discussed in more detail.

2.5.2.1 Depression

Children who receive medical treatment for obesity indicate an increased incidence of depression (Dreyer & Egan, 2008:160). Erickson *et al.* (2000:931) found that other factors, i.e. how the child feels about his/her weight, rather than the higher BMI, plays a more central role in the development of depression. It is, therefore, not only the weight status or BMI that leads to depression, but rather the child's negative view about him-/herself (Erickson *et al.*, 2000:931).

2.5.2.2 Self-concept/self-confidence

Self-concept is the image which an individual has of him-/herself and self-confidence the amount of value he/she appropriates for him-/herself (Dreyer & Egan, 2008:160). It is important to understand children's self-concept and -confidence, because a low self-image and confidence can lead to increased sadness, loneliness and anxiety (Strauss, 2000:1). The identification of a low self-image and -concept in obese children can be useful in the early

recognition of other psychosocial problems that may develop, such as depression (Dreyer & Egan, 2008:160).

2.5.2.3 Health related quality of life

Quality of life refers to the all-encompassing standard of the child's lifestyle and whether the population can provide for the basic needs of the child, which include access to food, housing and health care (WHO, 2012). Hampering the quality of life indicates an inability to execute daily or physical activities. Results indicate that the quality of life of obese children can deteriorate and should regularly be evaluated and monitored to prevent future shortcomings (Dreyer & Egan, 2008:161). The quality of life of children suffering from obesity can deteriorate 5,5 times to that of normal weight children (Schwinner *et al*., 2003:1813).

2.5.2.4 Peer group relationships

Good relationships with classmates during childhood and adolescence are essential for healthy social and cognitive development. Through interaction with friends, children develop social and problem solving skills and learn how to develop and maintain relationships with others (Dreyer & Egan, 2008:161). During stress situations, healthy relationships with classmates can provide important social and cognitive aids (Hartup, 1996:1). Recent research found that obese children have problematic social functioning (Dreyer & Egan, 2008:161). Zeller *et al.* (2008:755) found that obese children are less often regarded by their classmates as "best friends" and they are less popular. Obese children are also described by their classmates and teachers as more isolated and sensitive (Dreyer & Egan, 2008:161), they also show less leadership behaviour and are more prone to aggressive and explosive behaviour (Zeller *et al.*, 2008:755).

2.5.3 Intellectual and cognitive development

Obesity during childhood does not only have social implications, but also lead to cognitive problems (Dreyer & Egan, 2008:161). Children spend a considerable amount of time at school on a daily basis and the effect of overweight is experienced in various aspects of school life, including academic achievement, social skills and school attendance (Datar & Sturm, 2006:1449). Recent research proves that children who experience obesity early in

their lives have a cognitive functioning on par with children suffering from Prader-Willi syndrome (Dreyer & Egan, 2008:161). According to Miller *et al*. (2006:192) children suffering early obesity display more negative behaviour, weaker adaptive functioning and lower cognitive functioning.

Several studies confirm a relationship between child obesity and academic achievement. A national American study among primary school children found a negative association between overweight status and academic achievement (Datar *et al.*, 2004:58). In this study overweight children scored considerably lower marks in mathematics and reading than non-overweight children (Datar *et al.*, 2004:58). Another study among children and adolescents in Thailand found overweight to be associated with lower grade averages between Grades 7 to 9, but not between Grades 3 to 6 (Mo-Suwan, 1999:272). Du Toit *et al*. (2011:113) conducted a study in SA among 9-12 year old children to determine the relationship between physical fitness and academic achievement. Clear relationships were found between specific strength tests and academic achievement and the conclusion was drawn that a positive relationship exists between physical fitness components and academic achievements.

Overweight can, for example, lower self-confidence and self-image, which makes it more difficult to concentrate or pay attention during classes (Datar & Sturm, 2006:1449). Furthermore, the health risks associated with overweight can result in increased absence due to illness, which may lead to classes being missed or increased lethargy and the resultant decline in academic achievement (Datar & Sturm, 2006:1449).

2.6 HEALTH RISKS ASSOCIATED WITH OVERWEIGHT AND OBESITY IN CHILDREN

The obesity epidemic places high demands on the health of children. Certain obesity-related conditions have an immediate health effect, while others manifest a longer term chronic effect (Daniels, 2006:48). Overweight and obesity can give rise to numerous negative health conditions. Table 2.3 indicate conditions that may develop in children and adolescents who are overweight or obese (Daniels *et al.*, 2005:2004; Daniels, 2006:49).

Table 2.3: Harmful outcomes of child obesity and overweight (Daniels *et al.*, 2005:2004; Daniels, 2006:49)

Metabolic	**Type 2 Diabetes Mellitus** See 2.6.2
	Metabolic syndrome There is an association between insulin resistance and hypertension, dyslipidaemia, Type 2 diabetes and other metabolic abnormalities associated with a heightened risk for arteriosclerotic cardiovascular diseases in adulthood (Reavan, 1988:1595).
Orthopaedic	**Femoral epiphyses** This condition occurs during the adolescent growth phase and generally mostly among obese children (Randall & Loder, 1998:2135). Femoral epiphysis is the most general hip condition (Manoff *et al*., 2005:744).
	"Blount's" disease (Tibia vara) "Blount's" disease is growth retardation with an epiphysis deficiency on the upper end of the tibia (Blount & Milwaukee, 1937:1).
Cardiovascular	**Diabetic Dyslipidaemia** Diabetic dyslipidaemia is an important cardiovascular risk factor for Type 2 diabetes. It is characterised in low HDL cholesterol and high serum very low-density lipoprotein-triglycerides. The slightest increase in LDL-cholesterol in Type 2 diabetic patients is associated with a remarkable increase in cardiovascular risk (Taskinen, 2002:47).
	Hypertension Childhood obesity is the main cause of paediatric hypertension, although children do not normally suffer from hypertension (Speiser *et al*., 2005:1877). Hypertension refers to higher than normal blood-pressure (Whitney & Rolfes, 1999:570).
	Arteriosclerosis Hardening of the arteries, also known as arteriosclerosis, is a common illness (WHO, 1999). It occurs when fat, cholesterol and other substances build up in the walls of the arteries and start hardening (WHO, 1999). In time it causes blockages in the arteries and results in symptoms and problems throughout the body (WHO, 1999).

Psychological	**Depression** See 2.5.2.1
	Poor quality of life See 2.5.2.3
Hepatic	**Fat liver disease** Fat liver disease is the most common liver abnormality in children between the ages of 2-19 years (Schwimmer *et al.*, 2006:1888). Obesity is a big risk factor and is associated with an increased tempo of fat liver disease in children (Schwimmer *et al.*, 2006:1898). Fat liver disease is associated with macro-vesicular fat and different degrees of inflammation, cellular damage and fibrosis (Lavine & Schwimmer, 2004:549).
	Non-alcoholic Steato hepatitis This is a condition characterised by hepatomegaly, increased serum aminotransferase levels and a histologic picture, similar to alcoholic hepatitis, but it manifests in the absence of alcohol abuse (Reid, 2001:710).
Pulmonary	**Obstructive sleep apnoea** See 2.6.4
	Asthma See 2.6.1
Renal	**Proteinuria** Proteinuria is not only a good indicator of kidney disease, but also an independent risk factor for the progress of renal deterioration (Tryggvason & Pettersson, 2003:216). Various proteins appear in the glomular podocytes, where mutations lead to the disease (Tryggvason & Petersson, 2003:216).

A brief discussion will now follow of a few of the most common health risks associated with overweight and obesity in children.

2.6.1 Asthma

According to Delgado *et al.* (2008:420) asthma and obesity have a major impact on public health and the incidence has increased over the past years. Asthma is the most common chronic respiratory disease among children and is characterised by airway obstruction, airway inflammation and heightened airway reactions to a variety of stimuli (Murphy *et al.*, 1997:1). Obesity has the ability to lower the pulmonary availability, lung volumes and the diameter of the peripheral respiratory airways, and also to affect the blood volume and ventilation perfusion (Delgado *et al.*, 2008:422). Positive relationships are reported between asthma and overweight or obesity (Luder *et al.*, 2004:29). Most studies indicate that obesity is a risk factor for asthma, with a positive correlation between baseline BMI and the development of asthma. Weight increase also increases the risk of asthma and weight loss improves the condition (Delgado *et al.*, 2008:420). A study done by Gennuso *et al*. (1998:1197) on 171 4 to 16 year old children studied the correlation between asthma and obesity. Eighty-five children were diagnosed with asthma, while 86 children showed no symptoms. The results reported that more children (30,6%) who were diagnosed with asthma were also obese (Gennuso *et al*., 1998:1197). A lung health study undertaken in Israel on 5 987 children also found that asthma was diagnosed more among obese children (7,2%) than non-obese children (3,9%) (Bibi *et al*., 2004:403). More obese children (15,9%) used an asthma pump than non-obese children (8,8%) in this study (Bibi *et al*., 2004:403).

2.6.2 Diabetes

Diabetes is a chronic condition which can lead to the following medical complications: heart disease, stroke, kidney failure, blindness and nerve damage (Steppan *et al*., 2001:307). According to Hossain *et al.* (2007:213), 18 million people die annually as a result of cardiovascular diseases of which diabetes is a major contributory factor. Obese children have a 10 times higher risk for developing diabetes than non-obese children (Stein & Colditz, 2004:2523). Resnick *et al.* (2000:596) indicate that obesity and weight increase are associated with a heightened risk for diabetes. Obesity is associated with insulin resistance, which when linked with relative insulin deficiency, may lead to the development of Type 2 diabetes (Hannon *et al.*, 2005:473). Type 2 diabetes is characterised by target tissue which resists insulin (Steppan *et al*., 2001:307). In the past the majority types of diabetes diagnosed in children and adolescents were Type 1 diabetes. Obesity has, however, resulted in a dramatic

increase in the occurrence of Type 2 diabetes among children and adolescents (Hannon *et al.,* 2005:473). Approximately 90% of all Type 2 diabetes cases is the result of overweight (Hossain *et al*., 2007:213). Children and adolescents with Type 2 diabetes may experience macro (larger) and micro (smaller) vascular complications such as arteriosclerosis, cardiovascular diseases, strokes, myocardial infarction, kidney inefficiency and blindness, at a younger age as opposed to individuals who develop the disease in adulthood (Hannon *et al.,* 2005:473). A study by Hyppönen *et al.* (2000:1755) evaluated the effect of obesity and linear growth on the risk of children to developing Type 1 diabetes. The results indicated that boys and girls, who developed Type 1 diabetes, were taller and weighed more and that obesity and linear growth were risk factors for diabetes in children (Hyppönen *et al.,* 2000:1755).

2.6.3 Cardiovascular diseases

The cardiovascular system is responsible for the transport of blood to and from the heart and the rest of the body. Arteries supplying blood are susceptible to various diseases which could eventually lead to heart attacks and strokes (Daniels, 2006:48). All diseases relating to the heart and blood vessels are known as cardiovascular diseases. Professional health-workers have found that hardening of the arteries, which was previously only diagnosed among adults, is now also appearing among children (Daniels, 2006:49). This hardening of the arteries is also known as atherosclerosis, which is the main cause of cardiovascular disease due to the vessels pumping blood to the heart becoming clogged (Whitney & Rolfes, 1999:143). One of the biggest risk factors for heart attacks and strokes is high blood-pressure (Daniels, 2006:48). Obesity contributes to the development of high blood-pressure, not only in adults, but also in children and adolescents (Falkner *et al.*, 2004:88). Rosner *et al.* (2000:1018) found the incidence of high blood-pressure to be considerably higher among children with a BMI of/or above the 90th percentile as opposed to children whose BMI is below the 10th percentile. According to Rosner *et al.* (2000:1018), the risk for heightened blood-pressure is between 2,5 and 3,7 times higher among overweight children, depending on their race and gender. A study by Kemp *et al.* (2011:117) on 816 Grade 1-learners in the NWP of SA also confirms a strong relationship between hypertension and body composition. The incidence of hypertension in the study was 24,9% and both systolic and diastolic blood pressure were associated with BMI, body fat percentage and waist circumference (Kemp *et al.,* 2011:117).

2.6.4 Obstructive sleep apnoea

Obesity and obstructive sleep apnoea are related to each other in both adult and child populations. Obstructive sleep apnoea or the abnormal collapse of airways during sleep; contribute to snoring, uneven breathing and disruptions in sleep patterns (Daniels, 2006:54). Sleep disruptions can result in excessive tiredness during the day, which could lead to lowered participation in physical activity as well as the risk of further increases of obesity. Daytime tiredness can also have a negative impact on academic achievement (Daniels, 2006:54). According to Rhodes *et al.* (1995:743) obstructive sleep apnoea affects children's achievement in neuro-cognitive tests, memory, learning and intellectual abilities. Breathing problems during sleep is one of the most important, but least acknowledged, medical complications among overweight children and adolescents (Daniels, 2006:54).

2.7 UNDERNUTRITION

The literature overview will now focus on a discussion of undernutrition (stunting, wasting and underweight). The classification and definition of undernutrition will be discussed first, before the incidence of undernutrition among children will be studied. The effect of undernutrition on child development and health will then be considered and, in conclusion the relationship between stunting and overweight will be analysed by means of available literature.

2.7.1 Definition and classification of undernutrition

The WHO (WHO, 2011a) defines undernutrition as a cellular imbalance between the supply of nutrients and energy and the body's ability to use it for growth and to maintain specific functions, including resistance against infections and recovering from illnesses (UNICEF, 1998). Undernutrition is the result of an imbalance between the provision of nutrients and energy supply to the body (too low) in relationship to its needs and requirements (Alberta *et al*., 2006:419). Nutritional status reflects growth among children, thus abnormalities in growth is an indicator of undernutrition (Robinson *et al.,* 2001:287). Undernutrition is characterised in chronic undernutrition (stunting), acute undernutrition (wasting or thinness) and underweight (Tharakan & Suchindran, 1999:843). Stunting is defined as insufficient

height-for-age and wasting or thinness as insufficient mass-for-height, and is also considered to be equivalent to BMI-for-age (Victoria, 1992:1105).

The reference data (Ogden *et al.*, 2002:45) of the "US National Centre for Health Statistics" (NCHS, 1977) is used as a standard to calculate the z-scores for weight-for-age (WAZ), height-for-age (HAZ) and weight-for-height (WHZ). The WHZ z-score is equivalent to the BMI-for-age. A child is classified in categories of stunting or severe stunting, wasting or thinness and underweight or severe underweight if the z-score falls into one of the following categories, as displayed in Table 2.4.

Table 2.4: Categories of stunting, wasting and underweight

Z-Score		**Category**
Stunting Height-for-age	Stunting	Z-score less than -2 standard deviation of the median from the reference population
	Severe stunting	Z-score less than -3 standard deviation of the median from the reference population
Wasting or thinness BMI-for-age	Wasting or thinness	Under the 5^{th} percentile of the International reference population
Underweight Weight-for-age	Underweight	Z-score less than -2 standard deviation of the median from the reference population
	Severe underweight	Z-score less than -3 standard deviation of the median from the reference population

2.8 THE OCCURRENCE OF UNDERNUTRITION IN CHILDREN

According to the WHO (WHO, 2011c), undernutrition is the reason that 171 million children under the age of 5 years to be stunted annually and 115 million children to suffer from wasting. Underweight is furthermore the cause of more than half of child deaths in developing countries. In the year 2000, underweight was the cause of 3,4 million deaths worldwide of which 1,8 million was in Africa. In 2005, UNICEF reported that undernutrition had led to more than a third of child deaths in developing countries. Underweight is mainly the result of an insufficient diet and regular infections, which lead to a shortage of calories, proteins, vitamins and minerals. Underweight remains a consistent problem in developing countries where poverty is a major underlying cause. Poverty further contributes to food shortages in the home, inadequate child care, underfeeding during pregnancy, unhealthy surroundings and poor health care (WHO, 2011a). The "General Household Survey" done in 2007, reported that 2,7 million South African children suffer from a lack of food. It is, therefore, considered to be a serious problem in SA (WHO, 2007).

Literature findings relating to the incidence of stunting, wasting and underweight worldwide and more specifically, the incidence thereof in SA, will now be discussed.

2.8.1 Worldwide statistics

The WHO (2011c) reports that worldwide 36 countries are home to 90% of children who are on a worldwide scale, stunted. Furthermore, undernutrition leads to 11% of all illnesses which in the long-term contribute to poor health. The WHO further reports that 20 million children worldwide suffer from stunting (WHO, 2011c). Popkin *et al.* (1996:3013) conducted studies in various countries to determine the incidence of stunting. These researchers found that in Brazil 15% of the children who participated in the study, were stunted, while 25,9% in China and 9,2% in Russia, showed signs of stunting (Popkin *et al*., 1996:3013). Gray *et al.* (2006:553) reports that 10% of the children in their study suffered from wasting and 42,4% were stunted.

In Africa, 1 of every 3 children is affected by stunting (Fleshman, 2002:2), and statistics indicate that stunting and wasting are still on the increase here (Shashidhar & Grigsby, 2009:3). Since 1990, the rate of stunting and wasting has increased from 24% to 26,8% and

47,3% to 48% respectively (Shashidhar & Grigsby, 2009:3). Children who live in rural areas are also most affected according to Tharakan and Suchindran (1999:844). A study by Prista *et al.* (2003:956) in Mozambique on 2 316 children aged between 6 and 18 years indicates a decrease in stunting from 34,5% to 3% in boys and 24,6% to 2,3% in girls over the period of the study (September 1992–June 2000).

A study of 734 children between the ages of 0 and 6 years in Botswana, reports stunting in 29,6% of the children, 7,1% were wasting and 14,9% were underweight. Toddlers under the age of one year in this study had very low levels of stunting and wasting, while the figures were higher among older children. These figures indicate that age is an important factor to consider in stunting and wasting statistics (Tharakan & Suchindran, 1999:846). A possible reason for this phenomenon is that approximately 13 million babies are born with a low birth weight and thus do not grow to their full potential during their childhood (WHO, 2011c).

The incidence of stunting, wasting and underweight among the different genders and racial groups worldwide, also have relevance to this study and will therefore be discussed. A study by Gray *et al.* (2006:551), in Central Honduras, of school children (N=799) between 7 and 12 years of age found that 53,3% of boys and 46,7% of girls had stunted growth. Another study by Wamani *et al*. (2007:17) reported the same results, where stunting was higher among boys (40%) than girls (36%). There are only a few studies available regarding gender differences relating to wasting and underweight. Malat *et al.* (2005:442) also reports that Black children in America had a poorer health status than White children in their study. Most babies born with a low birth weight in America are Black and this racial group also has the highest incidence of low birth weight babies of all other ethnic and racial groups (WHO, 2008). Again very few research results are available relating to the incidence of stunting, wasting and underweight among different racial groups worldwide.

2.8.2 South African statistics

In SA, two-thirds of children grow up in four of the nine provinces, namely, KwaZulu-Natal (22%), Eastern Cape (16%), Gauteng (16%) and Limpopo (14%) (South African Child Gauge 2008/2009, 2009:71). Furthermore, a great amount of children grow up in provinces with large rural populations (South African Child Gauge 2008/2009, 2009:71). According to the "South African Child Gauge 2008/2009" (2009:77) two-thirds (68%) of children are exposed

to households with income poverty (per capita income below R350). The THUSA BANA study done in the NWP by Mukuddem-Peterson and Kruger (2004:842) on 1 257 children between the ages of 10 and 15 years, found that stunting was higher in rural areas (26,7% boys; 23,7% girls) opposed to urban areas (17,1% boys; 11,6% girls). The "National Food Consumption Survey" (Labadarios *et al.*, 2005:533) done on pre-school children in SA, indicated that 1 of 4 children was stunted and 1 of every 10 children were underweight. A study in KwaZulu-Natal of 579 primary school children between the ages of 8-10 years found that 7,3% of the children were stunted (Jinabhai *et al*., 2001:50). In 2005 Steyn *et al*. (2005:4) did a national study of 2 894 children between the ages of 1 and 9 years and reported stunting to be 19,3% (Steyn *et al*., 2005:9).

Faber *et al*. (2001:401) conducted a study in a rural community of Ndunakazi in KwaZulu-Natal of 164 children between 2 and 5 years old. These research results indicated that one-fifth of the children had poor linear growth and 9% suffered from wasting and 21% from stunting (Faber *et al*., 2001:408). Another study in KwaZulu-Natal (Chopra, 2003:645) found that of the 516 households with children that participated in the study, 12% suffered from wasting and 26,3% from stunting. In the Agincourt sub-district of the Mpumalanga province, Kimani-Murage *et al*. (2010:158) did a growth study on 3 511 children and adolescents, in which 1 of every 5 children between the ages of 1 and 4 years were stunted.

A physical growth and nutrition study was done by Monyeki *et al*. (2000:42) on 1 335 children between the ages of 7 and 7,9 years in Ellisras in the Limpopo Province. These researchers found that 28,6% of boys and 32,2% of girls were underweight, while stunting was present in 5,5% of boys and 3,5% of girls (Moneyki *et al*., 2000:46-47). Data of the "Living Standards and Development Survey" (LSDS) was used to determine the incidence of undernutrition among 3 765 children in SA under the age of 5 years (Zere & McIntyre, 2003:7). The results indicated that of all the undernutrition indicators, stunting is most prevalent in SA. The study by Zere and McIntyre (2003:7) further indicated that the prevalence of stunting was the highest in the Eastern Cape and Northern Province of SA.

Race and gender differences were also found among children in SA regarding stunting, wasting and underweight. According to a study by Reddy *et al.* (2008:205) a higher percentage of boys than girls were underweight, while racial differences were found between Black and Mixed ancestry population groups, but not among White groups. A study by

Armstrong *et al*. (2006:441) reported difference in height and weight among the different racial groups for both boys and girls, with White children being taller and heavier, while Black children were shorter and lighter (Armstrong *et al*., 2006:441).

In summary it appears that the incidence of stunting and wasting in SA is higher in the rural than the urban areas (Mukuddem-Peterson & Kruger, 2004:842). One of the main reasons for this is that a larger number of children live in rural areas (South African Child Gauge 2008/2009, 2009:71) and other in poorer socio-economic circumstances. Several studies found that undernutrition is more prevalent among boys than girls (Moneyki *et al*., 2000:46-47; Mukuddem-Peterson & Kruger, 2004:842; Reddy *et al*., 2008:205). With regard to race, undernutrition is more prevalent among the Black and Mixed ancestry children than among the White children (Armstrong *et al*., 2006:441; Reddy *et al*., 2008:205). However, too little research has been done on the various racial groups in SA to make a proper comparison in this regard.

2.9 THE EFFECT OF UNDERNUTRITION ON CHILD DEVELOPMENT

Undernutrition threatens children's educational progress and development (WHO, 2012), and delays physical, motor and mental development (UNICEF, 1998). Weak fetal growth and stunting in the first two years of life is reported to lead to irreversible damage, which includes lower attainment of grades in the primary school (Victora *et al.,* 2008:340). The researchers further reported that genetic and environmental factors influence growth lengthwise throughout the growth phase (Victora *et al.,* 2008:340).

2.9.1 Cognitive development

According to Victora *et al.* (2008:343), undernutrition can cause permanent brain damage which can affect cognitive development and lead to poor mental development (Brown & Pollitt, 1996:38). Studies of undernourished children indicate changes in brain development, including a slower growth tempo of the brain, lower brain weight, a thinner cortex and a lower number of neurons (Shashidhar & Grigsby, 2009:2). Researchers also found relationships between stunting and the presence of immediate or later cognitive abilities (Brown & Pollitt, 1996:38; Scrimshaw, 1998:368; Victora *et al.,* 2008:340), poor school

performance (Mendez & Adair, 1999:1555; Victora *et al.*, 2008:340) as well as poor school achievement (Victora *et al.*, 2008:340; Walton & Allen, 2011:418). Children's height-for-age (stunting), weight-for-age (underweight) and BMI have furthermore been positively associated with achievements in both English and Mathematics in the study by Themane *et al*. (2003:637). According to Grantham-McGregor *et al.* (2007:60) growth impediment and poverty are negatively associated with school achievement and cognition.

2.9.2 Psychological problems

Apart from all the physical problems associated with undernutrition, a child's psychological development is also negatively influenced (Saunders *et al*., 2010:47). According to Guest *et al*. (2011:422), undernutrition is a serious clinical and public health problem, which affects the physical and psychosocial well-being of children negatively and could lower the possibility of becoming independent. Children suffering from undernutrition exhibit behavioural changes and appear irritated, are apathetic, have attention deficiency, are anxious, have lower social responses (Shashidhar & Grigsby, 2009:4) and show signs of depression and self-pity (Saunders *et al*., 2010:47).

2.9.3 Motor development

Apart from growth impediment, undernutrition also has a negative effect on children's motor development (Milman *et al*., 2005:1415). Chopra and Sharma (1992:9) found that undernutrition negatively influences children's speed, fine motor skills and coordination. The peripheral nerves and muscle functions are negatively affected by undernutrition according to Chopra and Sharma (1992:8). Weaver (2003:38) found that undernutrition leads to anaemia which negatively influences young children's behavioural and motor development.

2.10 HEALTH RISKS ASSOCIATED WITH UNDERNUTRITION IN CHILDREN

According to Guest *et al*. (2011:422), the health care expenses for treating people suffering from undernutrition are more than double to those not suffering from undernutrition. The main reason for this is that an increased number of health care resources have to be used (Guest *et al*., 2011:422). Stunting indicates the cumulative results of slow skeletal growth, normally associated with long-term dietary deficiency or repetitive infections. It is also associated with poor health outcomes in babies and children (Ricci & Becker, 1996:966).

Furthermore, wasting leads to numerous problems in children, many of which can become chronic conditions. In this regard, serious weight loss, lowered resistance to illness and in more severe cases, early deaths, are reported (Brown & Pollitt, 1996:38). Victora *et al.* (2008:340) reports that wasting can lead to a lack of work capacity, immune function, healing of wounds, organ function, mental capacity as well as physical growth (Green, 1999:3).

Undernutrition furthermore affects the functions of every organ system in the human body (Shashidhar & Grigsby, 2009:1; Saunders *et al*., 2010:46). The influence of undernutrition on the functionary of certain organ systems will now be discussed.

2.10.1 Muscle and bone development

The most clinical sign of undernutrition is weight loss caused by the depletion of fat and muscle sources, including organ mass. Bone mass is depleted during weight loss, especially when the intake of calcium, magnesium and/or vitamin D is insufficient. The new forming of bone is slow during recovery and the risk of fractures increases (Saunders *et al*., 2010:46-47).

2.10.2 Cardiovascular and respiratory function

Saunders *et al*. (2010:47) report a decrease in cardiac muscle mass in individuals suffering from undernutrition. The lowered cardiac muscle mass lead to a lowering of cardiac output with a direct corresponding effect on renal function, due to lowered renal perfusion and glomerular filtration (Saunders *et al*., 2010:47). Undernutrition during the early years of life can increase the risk of cardiovascular disease and can lead to life-long negative consequences (Victora *et al.,* 2008:347). A weak diaphragm and respiratory muscle function

are also found in people suffering from undernutrition, which lower the cough pressure and spitting of excretions that lead to slower healing of respiratory infections (Saunders *et al*., 2010:47).

2.10.3 Gastro-intestinal function

Sufficient nutrition is important for the preservation of the gastro-intestinal function. Undernutrition directly leads to changes in the pancreatic exocrine function, intestinal blood flow and intestinal permeation (Saunders *et al*., 2010:47). According to Saunders *et al*. (2010:47) the loss of digestive enzymes occurs early during food insecurity and generally leads to secondary lactose tolerance with diarrhoea. The colon loses its absorption ability for water and electrolytes and the secretion of ions and liquids occur in the colon, which leads to diarrhoea. A high mortality figure is associated with diarrhoea in undernourished individuals (Saunders *et al*., 2010:47). Other pathological changes include fat degeneration in the liver and heart, atrophy of the colon and lowered intra-vascular volume (Shashidhar & Grigsby, 2009:2).

2.10.4 Immune and tissue recovery function

The immune function comes early under pressure during wasting (Saunders *et al*., 2010:47) and immune response changes occur early in children suffering from undernutrition (Shashidhar & Grigsby, 2009:1). Wasted people, especially, have a higher risk of respiratory infections and any bacterial or parasitic infections will spread quickly (Saunders *et al*., 2010:47).

2.10.5 Endocrine function

Most endocrine functions are put under pressure by undernutrition due to the decrease of insulin secretion and the increase of insulin sensitivity during wasting (Saunders *et al*., 2010:47). Blood glucose thus remains low-normal. Thyroid-stimulating hormones usually remain normal unless the iodine status is damaged (Saunders *et al*., 2010:47).

2.11 THE RELATIONSHIP BETWEEN UNDERNUTRITION AND OVERWEIGHT AND OBESITY IN CHILDREN

In conclusion, this section will provide a short discussion of the possible relationship between undernutrition and overweight and obesity in children. Popkin *et al.* (1996:3009*)* state that in the past a distinct relationship was reported between stunting and the availability of food; the higher the food supply, the lower was the incidence of stunting. However, currently this association is not that clear (Popkin *et al.*, 1996:3009*).* Stunting is further regarded as a contributory factor in the increase of obesity in developing countries (Mukuddem-Peterson & Kruger, 2004:843). In this regard, a higher risk for obesity in children suffering from stunting in Spanish-American and Jamaican populations, is described (Popkin *et al.*, 1996:3009*).* Studies by Popkin *et al*. (1996:3009) investigated the relationship between stunting and overweight among children 3 to 6 years and 7 to 9 years in Russia, Brazil, SA and China respectively. The results showed a clear association between stunting and overweight status in all these countries (Popkin *et al*., 1996:3009).

Barker's hypothesis implied that the risk for the development of chronic diseases including cardiovascular diseases, hypertension, Type 2 diabetes and obesity increased in later life due to the fetal in-utero environment (Kim, 2004:192). A low birth weight is the reason for slow fetal growth and can lead to a dramatic weight increase during childhood (Barker *et al*., 2002:1235). James *et al.* (2001:228S) also confirmed that obesity is prominently associated with poverty and that obesity in adults sometimes occurs among those who had a low birth weight or were stunted during childhood.

Mukuddem-Peterson and Kruger (2004:842) report that the worldwide problem of overweight and stunting is the result of the social, economic and cultural problems experienced in developing and newly industrialised countries. A large number of South Africans in urban and rural areas find themselves in a phase of food transition due to changes in the economic, social demographic and health factors (Popkin, 1993:138). These changes lead to an increase in the incidence of overweight and obesity (Drewnowski & Popkin, 1997:31). It is reported that in disadvantaged communities in SA, undernutrition can occur among children and obesity among adolescents, in the same socio-geographic population (Kimani-Murage *et al.*, 2010:158), as well as the same family (Vorster, 2010:2). In SA,

undernutrition and overweight or obesity are found in the same populations, in the same households and even in the same children (Rossouw *et al*., 2012:1).

2.12 CHAPTER SUMMARY

The preceding literature overview firstly aimed at elucidating the diversity of the South African population with its social and welfare problems, to serve as a background for a better understanding of the incidence of child obesity and stunting among South African child populations. This analysis clearly indicated that SA is a diverse population regarding race, nutritional status and socio-economic circumstances. Secondly, the literature overview aimed to explain the incidence of overweight and obesity among the child population within the context of current world tendencies. This literature overview indicated noticeable increases in the incidence of overweight and obesity in recent years, worldwide as well as in SA. Due to this increased incidence it has become a health problem of great concern worldwide. The literature overview further clearly illustrated that child development is influenced in numerous ways by overweight and obesity. Literature in this regard showed that gross and fine motor skills, psychosocial, cognitive and intellectual development are negatively influenced by overweight and obesity. The literature overview also drew attention to the fact that various health risks are the result of overweight and obesity and it is clear that overweight and obesity place considerable pressure on children's health.

Thirdly, the literature overview aimed to draw attention to the incidence of stunting, wasting and underweight among children worldwide and, more specifically, in SA. Undernutrition regularly forms part of a negative cycle that includes poverty and illness. The literature overview also made it clear that undernutrition has a negative influence on child development. Researchers indicated that gross motor, fine motor, cognitive and psychosocial development is negatively influenced by undernutrition. The literature overview also links various health risks to undernutrition which indicates that children suffering from the condition will not enjoy optimal well-being.

In conclusion, the literature overview investigated the possible relationship between stunting and overweight and discussed literature findings in this regard. A clear relationship between stunting and overweight is reported, which indicates that individuals who were exposed to

stunting during childhood are more likely to be obese as adults. Literature also indicated that stunting and overweight can occur in the same area and family in certain life circumstances. With these literature findings as background, the results of the study will be discussed in Chapters 3 and 4.

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CHAPTER 3

CHAPTER 3

The prevalence of overweight and obesity in Grade 1-learners in the North West Province of South Africa: The NW-CHILD Study

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CHAPTER 3

Abstract

Objectives. To determine the prevalence of overweight and obesity among Grade 1-learners in the North West Province (NWP) of South Africa (SA) and how it relates to age, gender, race and school type.

Design. The study formed part of the baseline measurements of the longitudinal NW-CHILD study. Stratified random sampling was used to identify 20 schools from 4 educational districts and 5 different school Quintiles in the NWP of SA.

Setting. NWP of SA.

Subjects. Eight hundred and sixteen (419 boys, 397 girls) Grade 1-learners with a mean age of 6.78 years participated in the study (567 black learners, 218 white learners, 31 other race groups).

Outcome measured. Standard anthropometric techniques and International BMI cut-off values (Cole et al., 2000) for children were used to determine overweight and obesity.

Results. An overall percentage of 11.64% of overweight (7.8%), obesity (1.8%) and severe obesity (2.0%) were found in the group. Overweight and severe obesity increased in white learners from 11.6% and 2.9% to 16.3% and 3.8% respectively at 7 years of age. A higher prevalence of overweight and obesity were found in the 6 year old girls (8.1%; 3.5%) compared to 6 year old boys (4.4%; 1.6%), and in 7 year old girls (11.8%; 1.5%) compared to 7 year old boys (9.5%; 0%). Boys showed the highest prevalence for severe obesity at 6 and 7 years of age. White learners showed the highest prevalence for overweight, obesity and severe obesity at 6 and 7 years. White learners and Quintile 4 schools (higher socio-economic areas) had the highest prevalence of overweight, obesity and severe obesity at 6 years of age, while the highest prevalence of overweight and obesity in 7 year old learners were in Quintile 5 schools. White learners and Quintile 4 schools showed the highest prevalence for severe obesity at 7 years.

Conclusion. One in 10 school beginners were overweight and obese, although the incidence were lower in school types associated with low SES. Evidence of severe obesity in both genders and in all race groups. Prevention strategies are thus needed to combat overweight and obesity and the associated negative consequences of this health risk.

Key words: overweight, obesity**,** children, race, gender

The prevalence of overweight and obesity in Grade 1-learners in the North West Province of South Africa: The NW-CHILD Study

Introduction

Overweight and obesity have become a global epidemic, especially in children.[1,2,3] The statement *"Today's generation of children will be the first for over a century for whom life expectancy falls"*,[1] emphasize the seriousness of obesity in children. Overweight and obesity can be defined as abnormal excessive accumulation of body fat,[4] which is the result of an imbalance between energy intake and energy expenditure.[5] One billion people in both developed and developing countries are affected by overweight and obesity.[4] In 2010, nearly 43 million children under the age of 5 years worldwide were overweight.[4] The incidence of overweight and obesity in Canada, Norway and America in children aged between 6 and 11 years, were 6.3%, 10.1% and 20.7% respectively.[6] Although the incidence of overweight in children has doubled over the past 2 decades,[7] severe obesity is also becoming a more general phenomenon among children.[8] A study in America indicates that rates of severe obesity have tripled in the last 25 years where 3.8% of children were severely obese, with significant differences by race, gender and poverty.[8] Another study in the Netherlands also reported that the prevalence of severe obesity worldwide is still rising.[9]

Some parts of South Africa (SA) are more affected by overweight and obesity and possible contributing factors are improved socio-economic status, urbanisation and a decrease of physical activity.[10] A study of 6 to 13 year old South African children of different races, found that 14% boys and 17.9% girls were overweight and 3.2% boys and 4.9% girls were obese.[11] Armstrong *et al.* [11] also found that white children were more overweight and obese than black and mixed ancestry children at 6 and 7 years. Truter *et al.* [12] report that one in five children between the ages of 9 to 12 years were overweight or obese, and girls were more overweight and/or obese than boys. The National Food Consumption Survey (NFCS) in 1999 (N=2 894) investigating one to eight year old children, indicated that 6.7% children were overweight and 3.7% were obese.[13] No statistics of severely obese South African children, are however, are reported.

The obesity epidemic places high demands on the health of children and certain obesity-related conditions have immediate health effects, while others have long-term chronic consequences.[14] Overweight and obesity can lead to numerous negative health conditions,

including asthma, cardiovascular illnesses, Type 2 diabetes, hypertension and obstructive sleep apnoea.[5,14] A more sedentary lifestyle is also preferred by obese children compared to non-obese children, and obese children are less active.[15] Lowered physical activity levels lead to lower energy expenditure and increased risk of obesity and poor health later in life.[15] Graft *et al.*[16] reported poorer gross motor development and aerobic capacity in obese compared to non-obese Grade 1-learners in Germany. A study by D'Hondt *et al.*[17] found that the general level of motor coordination in obese children is lower when compared to that of children with normal weight, while poorer locomotor skills, i.e. jumping and kicking are also reported.[16,18] Children's fine motor skills are also negatively influenced by overweight and obesity.[17] Overweight and obesity further have a negative impact on the physical fitness of children, where children with normal weight showed higher cardiovascular fitness than overweight and obese children.[12] Kain *et al*.[19] report that the incidence of overweight and obesity among pre-school children is low, but increases dramatically in school beginners. Although overweight and obesity are studied among South African children populations, none of these studies focussed primarily on the school beginner. A gap is thus identified in the current status of overweight and obesity in school beginners in SA and how it relates to age, gender and socio-economic circumstances (SES). As overweight and obesity have hampering effects on the development and well-being of young children, it is important to obtain more information regarding their current health status.

The aim of this study is therefore to fill this knowledge gap by obtaining more information about the current incidence of overweight, obesity and possible severe obesity among Grade 1-learners in the NWP of SA.

Method

Sample size and sampling procedure

The research formed part of the NW-CHILD (Child-Health-Integrated-Learning and Development) Study. The research group was selected by means of a stratified random sample in conjunction with the Statistical Consultation Service of the North-West University (NWU). To determine the research group, a list of schools in the North West Province (NWP) was obtained from the Department of Basic Education. From the list of schools in the NWP, which are grouped in 8 education districts, each representing 12-22 regions with approximately 20 schools (minimum 12, maximum 47) per region. Stratified random

sampling was used to select regions and schools with regard to population density and school status (Quintile 1, i.e. schools from very poor economic sectors to Quintile 5, i.e. schools from very good economic sectors). The distribution of the learners were as follows: 138 learners in Quintile 1 , 159 learners in Quintile 2, 173 learners in Quintile 3, 145 learners in Quintile 4 and 170 learners in Quintile 5. The total group measured consisted of 816 learners (419 boys and 397 girls) with a mean age of 6.78 years. The ethnic distribution was 567 black, 218 white, 20 mixed ancestry and 11 Indian learners

Ethnical clearance

Ethnical approval for the execution of the study was obtained from the Ethics Committee of the NWU (No. 00070 09 A1). Permission was also obtained from the Department of Basic Education of the NWP. Principles from every school gave permission for the study to be performed at their school while informed consent was provided for each learner by their parents.

Anthropometry

The anthropometric measurements included the following: height (cm), body mass (kg), 3 skinfolds (sub-scapular, triceps and medial calf) (mm) and waist circumference (cm). These variables were measured by trained postgraduate students in Human Movement Sciences, specialising in Kinderkinetics. The same researcher measured the anthropometric measurements throughout the study to assure quality and to control for inter-tester reliability, in accordance with the protocol of the International Society for the Advancement of Kinanthropometry.[20] Height was measured barefoot to the nearest 0.1 cm by means of a portable stadiometer, and body mass was measured with an electronic scale (BF 511, Omron) to the nearest 0.1 kg. From the height and body mass measurement the body mass index (BMI) was calculated for each participant (body mass (kg)/height $(m)^2$). The triceps and sub-scapular skinfolds were measured with a pair of Harpenden skinfold callipers and each skinfold was measured twice to obtain the average of the two measurements. These skinfold measurements were selected because they show the highest correlation with the overall percentage of fat in the bodies of children.[21] The prevalence of overweight and obesity were determined by using the International age-specific cut-off points provided by Cole *et al.*[22]

Children have a risk for overweight, obesity and severe obesity if their BMI is respectively between the 85^{th}, 95^{th} and 98^{th} percentile for age and gender.[22] The BMI cut-off points for

severe obesity for this group were calculated using this sample as a reference from frequency tables and can be observed in Table 1.

Table 1: Age specific BMI cut-off points for severely obese children (>98 percentile)

	White	Black	Mixed ancestry	Indian
6 years				
Boys	23.6	20.6	35.0	13.5
Girls	21.7	21.1	16.1	17.7
7 years				
Boys	24.3	20.0	16.8	15.7
Girls	24.0	19.8	15.7	16.0

Data Analysis

Statistica [23] was used to analyse the data. Data was analysed by means of percentages, minimum, maximum and standard deviations (SD) and independent t-testing. Two way frequency tables were used for further analyses of the data, where the group was divided according to age, gender, race and school type. The BMI cut-off points of Cole *et al.*[22] were used to determine overweight and obesity levels in children.

Results

Table 2 and 3 show the mean height, weight, fat percentage, skinfolds and BMI values for the group and the group separated into 6 and 7 year old groups. Table 2 indicates that the white learners had the highest mean heights (123.1 cm and 125.7 cm) and mass (24.2 kg and 25.7 kg) at 6 and 7 years respectively. The mean fat percentage was the highest in the Indian learners (17.4%) at 6 years of age. White learners displayed the highest fat percentage at 7 years (17.9%).

Table 3 indicates that BMI were slightly lower in 6- and 7-year-old boys, compared to girls of the same age groups. Differences were also found between the race groups, where the mixed ancestry and white boys displayed the highest BMI values. The group of girls also showed differences between the race groups, with the white girls displaying the highest BMI values.

Table 2: Anthropometric measurements of the group and black, white, mixed ancestry and Indian learners (6-7 years) separately. Values are expressed in means, minimums, maximums and standard deviations

	Black				White				Mixed ancestry				Indian				Group			
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max
6 years																				
Height (cm)	116.3	5.4	100.8	133.6	123.1	5.9	111.2	135.2	118.0	4.6	109.7	125.7	116.9	5.0	111.1	120.1	118.2	6.2	100.8	135.2
Mass (kg)	20.8	4.3	13.7	68.6	24.2	4.9	16.9	42.6	21.9	9.1	16.3	55.3	21.0	3.9	18.3	25.5	21.8	4.9	13.7	68.6
Fat (%)	14.9	4.2	6.5	39.4	16.3	5.3	7.3	39.0	13.6	8.1	7.6	42.7	17.4	3.7	13.1	19.5	15.2	4.7	6.5	42.7
Tc sf (mm)	7.7	3.0	3.3	25.0	9.8	3.9	4.0	23.3	7.3	5.8	4.3	28.5	10.5	4.3	5.5	13.3	8.3	3.4	3.3	28.5
Sc sf (mm)	6.7	2.9	3.0	30.3	6.1	3.3	2.5	27.3	5.9	5.0	3.0	24.0	6.9	1.5	5.3	8.0	6.5	3.1	2.5	30.3
7 years																				
Height (cm)	120.8	5.6	107.4	135.0	125.7	5.8	112.2	141.7	113.7	3.2	109.6	116.3	123.1	5.2	116.0	131.3	122.0	6.1	107.4	141.7
Mass (kg)	22.4	4.0	15.5	40.8	25.7	5.5	17.2	45.9	19.6	1.2	18.9	21.4	22.0	3.2	16.6	26.1	23.2	4.6	15.5	45.9
Fat (%)	15.9	4.6	7.9	37.8	17.9	5.8	11.2	38.6	14.7	0.9	13.3	15.5	17.3	4.0	12.8	23.1	16.4	5.0	7.9	38.6
Tc sf (mm)	8.3	3.4	3.0	23.0	10.3	4.0	5.3	24.3	8.8	1.7	6.5	10.8	9.1	2.5	6.0	12.5	8.9	3.6	3.0	24.3
Sc sf (mm)	6.9	2.6	3.5	22.0	7.2	4.1	3.0	23.0	5.8	1.1	4.5	6.8	7.2	2.7	5.0	13.3	7.0	3.1	3.0	23.0
Group																				
Height (cm)	118.0	5.9	100.8	135.0	124.1	5.9	111.2	141.7	117.2	4.6	109.6	125.7	121.4	5.7	111.1	131.3	119.6	6.5	100.8	141.7
Mass (kg)	21.4	4.2	13.7	68.6	24.8	5.2	16.9	45.9	21.4	8.2	16.3	55.3	21.7	3.2	16.6	26.1	22.3	4.8	13.7	68.6
Fat (%)	15.2	4.4	6.5	39.4	16.9	5.5	7.3	38.8	13.8	7.2	7.6	42.7	17.3	3.7	12.8	23.1	15.7	4.9	6.5	42.7
Tc sf (mm)	7.9	3.2	3.0	25.0	10.0	3.8	4.0	24.3	7.6	5.3	4.3	28.5	9.5	3.0	5.5	13.3	8.5	3.5	3.0	28.5
Sc sf (mm)	6.8	2.8	3.0	30.3	6.5	3.7	2.5	27.3	5.9	4.5	3.0	24.0	7.1	2.4	5.0	13.3	6.7	3.1	2.5	30.3

M = Mean; Min = Minimum; Max = Maximum; SD = standard deviation; cm = centimetre; kg = kilogram; % = percentage; mm = millimetre; sf = skinfold; Tc=Triceps; Sc=Sub-scapular

Table 3: Body mass index of black, white, mixed ancestry and Indian boys and girls, 6 and 7 years) Values are expressed as means ± SD, sample size (N) and significant differences between genders

Age	Black	White	Mixed ancestry	Indian	Group
	Mean SD n	Mean SD n	Mean SD n	Mean SD n	Mean SD N
Boys					
6	15.3 ± 1.7 (166)	16.1 ± 2.3 (73)	16.3 ± 6.7 (10)	13.5 ± 0.0 (1)	15.6 ± 2.3 (250)
7	15.2 ± 1.9 (113)	16.2 ± 2.7 (50)	16.8 ± 0.0 (1)	14.5 ± 1.4 (5)	15.5 ± 2.2 (169)
Group	15.3 ± 1.8 (279)	16.1 ± 2.4 (123)	16.3 ± 6.3 (11)	14.3 ± 1.4 (6)	15.5 ± 2.2 (419)
Girls					
6	15.3 ± 2.5 (188)	15.8 ± 2.5 (65)	14.3 ± 1.4 (6)	16.3 ± 2.1 (2)	15.4 ± 2.5 (261)
7	15.4 ± 1.7 (100)	16.2 ± 2.5 (30)	14.6 ± 1.0 (3)	14.3 ± 1.5 (3)	15.6 ± 1.9 (136)
Group	15.4 ± 2.3 (288)	15.9 ± 2.5 (95)	14.4 ± 1.2 (9)	15.1 ± 1.8 (5)	15.5 ± 2.3 (397)

Table 4 indicates that 7.8% of Grade 1-learners were overweight, 1.8% was obese and 2.0% was severely obese, which amounts to a total percentage of overweight and obesity of 11.64% in the group. Overweight was most prevalent in girls (9.3%), white learners (13.3%) and Quintile 5 schools (16.2%). Obesity had the highest prevalence in girls (2.8%), white learners (3.2%) and Quintile 5 schools (2.9%). Table 4 further shows that severe obesity was the highest among the boys (2.4%) and in Quintile 4 schools (4.6%). In the overall group, more black learners were severely obese (n=8). Table 4 reports higher overweight among 7 year old (10.5%) compared to 6 year old (6.3%) learners. Older boys and girls (7 years) also had higher percentages for overweight than the 6 year old group with 9.5% and 11.8%, compared to 4.4% and 8.1%, respectively. More girls in the 6 and 7 year old group (8.1% and 11.8%) compared to boys in the 6 and 7 year old group (4.4% and 9.5%) were classified as overweight. A higher percentage of white 6 and 7 year old learners were overweight (11.6% and 16.3%) compared to black, mixed ancestry and Indian learners. Quintile 4 and 5 schools had the highest prevalence for overweight in the 6 years old group (13.2% and 12.9%), while Quintile 2 and 5 schools had the highest prevalence in the 7 year old group (8.7 and 19.3%). Table 4 indicates that obesity and severe obesity were lower in the 7 year old group (2.5% and 2.6% (6 years) and 0.7% and 2.4% (7 years).

Table 4: Sample size and percentage of Grade 1-learners (6 and 7 years) by gender, race and Quintile school classified as overweight, obese and severe obese

	Normal		**Overweight***		**Obese***		**Severely obese #**		**Total**
	n	%	n	%	n	%	n	%	N
6 years									
Boys	220	91.6	11	4.4	4	1.6	7	2.9	250
Girls	226	86.6	21	8.1	9	3.5	6	2.4	261
White	113	81.9	16	11.6	5	3.6	4	2.9	138
Black	325	91.8	15	4.2	8	2.3	9	2.5	354
MA	15	93.8	0	0	0	0	1	6.3	16
Indian	2	66.7	1	33.3	0	0	0	0	3
Quintile 1	87	90.8	5	5.2	2	2.1	2	2.1	96
Quintile 2	106	93.8	3	2.7	3	2.7	1	0.9	113
Quintile 3	122	96.8	1	0.8	1	0.8	2	1.6	126
Quintile 4	71	78.0	12	13.2	4	4.4	4	4.4	91
Quintile 5	69	81.2	11	12.9	3	3.5	2	2.4	85
Group	455	89.0	32	6.3	13	2.5	13	2.6	511
7 years									
Boys	149	88.2	16	9.5	0	0	4	2.5	169
Girls	117	86.0	16	11.8	2	1.5	3	2.3	136
White	62	77.5	13	16.3	2	2.5	2	2.5	80
Black	192	90.1	19	8.9	0	0	5	2.4	213
MA	4	100.0	0	0	0	0	0	0	4
Indian	8	100.0	0	0	0	0	0	0	8
Quintile 1	56	94.9	3	5.1	0	0	0	0	59
Quintile 2	42	91.3	4	8.7	0	0	0	0	46
Quintile 3	46	93.9	3	6.1	0	0	0	0	49
Quintile 4	55	87.3	5	7.9	0	0	3	4.8	63
Quintile 5	67	76.1	17	19.3	2	2.3	2	2.3	88
Group	266	87.2	32	10.5	2	0.7	7	2.4	305
Group									
Boys	378	90.2	27	6.4	4	1.0	10	2.4	419
Girls	343	86.4	37	9.3	11	2.8	6	1.5	397
White	175	80.3	29	13.3	7	3.2	7	3.2	218
Black	517	91.2	34	6.0	8	1.4	8	1.4	567
MA	19	95.0	0	0	0	0	1	5.0	20
Indian	10	90.9	1	9.1	0	0	0	0	11
Quintile 1	143	92.3	8	5.2	2	1.3	2	1.3	155
Quintile 2	148	93.1	7	4.4	3	1.9	1	0.6	159
Quintile 3	168	96.0	4	2.3	1	0.6	2	1.1	175
Quintile 4	126	81.8	17	11.0	4	2.6	7	4.6	154
Quintile 5	136	78.6	28	16.2	5	2.9	4	2.3	173
Group	721	88.4	64	7.8	15	1.8	16	2.0	816

n = Sample size; N = Total sample size; % = Percentage; MA = Mixed ancestry

* International BMI cut-off values of Cole et al. were used to determine overweight and obesity.

BMI cut-off points for severe obesity (>98 percentile) were used.

Younger boys and girls (6 years) had the highest percentages for obesity and severe obesity compared to the older boys and girls. White learners at 6 and 7 years of age had the highest prevalence of obesity (3.6% and 2.5%). Severe obesity was more prevalent among the 6 year old black learners (n=9) and the 7 year old black learners (n=5). Obesity and severe obesity was more prevalent in Quintile 4 schools for 6 year old learners with 5.5% and 4.4% respectively. In the 7 year old group, obesity was more prevalent among the learners in the Quintile 5 schools (2.3%), while no obesity was seen in Quintile 1-4 schools. However, learners in Quintile 4 schools (4.8%) showed the highest prevalence for severe obesity at 7 years

Discussion

The aim of this study was to determine the prevalence of overweight and obesity in Grade 1-learners in the NWP of SA and to determine whether overweight and obesity are related to age, gender, race and socio-economic circumstances. A percentage of 11.6% of overweight and obesity were found in the group of Grade 1-learners. The results further indicated that 7.8% of Grade 1-learners were overweight and 3.8% were obese (1.8% obese and 2.0% severe obese), while 6.3% of 6 year old learners and 10.5% of 7-year-old learners were overweight. Obesity rates were lower than overweight rates, where 2.5% learners at 6 years and 0.7% learners at 7 years were obese. The results further showed that 2.6% of 6-year-old learners and 2.4% of 7-year-old learners were already severely obese. These percentages are lower when compared to other studies conducted worldwide and similar to most studies done in SA among learners of the same age.[13, 26, 27]

Studies worldwide mostly report higher percentages on overweight, obesity and severe obesity in the 6- to 7-year age group. Different thresholds to define overweight and obesity were used in some of these studies which made direct comparisons difficult. Studies done in Canada, Norway and America on children 6 to 11 years of age, report the prevalence of overweight and obesity to be 16.1%, 6.3%, and 20.7% respectively.[6] The thresholds from the Centre of Disease Control (CDC) were used, where the CDC Growth charts are based on information for US children.[6] A study on French children aged 7 to 9 years (N=1 582), which was also based on the thresholds on the CDC Growth charts, reported that 20.6% of the children were overweight and 6.4% obese.[24] Padez *et al.*[25] undertook a study of 7 to 9-year-old Portuguese children which indicated that 31.5% were overweight and obese (20.3%

overweight; 11.3% obese). These researchers used the cut-off points of the International Obesity Taskforce (IOTF) to define overweight and obesity.[25] A study done by Skelton *et al.*[8] in America, found that 3.8% of the 2 to 19 year old children, who participated in the study, showed severe obesity.

The majority of South African[13, 26, 27] studies reports a similar result for overweight and obesity among children of the same age group. The results of the "National Food Consumption Survey" based on the IOTF cut-off points, and conducted on children between the ages of 1 and 8 years (N=2 894), reported that 6.7% children could be classified as overweight and 3.7% as obese.[13] A study on 579 primary school children between the ages of 8 and 10 years in the rural magisterial district of KwaZulu-Natal, found that 3.1% of the children were obese.[25] In another study undertaken by Jinabhai *et al.*[27] in KwaZulu-Natal on 802 children between the ages of 8 and 11 years, the incidence of overweight varied between 0.4% to 13.3% and obesity between 0.1% to 3.7%. Two sets of criteria were used by Jinabhai *et al.*[27] to measure overweight and obesity, namely the WHO/NCHS standard based on the 85th and 95th percentiles and the IOTF criteria.

The results of this study further indicated that there was a higher incidence of overweight among girls between the ages 6 and 7 years (6 years: 5.8%; 7 years: 11.0%), as opposed to the 6 and 7 year old boys (6 years: 3.6%; 7 years: 8.9%). These findings agree with a study,[11] which also found that girls at the age of 6 and 7 years, (6 years: 11.9%; 7 years: 11.8%) had a higher incidence of overweight when compared to boys (6 years: 8.0%; 7 years: 9.2%). This study also reported a higher incidence of obesity among 6 and 7-year-old girls (6 years: 3.5%; 7 years: 1.5%), compared to 6 and 7-year-old boys (6 years: 1.6%; 7 years: 0%). Armstrong *et al.*[11], who also used the cut-off points of Cole *et al.*[22], reported similar results among 7 year old girls and boys, where the girls (5.8%) had a higher incidence of overweight than the boys (2.5%). The results of Armstrong *et al.*[11] however, differed from the results of our study with regard to 6 year old children, where the 6 year old boys had a higher incidence of obesity than the girls (6.0% and 4.1%). Our study also found that girls were more overweight (9.3%) and obese (2.8%) than boys, although boys were more severely obese (2.4%). Boys at 6 and 7 years had the highest prevalence of severe obesity. Other studies in SA also report a higher incidence of overweight and obesity among girls than among boys.[27,28] The results of this study further indicated that severe obesity is more prevalent among boys (2.9%) than girls (2.5%) at 6 years and 7 years of age (boys 2.5%; girls 2.3%). There is presently no research

available regarding severe obesity in South African children to compare the results with, although Skelton *et al.*[8] did find that severe obesity in American children had tripled over the past 25 years. This researcher states that the highest rates of severe obesity among children are among those who are underserved by the health care system.[8] However, in our study, it seemed that children from higher socio-economic circumstances (which is mainly Quintile 4 and 5 school types) showed the highest percentages of severe obesity.

Furthermore, this study found that more 6 and 7-year-old white (8.0% and 13.8%) children, opposed to black, mixed ancestry and Indian children, were overweight. A similar tendency was found for obesity and severe obesity, where the white 6 and 7-year-old children showed the highest incidence. A study by Kruger *et al.*[28] also found that white children living in the NWP of SA had the highest prevalence of overweight and obesity (white 14.2%, black 7.1%, Indian 6.4% and mixed ancestry 2.9%), although this study was conducted on older children (10-15 years). Research by Reddy *et al.*[29] based on the National Youth Behaviour Survey in 2002, reported similar results, where white boys and girls showed a higher incidence of overweight and obesity than black boys and girls.

Very few research results however are available in SA relating to overweight and obesity among mixed ancestry and Indian populations, as well as severe obesity among all race groups. A study in the NWP among 10 to 12-year-old girls, indicated that 16.5% girls were overweight and 4.9% were obese.[30] These researchers, reported differences between racial groups in overweight (21.3% white, 15.81% black, 9.1% mixed ancestry; 17.4% Indian) girls and obesity (8.5% white, 4.4% black, 0% mixed ancestry; 8.7% Indian).[30]

Quintile 4 and 5 schools representing schools in areas with higher socio-economic circumstances, have shown a higher incidence of overweight (n=23), obesity (n=7) and severe obesity (n=6) in the 6 year old age group. In the 7 year old age group, Quintile 5 schools had the highest incidence of overweight (n=17; 19.3%) and obesity (n=2; 2.3%), whereas severe obesity (n=3; 4.8%) was more prevalent in Quintile 4 schools. Quintile 1, 2 and 3 schools, which represent schools in lower socio-economic areas, had the lowest incidence of overweight, obesity and severe obesity. These results agree with the findings of several researchers[13,28,31] indicating that children living in lower socio-economic areas show a lower incidence of overweight and obesity. Steyn *et al.*[13] also reported that the highest incidence of overweight and obesity, among younger children (1-8 years) in SA is seen in

urban areas. Kruger *et al.*[28] report the same findings among 10 to 15 year old children, where a higher incidence of overweight and obesity was found in urban areas and smaller households. A study done by Moneyki *et al.*[31] reported that very few black children in rural areas who reach the age of 7 years, were above the NHANNES III (The Third National Health And Nutrition Examination Survey) 85th percentile for BMI.

Conclusion

Percentages that amount to 11.6% were found among Grade 1-learners in the NWP of SA for overweight (7.8%), obesity (1.8%) and severe obesity (2.0%), indicating that 1 in 10 children were either overweight, obese or severe obese when they enter the formal school in Grade 1. White learners attending schools in higher socio-economic areas (Quintile 4 and 5), showed the highest incidence for overweight, obesity and severe obesity, although overweight, obesity and severe obesity was also prevalent among black learners who mostly attended schools representing lower socio-economic circumstances. Girls had the highest incidence for overweight and obesity, while boys showed the highest incidence for severe obesity. The incidence for overweight increased from 6 to 7 years, although obesity and severe obesity were slightly lower in the older children. The results are worrying as overweight, obesity and especially severe obesity have a negative impact on children's development and health related fitness levels, and early exposure to the development of chronic diseases as a result of obesity are a major concern from a health perspective. These results can thus help experts in the field of child development to plan future strategies to address problems relating to overweight, obesity and severe obesity. It is recommended that intervention programmes in physical education, which include physical activity, diet and behaviour modification, should be implemented at schools in order to prevent, but also to lower the prevalence of overweight, obesity and severe obesity among these children. Policy makers should also be made aware of these statistics in order to develop sound preventative health strategies for the children of the country. Follow-up longitudinal research is also recommended to determine if the incidence of overweight and obesity rise with increasing age.

ACKNOWLEDGEMENTS

This work is based upon research supported by the National Research Foundation of South Africa (NRF), the National Lottery Distribution Fund and the Focus area of PhASRec which are greatly acknowledged for their contributions.
Disclaimer: any opinion, findings and conclusions or recommendations expressed in this material are the opinion of the author(s) and therefor the NRF do not accept any liability in regard thereto.

The authors would also like to express their gratitude to the students, research and administration teams and the schools and learners who participated in the study.

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CHAPTER 4

CHAPTER 4

The prevalence of stunting, wasting and underweight in grade 1-learners in the North West Province of South Africa: The NW-CHILD Study

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CHAPTER 4

ABSTRACT

The objective of the study was to determine the prevalence of stunting, wasting and underweight among grade 1-learners in the North West Province (NWP) of South Africa (SA), and the relationship with gender, race and school type. The study formed part of the baseline measurements of the longitudinal NW-CHILD Study. Eight hundred and sixteen (419 boys, 397 girls) grade 1-learners participated in the study (567 black, 218 white, 31 other race groups). The prevalence of underweight, stunting and wasting was determined by using standard anthropometric techniques. Height-for-age (HAZ), BMI-for-age (BMIZ) and weight-for-age (WAZ), z-scores of the WHO (2007) reference sample was used. The results showed a higher prevalence of wasting and underweight among the boys (8.4%; 6.0%) compared to the girls (6.3%; 2.5%), although the differences were only significant for underweight ($p=0.02$), while stunting percentages were very similar among girls (4.5%) and boys (4.1%). Underweight was the highest in the black learners (5.5%; $p<0.01$) and the prevalence of the conditions is associated with school type which represent low socio-economic circumstances. Only black learners showed stunting ($p<0.01$) and more black learners were wasted (n=39) compared to white (n=15) learners. Quintile1-3 schools had the highest prevalence of underweight (5.1% – 8.2%) and stunting (3.9% – 10.7%), which was significantly ($p<0.01$) higher than in Quintile 4 and 5 schools. It is concluded, that stunting, wasting and underweight are still evident among school beginners, especially those in Quintile 1-3 type schools of the NWP. These growth deficiencies need to be addressed as it can have significant hampering effects on the further development and well-being of children.

Key words: Undernutrition, stunting, wasting, underweight, children

CHAPTER 4

INTRODUCTION

In developing countries, child undernutrition remains a major public health concern (UNICEF, 2012:20). The World Health Organisation states that globally undernutrition is the most important risk factor for illness and mortality (WHO, 2000). Insufficient nutrition is one of a wide range of interlinked factors forming the so-called poverty syndrome (UNICEF, 2012:20). The WHO defines undernutrition as the cellular imbalance between the supply of nutrients and energy and the body's ability to utilise it for growth and the maintenance of specific functions, including resistance to infections and recovery from illness (WHO, 2011a). Abnormalities in growth are indicators of undernutrition because feeding status reflects growth among children (Robinson *et al*. 2001:287). Undernutrition is characterised by stunting, wasting/thinness and underweight. Stunting is defined as insufficient height for age and wasting/thinness as insufficient mass for height (Victoria, 1991:1105). Saloojee and Pettifor (2012:383) report that underweight and stunting, which are considered moderate forms of malnutrition, is mainly the result of poor feeding practices over a long period, coupled to an increased incidence of infections, rather than a lack of food in South African households.

More than half of all deaths among children worldwide, is caused by undernutrition (WHO, 2000) and in 2001, undernutrition was responsible for 54% of all child deaths. Underweight was the cause of 3.4 million deaths worldwide in 2000 of which 1.8 million was in Africa (WHO, 2011a). Food insecurity among children is a serious problem, and the General Household Survey which was done in 2007 in SA, reported that 2.7 million South African children suffered from food insecurity (SACG), 2008/2009:92). An anthropometric study conducted in South Africa (SA) in 2005 on children aged between 1 and 9 years, indicated that 20.7% were stunted, 8.1% were underweight and 5.8% were wasted (Kruger *et al*. 2011:594). A study in the magisterial district of KwaZulu-Natal of primary school children between the ages of 8 and 10 (N=579), report that 7.3% of them suffered from stunting (Jinabhai *et al*. 2001:50).

Undernutrition contributes to serious developmental complications among children. Researchers report a relationship between stunting and problems in cognitive abilities (Brown & Pollit 1996:38; Scrimshaw 1998:368; Victora *et al*. 2008:340), scholastic achievement (Mendez & Adair, 1999:1555; Victora *et al*. 2008:343), and early school failure (Victora *et*

al. 2008:340; Walton & Allen 2011:418). Apart from the physical problems, undernutrition is also associated with negative psychological development (Saunders, *et al*. 2010:47). Children suffering from undernutrition also manifest various behavioural changes and sometimes appear irritated, apathetic, attention deficient, anxious and have a lowered social response (Shashidhar & Grigsby 2009:4). Gross motor skills, including speed and co-ordination, as well as fine motor skills, are negatively influenced by undernutrition (Chopra & Sharma 1992:9). Undernutrition also results in negative health conditions in which every organ system in the human body is affected (Shashidhar & Grigsby 2009:1; Saunders, *et al*. 2010:46). Children suffering from undernutrition are also more susceptible to illness (Torpy, *et al*. 2004:648). Motor, cognitive and physical development are some of the main areas of a young child's vast development needs (Pienaar, 2009:49), that are affected by undernutrition.

From the aforementioned literature it appears that undernutrition is a worldwide problem among children. Prista *et al*. (2003:956) report that because the prevalence of malnutrition in adolescents is considerably less than those in children, relatively few studies have been carried out on this topic with school-age populations. Presently, there is a shortage of literature relating to the body composition profiles of school-beginners in SA, including the prevalence of undernutrition as indicated by stunting, wasting and underweight. It is, however, important to obtain more information regarding anthropometric indicators of stunting, wasting and underweight in school-beginners, since undernutrition plays an important role in various aspects of children's development, as already indicated. Thus the aims arising from above-mentioned are to determine the current status of stunting, wasting and underweight among grade 1-learners in the North West Province (NWP) of SA, and secondly to determine whether this status is related to gender, race and school type.

METHOD

Sample size and sampling procedure

The research formed part of the NW-CHILD (Child-Health-Integrated-Learning and Development) study. Grade 1-learners in the NWP of SA served as the target population for the study. The research group was selected by means of a stratified random sample in conjunction with the Statistical Consultation Service of the North-West University (NWU). To determine the research group, a list of names of schools in the North West Province was

obtained from the Department of Basic Education. From the list of schools in the NWP, which are grouped in 8 education districts, each representing 12-22 regions with approximately 20 schools (minimum 12, maximum 47) per region, districts and schools were randomly selected with regard to population density and school status (Quintile 1, i.e. schools from very poor economic sectors to Quintile 5, i.e. schools from very good economic sectors). Twenty schools, from 4 districts with a minimum of 40 children per school, and with an even gender distribution, were involved in the study. The total group that was measured consisted of 816 learners (419 boys and 397 girls) with a mean age of 6.78 years and an ethnic distribution of 567 black (69.5%), 218 white (26.7%), 20 mixed ancestry (2.5%) and 11 Indian (1.3%) learners. Thirteen parents (1.5%) did not consent to participation, while the rest of the selected participants were absent from school on the day of testing or had to be excluded because of incorrect ages that were provided by the schools.

Ethnical clearance

Ethnical approval for the execution of the study was obtained from the Ethics Committee of the NWU (No. 00070 09 A1). Permission was also obtained from the Education Department of the NWP. Informed consent was given by the learner's parents and the principles from every school also gave permission for the measurements.

Anthropometry

The anthropometric measurements included the following: height (cm), body mass (kg), three skinfolds (sub scapular, triceps and medial calf) (mm) and waist circumference (cm). These variables were measured by trained postgraduate students in Human Movement Sciences specialising in Kinderkinetics in accordance with the protocol of the International Society for the Advancement of Kinanthropometry (Marfell-Jones *et al*. 2006:137). Height was measured barefoot to the nearest 0.1 cm by means of a portable stadiometer and body mass was measured with an electronic scale (BF 511, Omron) to the nearest 0.1 kg. From the height and body mass measurements, the body mass index (BMI) (kg/m^2) was calculated for each participant. Skinfolds were measured with a pair of Harpenden skinfold callipers and each skinfold was measured twice to obtain the average of the two measurements. These skinfold measurements were selected because, according to Meredith and Welk (2005:36), they show the highest correlation with the overall percentage of fat in the bodies of children.

Z-scores

The WHO (2007) reference data were used as a standard to determine the z-scores for height-for-age (HAZ), BMI-for-age (BMIZ) and weight-for-age (WAZ). Z-scores of less than -2 standard deviation (SD) for height-for-age and weight-for-age were used to determine the prevalence of stunting and underweight. The Z-scores for wasting was determined using BMI-for-age, under the 5th percentile from the international reference population (De Onis *et al*. 2006:943). Larger negative z-scores indicate higher undernutrition.

Data Analysis

Statistica (StatSoft, 2011) and AntroPlus software (version 1.0.2) in SAS (Statistical Analysis System) were used to analyse the data. For the purpose of description, data were analysed using means and percentages. Z-scores were determined for the classifying of stunting, wasting and underweight. Pearson Chi Square ($p \leq 0.05$) was used to determine statistical significance of differences in stunting, wasting and underweight between school types, race and genders. For the interpretation of practical significance, $d \geq 0.1$ indicates a small effect, $d \geq 0.3$ indicates a medium effect and $d \geq 0.5$ indicates a large effect (Cohen, 1988:20). A Tukey post Hoc test was used to determine the significance of differences between the school types (Quintile 1-5). Independent t-tests were used to analyse differences between the genders. Because of the small number of mixed ancestry and Indian children that entered the sample, these children (n=31) were excluded from the racial analyses.

RESULTS

Table 1 indicates that most of the black learners (N=567) mostly attended Quintile 1 to 3 schools (n=470), while all white learners attended Quintile 4 (n=85) and 5 (n=133) schools. Slightly more white boys (n=123) as opposed to white girls (n=95), and more black girls (n=288) as opposed to black boys (n=279) participated in the study.

TABLE 1: DESCRIPTIVE STATISTICS OF THE NUMBER AND GENDER OF THE BLACK AND WHITE LEARNERS IN THE DIFFERENT SCHOOL TYPES (N=785)

	White learners					Black learners				
	Boys		Girls		Total	Boys		Girls		Total
	n	%	n	%	N	n	%	n	%	N
Quintile 1	0	0	0	0	0	69	50.0	69	50.0	138
Quintile 2	0	0	0	0	0	84	52.8	75	47.2	159
Quintile 3	0	0	0	0	0	83	48.0	90	52.0	173
Quintile 4	51	60.0	34	40.0	85	27	45.0	33	55.0	60
Quintile 5	72	54.1	61	45.9	133	16	43.2	21	56.8	37
All	123		95		218	279		288		567

N=Sample size; %=percentage

Table 2 shows that, 35 participants (4.3%) in the group were stunted (HAZ), with a mean z-score of -2.4. Wasting (BMIZ) was more prevalent, with 60 participants (7.4%) displaying wasting (mean z-score= -2.0). Table 2 further indicates that 35 participants (4.3%) were underweight (WAZ), with a mean z-score of -2.4.

TABLE 2: MEAN Z-SCORES, SAMPLE SIZE CHARACTERISTICS- AND PERCENTAGE LEARNERS WITH STUNTING, WASTING AND UNDERWEIGHT

	HAZ			**BMIZ**			**WAZ**		
	Height-for-age-z-score			**BMI-for-age-z-score**			**Weight-for-age-z-score**		
	Mean	**N**	**%**	**Mean**	**N**	**%**	**Mean**	**N**	**%**
Normal									
Boys	-0.1	402	95.9	-0.2	384	91.7	-0.2	394	94.0
Girls	-0.2	379	95.5	-0.1	372	93.7	-0.2	387	97.5
Black	-0.4	533	94.0	-0.2	528	93.1	-0.4	536	94.5
White	-0.7	218	100.0	-0.2	203	93.1	-0.5	217	99.5
Quintile 1	-0.5	149	96.1	-0.2	142	91.6	-0.4	147	94.8
Quintile 2	-0.7	142	89.3	-0.3	148	93.1	-0.6	146	91.8
Quintile 3	-0.5	167	95.4	-0.5	163	93.1	-0.6	166	94.9
Quintile 4	-0.5	151	98.1	-0.0	139	90.3	-0.4	150	97.4
Quintile 5	-0.4	172	99.4	-0.3	164	94.80	-0.5	172	99.4
All	-0.1	781	95.71	-0.1	756	92.65	-0.2	781	95.7
Under nutrition									
All	-2.4	35	4.3	-2.0	60	7.4	-2.4	35	4.3

N = Sample size; % = Percentage; HAZ = Stunting; BMIZ = wasting; WAZ = Underweight

Table 3 displays the number and percentage of boys and girls who were stunted, wasted and underweight respectively. No significant differences were found in stunting between the genders (p=0.74; d=0.01), where 4.1% boys and 4.5% girls were stunted. A higher percentage of boys showed wasting (8.4%) compared to girls (6.3%), although the difference was also insignificant. A statistically significant (p=0.02) difference was however found between boys (6.0%) and girls (2.5%) who were underweight, although the difference was not practically significant (d=0.08).

TABLE 3: DIFFERENCES IN NUMBER AND PERCENTAGE OF BOYS AND GIRLS WITH UNDERNUTRITION CHARACTERISTICS

Variable	Boys		Girls		Significance in differences	
	n	%	n	%	p	d
HAZ < -2						
Stunting	17	4.1	18	4.5	0.74	0.01
BMIZ < - 2						
Wasting	35	8.4	25	6.3	0.30	-0.04
WAZ < -2						
Underweight	25	6.0	10	2.5	**0.02***	0.08

N = Number of participants; p-value ≤ 0.05*; d-value = practical significance where d ≥ 0.1 small*, d ≥ 0.3 medium** and d ≥ 0.5 large*** indicate significance

TABLE 4: DIFFERENCES IN NUMBER AND PERCENTAGE OF WHITE AND BLACK LEARNERS WITH UNDERNUTRITION CHARACTERISTICS

	White children		Black children		Significance in differences	
	n	%	n	%	p	d
HAZ < -2						
Stunting	0	0.0	34	6.0	**<0.01***	**0.13***
BMIZ < -2						
Wasting	15	6.9	39	6.9	0.08	**0.13***
WAZ < -2						
Underweight	1	0.5	31	5.5	**<0.01***	**0.11***

N = Number of participants; p-value ≤ 0.05*; d-value = practical significance where d ≥ 0.1 small *, d ≥ 0.3 medium** and d ≥ 0.5 large*** indicate significance

Table 4 indicates the number and percentage of white and black learners who were stunted, wasted and underweight. Statistically (p≤0.01) and practically (d=0.13) significant differences were found in the percentages of stunting between white and black learners, where 6.0% of black children were stunted as opposed to no white learners. A borderline

significant difference was found for wasting among the racial learners (p=0.08), with 39 (6.9%) of the black learners, and 15 (6.9%) of the white learners who were wasted. The difference was however, practically significant (d=0.13). Statistical ($p \leq 0.01$) and practical (d=0.11) significant differences were also found among the white and black learners for underweight, where 5.5% of black learners and 0.5% of white learners were underweight.

Table 5 describes the number and percentage of undernutrition characteristics that were found, related to school type. Statistically significant differences ($p<0.01$) were found between the percentages of stunting in the Quintile 1-3 schools compared to Quintile 4 and 5 schools, where the Quintile 1 – 3 schools had the highest stunting percentages (3.88% - 10.7%). The highest prevalence of wasting was found in the Quintile 4 schools (n=15) (9.7%). Wasting varied between 5.2% (Quintile 5) and 9.7% (Quintile 4), although no significant differences were found among the different Quintile schools. Table 5 furthermore reflects a statistical ($p<0.01$) and practical (d=0.13) significant difference in the percentage underweight in Quintile 1 – 3 schools, compared to Quintile 4 and 5 schools, with Quintile 1 – 3 schools having the highest prevalence of underweight (5.1% - 8.2%).

TABLE 5: DIFFERENCES IN SAMPLE SIZE AND PERCENTAGE LEARNERS IN DIFFERENT SCHOOL TYPES (QUINTILE 1-5) WITH UNDER NUTRITION CHARACTERISTICS

	School type (Quintile)										Significance in differences	
	1		2		3		4		5			
	n	%	n	%	n	%	n	%	n	%	p	d
HAZ < -2												
Stunting	6	$3.9^{4,5}$	17	$10.7^{4,5}$	8	$4.6^{4,5}$	3	$2.0^{1,2,3}$	1	$0.6^{1,2,3}$	**<0.01***	0.17
BMIZ < -2												
Wasting	13	8.4	11	6.9	12	6.9	15	9.7	9	5.2	0.59	0.06
WAZ < -2												
Underweight	8	$5.2^{4,5}$	13	$8.2^{4,5}$	9	$5.1^{4,5}$	4	$2.6^{1,2,3}$	1	$0.6^{1,2,3}$	**<0.01***	**0.13***

N = Number of participants; p-value ≤ 0.05*; d-value = practical significance where d ≥ 0.1 small*, d ≥0.3 medium** and d ≥ 0.5*** indicate large significance; Upper script indicates significance between school types (1 = Quintile 1; 2 = Quintile 2; 3 = Quintile 3; 4 = Quintile 4; 5 = Quintile 5)

CHAPTER 4

DISCUSSION

This study aimed to firstly determine the current status of stunting, wasting and underweight among grade 1-learners in the NWP of SA and, secondly to determine whether this status is affected by gender, race and school type which is a reflection of the socio-economic circumstances in which learners grow up. The study found percentages of stunting (4.3%), wasting (7.4%) and underweight (4.3%) in the group. These percentages agree to some extent with other studies conducted on a worldwide scale on children of the same age group (Popkin, *et al*. 1996:3013; Vorster *et al*. 1997:1975; Tharakan & Suchindran 1999:844; Coutsoudis & Coovadia 2001:459; Jinabhai *et al*. 2001:50; Gray, *et al*. 2006:553). Worldwide studies relating to stunting report that 15% of Brazilian children and 9.2% of Russian children (N=4 872) between the ages of 7 to 9 years were stunted (Popkin, *et al.* 1996:3013) while a study by Gray, Cossman and Powers (2006:553) reported that 5.6% of children 6 years of age and 11.2% of children, 7 years of age in Central Honduras were stunted.

A South African study done by Jinabhai *et al*. (2001:50) in KwaZulu-Natal, reports that 7.3% children between the ages of 8 and 10 years old were stunted. An overview study (1975-1994) conducted by Vorster *et al* .(1997:1975) in SA over a period of 20 years regarding the nutritional status of children, indicated that the prevalence of stunting among primary school children decreased from 33.6% to 14.6% over this period. The results of the THUSA BANA study (N=1257) done in the NWP by Mukuddem-Peterson and Kruger (2004:842) on children between the ages of 10 to 15 years old, showed that stunting was higher in rural areas (23.7% girls; 26.7% boys) opposed to urban areas (11.6% girls; 17.1% boys). The lower prevalence of stunting (4.3%) found in this study, therefore indicates a decreasing trend in stunting among South African primary school children. This finding also agrees with the results of Prista *et al*. (2003:954) on Mozambique children who indicated a decrease in the rates of stunting over the period of their study (September 1992–June 2000), where the proportion of subjects with stunted growth dropped from 34.5% to 3% in males and from 24.6% to 2.3% in females. They ascribed these changes observed to socio-economic conditions in Mozambique. The situation changed after peace was reached in 1992 (war period from 1980-1992), which led to increases in urbanization, sedentary occupations and the advent of fast food, which all contributed to the decline in nutritional problems in the country (Prista *et al.,* 2003:957).

The South African primary school nutrition program implemented in 1994 may be one reason for the decline that was seen in the current study, as approximately 5 million children in 15 000 primary schools are annually fed by this program. These programs focus on relieving short-term hunger and thereby helping children to realise their full mental and physical potential and to perform optimally at school (Stuijvenberg, 2005:S213). Another reason may be the Child Support Grant (CSG) system implemented as a measure of poverty alleviation (Triegaardt, 2005:249). The CSG was first introduced in 1998 with the purpose of providing support, in the form of cash benefits, for children in poverty and this benefit increased over this period to R280 per month per child in 2012 (Triegaardt, 2005:249).

Slight differences were found in the percentages of girls (4.5%) and boys (4.1%) that were stunted. This result differs from the findings of Monyeki, *et al*. (2000:42) on Ellisras children, where stunting was more prevalent among boys 6.0 to 6.9 years (7.7%) and 7.0 to 7.9 years (5.5%) than girls 6.0 to 6.9 years (4.1%) and 7.0 to 7.9-years (3.5%). Mukuddem-Peterson and Kruger (2004:842:) also indicated higher percentages of boys being stunted at the age of 10 to 15 years.

Stunting was also more prevalent among black (6.0%) children, with no stunting found among white children. Children attending schools in low socio-economic circumstances (Quintile 1 – 3 school types) also had the highest incidences of stunting, varying between 3.9% and 10.7%. South African studies indicate in this regard that the prevalence of stunting is higher in rural areas (very low, low and medium socio-economic circumstances) opposed to urban areas (high and very high socio-economic circumstances) (Moneyki *et al*. 2000:42; Kruger *et al*. 2011:594). Studies from 33 countries, including Africa, also showed that on average stunting was 1.6 times higher in rural, compared to urban areas (UNICEF, 1998). Poverty is especially severe in the rural areas of SA, where percentages of 73.7% are indicated (Coutsoudis & Coovadia 2001:459).

The incidence of wasting that was found in this study (7.35%) is on par with statistics in other countries, except for a study done in Central Honduras, which showed that only 0.9% of the children between the ages of 5 and 9 years suffered from wasting (Gray Cossman and Powers (2006:553). In Botswana, 7.1% of children between the ages of 0 and 6 years of age were wasted (Tharakan & Suchindran 1999:844). A study in Mozambique reports that 21,9% boys and 10,0% girls aged between 6 and 18 years were wasted (Prista *et al.,* 2003:952). A South

African study in KwaZulu-Natal reports higher percentages among children aged between 3 months and 4 years, where Chopra (2003:645) reported that 12% of the children of 516 households were wasted. Wasting was also higher among black children (n=39) compared to white children (n=15) in the current study and most of these black children were in the Quintile 1 – 3 schools, that typically represent lower socio-economic circumstances. Statistics show that poverty is higher than 60% among black populations, compared to 5% among white populations in SA (Coutsoudis & Coovadia, 2001:459), which can explain the results.

Wasting showed the highest prevalence in the Quintile 4 schools (n=15). Quintile 4 schools were comprised of 85 white children and 60 black children. Although these schools had the highest incidence, it must be kept in mind that white children in this study only attended the Quintile 4 and 5 school types. Those who were wasted in the Quintile 4 schools could possibly be from poor households where they also experience food insecurity. These schools however, do not have feeding schemes, in comparison to Quintile 1-3 schools where feeding schemes are in place, which ensure that children receive meals during school hours, thus contributing to them developing fewer symptoms of wasting. Another possibility for the higher prevalence of wasting in the higher socio-economic school types could be because lower-income parents not living in the area of the school sometimes enrol their children in schools in more affluent areas, because they believe that their children will receive a better education there. The negative consequence of this is that such children might be sent to school hungry. A possible solution could thus be to implement feeding schemes in all schools or to provide other food support to needy children in these schools. Wasting is, however, an acute problem and childhood illnesses might also have an influence on this result (Saloojee & Pettifor, 2012:383). Prista *et al.* (2003:957) however, also found higher wasting percentages in higher socio-economic areas in Mozambique and could not provide an explanation for this.

The results further indicate that boys (5.7%) were considerably more underweight than girls (2.5%) and more black children (5.5%) compared to white learners (0.5%) were underweight. These results correspond with research done by Reddy *et al.* (2008:205) on 13 to 19 year old learners in SA, where underweight was also more prevalent among boys (15.6%) than girls (3.9%), and black (9.5%) versus white (1.9%) children. Reddy *et al*. (2008:205) indicated that there could be several reasons for this gender-racial distribution of nutritional status in SA, of which one can be the cultural effect of social pressure, causing white girls to be thin, while there is a positive social value to being larger for black girls. Research done among

children in Brazil, showed that white children had better nutrient intakes than black children and these differences were ascribed to differences in socio-economic conditions (Reis, 2012:174). Underweight was furthermore most prevalent in the school types that are associated with lower socio-economic status. Quintile 2 (8.2%) schools showed the highest prevalence, although the prevalence in Quintile 1 and 3 schools did not differ significantly (5.2%; 5.1%) than Quintile 2 schools. Labadarios *et al.* (2005:533) also found that underweight was more prevalent in the low socio-economic (rural) areas than in high socio-economic areas. The "South African Child Gauge" (2008/2009:77) reports in this regard that two thirds (68%) of children in SA come from households with income poverty (per capita income below R350).

CONCLUSION

Stunting, wasting and underweight were found in this study to be prevalent among grade 1-learners in the NWP of SA, although it appears that the prevalence, especially with regard to stunting, has decreased considerably, when compared to other published South African studies. Stunting and underweight were also more prevalent in schools in lower socio-economic circumstances (Quintile 1 – 3 schools). Although feeding schemes and grants are provided to needy schools and households, it is recommended that the Department of Basic Education and the Department of Health find more strategies to address these problems as undernutrition results in various negative developmental complications including motor- and cognitive delays and psychological problems and thus ought to be addressed. No differences were found in the prevalence of wasting between school types and while the highest percentage of wasting was found in the Quintile 4 schools, it is also recommended that the implementation of feeding schemes should be considered in these schools. It is further recommended that longitudinal follow-up studies be executed in order to determine whether the problems of undernutrition persist or decrease over time. The follow-up studies can furthermore determine the long-term effect of the feeding schemes that are in place at the lower socio-economic schools.

ACKNOWLEDGEMENTS

This work is based upon research supported by the National Research Foundation of South Africa (NRF), the National Lottery Distribution Fund and the Focus area of PhASRec which are greatly acknowledged for their contributions.
Disclaimer: any opinion, findings and conclusions or recommendations expressed in this material are the opinion of the author(s) and therefor the NRF do not accept any liability in regard thereto.

The authors would also like to express their gratitude to the students, research and administration teams and the schools and learners who participated in the study.

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CHAPTER 5

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

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5.1 Summary

Several researchers indicate that the occurrence of overweight and obesity as well as stunting, wasting and underweight among children, worldwide and in South Africa (SA), have increased and that it has become a major health problem.

The aim of this study was firstly, to establish the incidence of overweight and obesity among Grade 1-learners in the North West Province (NWP) of SA and to determine whether this incidence is related to gender, race and the socio-economic circumstances which these learners are exposed to. Secondly, to establish the incidence of stunting, wasting and underweight among Grade 1-learners in the NWP of SA and to determine whether this incidence is related to gender, race and the socio-economic circumstances which these learners are exposed to. The problem, aim and hypothesis of the study are presented in Chapter 1.

Chapter 2 provides a review of literature related to the aims of the study and firstly describes the diversity of the South African population. It was established that SA is a diverse country with regard to population size, racial composition and socio-economic circumstances. South Africa is further considered a low-to-middle-income country with socio-economic inequalities, where socio-economic inequalities reflect feeding status among South Africans.

In a single household, children can for example be underweight and adults obese, with the risk of chronic diseases as a result of lifestyle choice.

Secondly, the literature review aimed to provide a review of the prevalence, causes and consequences of overweight and obesity among children. The literature review showed that the prevalence of overweight and obesity among children is very high worldwide, including in SA. Girls, white children and higher socio-economic areas are more influenced by overweight and obesity. Furthermore, it became clear that the high incidence of overweight and obesity can largely be ascribed to an imbalance between energy intake and energy expenditure. Research indicates that a decrease in physical activity and increased patterns of sedentary behaviour are the main causes of overweight and obesity. Literature findings further indicated that an increase in socio-economic status, urbanisation and a decrease in physical activity, resulted in certain areas of SA being more affected by overweight and obesity than others. It was also established that overweight and obesity have a negative effect on children's gross and fine motor development, which include physical fitness, motor co-ordination, aerobic endurance, loco-motor skills, balance, ball skills and posture. Overweight and obesity also impacted negatively on children's psychosocial, intellectual and cognitive development. Overweight and obese children furthermore, often suffer from depression, low self-esteem, lower quality of life and poor peer group relationships. Research indicates that academic achievements of obese children can also be negatively influenced. It is also reported that overweight and obesity result in negative health outcomes, including asthma, Type 2 diabetes, cardiovascular diseases and obstructive sleep apnoea.

The third objective of the literature review was to discuss the prevalence of undernutrition (stunting, wasting and underweight) worldwide and in SA. A detailed discussion was also provided on the effects of undernutrition on children's health and development. Literature indicated that undernutrition has a high incidence worldwide and in SA, with the black population having the highest incidence of stunting, wasting and underweight. Boys also showed a higher incidence for undernutrition, compared to girls. Literature revealed that socio-economic circumstances have a direct impact on the nutritional status of children, and that children living in poor socio-economic areas are often undernourished. Studies further showed that children attending schools in lower socio-economic circumstances had a higher incidence of stunting, wasting and underweight. It was also reported that undernutrition is the result of a cellular imbalance between the provision of nutrients and energy and the body's

ability to use it for growth and maintaining specific functions, including resistance to infections and recovery from illnesses. It is indicated in this regard that undernutrition influences every organ system in the human body, namely: muscle and bone, cardiovascular and respiratory systems, gastro-intestinal system, immune and tissue recovery and the endocrine system. As feeding status reflects growth among children, abnormalities in growth can be used as an indicator of undernutrition. The literature findings further indicated that undernutrition lead to delayed child development, including cognitive, psychosocial and motor development. Undernutrition can also leads to permanent brain damage, which can result in poor cognitive development. It was also found by researchers that children suffering from undernutrition show behavioural changes, appear irritated, are apathetic, attention deficient and anxious, have a lowered social response, show depression and also suffer from self-pity. Children's motor skills such as speed, fine motor skills and co-ordination are also reported to be negatively affected by undernutrition.

Lastly, literature was explored regarding the possible relationship between undernutrition and overweight and obesity among children. The literature indicated that undernutrition is a contributory factor to the increased rise of obesity in developed countries. Obesity is prominently associated with poverty, and obesity is sometimes found among adults who had a low birth weight or who suffered undernutrition during childhood. A large number of South Africans in urban and rural areas find themselves in a food transition phase due to changes in economic, social, demographic and health factors. In disadvantaged communities in SA, undernutrition among children and obesity among adolescents can be found in the same socio-geographic population, as well as in the same household.

Chapter 3 was prepared in article format for submission to the '*South African Journal of Sports Medicine'* and presents the results with regard to the prevalence of overweight and obesity among Grade 1-learners in the NWP of SA. Eight hundred and sixteen Grade 1-learners (419 boys and 397 girls), with a mean age of 6,78 years, participated in the baseline measurements of the longitudinal NW-CHILD study. The prevalence of overweight and obesity was determined using standard anthropometric techniques (BMI, skin folds and fat percentages). The results analysed by means of cut-off points for BMI by Cole and associates, indicated that 11,6% of the Grade 1-learners were overweight and obese (7,8% overweight, 1,8% obese and 2,0% severely obese). The results also indicated increasing trends in overweight from 6 to 7 years (6,3% to 10,5%), but lower obesity (2,5% to 0,7%)

and severe obesity (2,6% to 2,4%) levels among 7 year old children compared to the 6 year old children. White learners showed the highest prevalence of overweight (11,6%; 16,3%), obesity (3,6%; 2,5%) and severe obesity (2,9%; 2,5%) at 6 and 7 years, respectively. Girls showed the highest incidence for overweight (8,1%; 11,8%) and obesity (3,5%; 1,5%) at 6 and 7 years, while boys showed the highest percentages for severe obesity (2,9%; 2,5%) during these ages. Overweight, obesity and severe obesity were most prevalent in Quintile 4 schools for 6 year old learners with 13,2%, 4,4% and 4,4% respectively. In the 7 year old group, obesity was more prevalent in the Quintile 5 schools (2,3%), while no obesity was prevalent in Quintile 1-4 schools. However, Quintile 4 schools (4,8%) showed the highest prevalence for severe obesity at 7 years. In Quintile 1-3 schools overweight and obesity ranged from 0,6% to 5,2%, indicating that learners in lower socio-economic areas are also suffering from these conditions. From these results it was concluded that preventative strategies such as intervention programmes are needed in schools to combat the incidence of overweight and obesity among young learners in SA.

Chapter 4 was prepared and submitted in article format to the '*SA Health/SA Gesondheid*' and provides results that were found with regard to the prevalence of stunting, wasting and underweight among Grade 1-learners in the NWP of SA. Eight hundred and sixteen Grade 1-learners (419 boys and 397 girls), with a mean age of 6,78 years, participated in the study that forms part of the baseline measurements of the longitudinal NW-CHILD study. The prevalence of stunting, wasting and underweight was determined by using standard anthropometric techniques. Height-for-age (HAZ), BMI-for-age (BMIZ) and weight-for-age (WAZ), z-scores of the World Health Organization (WHO) reference sample was used. The results indicated that 4,3% learners were stunted, 7,35% were wasted and 4,3% were underweight. Underweight was the highest among the black learners (5,5%) with very low percentages of underweight found among the white learners. Only black learners showed stunting while wasting was found in more black (n=39) compared to white (n=15) learners. A higher incidence of wasting and underweight was found among the boys (8,4% and 6,0%), opposed to the girls (6,3% and 2,5%), while the girls had a higher incidence of stunting (4,5%). Quintile1-3 schools had the highest prevalence of stunting and underweight, whereas wasting was the highest in Quintile 4 schools. From these results, it was concluded that stunting, wasting and underweight, which are symptoms of poor nutritional status, is evident among Grade 1-learners in the NWP of SA. The black learners attending schools in the lower socio-economic areas in the NWP of SA, were the most affected by stunting and

underweight. Undernutrition has various negative developmental complications and thus ought to be addressed more aggressively by the Departments of Basic Education and Health. The highest percentage for wasting was found in the Quintile 4 schools, and it is thus recommended that feeding schemes should also be implemented in these schools.

5.2 Conclusions

The conclusions of this study were formulated based on the results of the study.

5.2.1 Conclusion 1

Hypothesis 1 states that an incidence of more than 10% of overweight and obesity will be found among Grade 1-learners in the NWP of SA, and that white girls living in higher socio-economic areas will show the highest incidence of overweight and obesity. An incidence of 11,6% of overweight and obesity were found among the group of Grade 1-learners. The results further indicated the highest incidence of overweight (13,3%) and obesity (6.4%) among white Grade 1-learners that attended schools types associated with higher socio-economic areas. Girls also showed the highest overweight (9,3% and obesity 4,3%) percentages compared to boys (6,4% and obesity 3,4%). On the grounds of the above mentioned hypothesis and the results, this is **accepted**.

5.2.2 Conclusion 2

Hypothesis 2 states that an incidence of more than 10% of stunting, wasting and underweight will be found among Grade 1-learners in the NWP of SA, and that black boys living in lower socio-economic areas will show the highest incidence of stunting, wasting and underweight. The results however showed lower percentages than 10% in all these conditions, where 4,3% of the learners were stunted, 7,4% were wasted and 4.3% were underweight. The results further indicated that black learners showed the highest incidence for stunting (6,0%), wasting (6,9%) and underweight (5,5%). Boys also showed the highest incidence for wasting (8,4%) and underweight (6,0%), while girls showed the highest incidence for stunting (4,5%). Learners attending schools in lower socio-economic areas showed the highest incidence of stunting (10,7%) and underweight (8,2%), whereas wasting (9,7%) differed and showed the highest incidence in higher socio-economic school types (Quintile 4). A lower incidence of

10% of stunting, wasting and underweight were found among the group of Grade 1-learners, while girls showed a higher incidence for stunting than boys and wasting showed a lower incidence among the lower socio-economic areas. From these results, the hypothesis is **rejected**.

5.3 Recommendations and limitations of the study

The results of this dissertation indicated a high percentage of overweight and obesity among Grade 1-learners, as 1 in 10 learners suffered from these conditions. It is thus a problem in SA that consequently needs to be addressed from an early age. Although the learners in the schools in the higher socio-economic areas showed the highest incidence of overweight and obesity, the results also indicated that children living in lower socio-economic areas are also affected by these conditions. This study therefore substantiate that poverty is already associated with overweight and obesity at a very young age. It is therefore recommended that specialised teachers such as physical educators should be appointed by the Department of Basic Education in schools to address the inactivity problems of obese children which are considered one contributing factor to the problem. It is also recommended that the statistics obtained by this dissertation should be made available to the Ministers of Basic Education and Health in order to increase awareness of the severity of this problem at a young age in the NWP of SA among policy makers.

The results of this dissertation further showed that undernutrition in SA has improved over the last couple of years, especially among older children such as school beginners. Although undernutrition was still evident among the group of Grade 1-learners, the percentages of stunting, wasting and underweight were lower than expected, which is a positive result. Undernutrition should, however, still receive attention. It is recommended that feeding schemes be revised and also be implemented in Quintile 4 schools, because lower-income parents, not living in the area of the school, sometimes enrol their children in schools in more affluent areas, because they believe that their children will receive a better education there.

It is further concluded from the incidences found for overweight and obesity, as well as stunting, wasting and underweight respectively, that overweight and obesity is currently a

bigger problem among school beginners compared to undernutrition, especially among white children.

Although all efforts were made in this dissertation to optimize the results, some limitations need to be acknowledged that could have improved the outcome of the study. The following limitations are acknowledged and recommendations for further research are subsequently indicated.

- The results of the study were based on data obtained from only one of the nine provinces in SA. Although the results are based on a randomized study, with good generalizability, it is recommended that future studies should be conducted across SA in all nine provinces. Results of such a nature could reflect a better overall picture of the body composition profiles of children in SA in order to improve future intervention.

- The analyses that determined the undernutrition profiles of the group were only done on the black and white racial groups, because of a limited number of mixed ancestry and Indian learners in the sample. It is recommended that future studies should include a more representative sample of all racial groups (black, white, mixed ancestry and Indian children), which will reflect a better overall picture of undernutrition profiles of children in SA.

- The results of this study are based upon cross-sectional data. Follow-up studies are recommended on these learners in order to establish whether the problems with overweight and underweight decreased or increased over time. Follow-up studies can further establish the long-term effects of intervention programs such as physical activity interventions for obesity and feeding schemes in lower and higher socio-economic areas.

- The main objective of this dissertation was to determine the body composition profiles of Grade 1-learners. It is recommended that future research should also determine possible contributing factors such as diet, eating habits and physical activity levels of learners, which will provide future researchers with answers about

the different possible causes of undernutrition characteristics (overweight, obesity, stunting, wasting and underweight) that were found in these learners.

- The results indicated that Grade 1-learners in SA, which is considered a low-to-middle income country, also showed problems with overweight and obesity although to a lower extent, in lower socio-economic areas. More research is recommended to determine the possible causes of these problems especially in lower socio-economic areas.

APPENDIX A

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOMKAMPUS

Bussie 616, PU vir CHO, Potchefstroom 2531.
Tel. (018) 299 1794/6

NAVORSINGSPROJEK – 'n Profiel en strategieë ter verbetering van liggaamsamestelling, perseptueel-motoriese, fisieke en visuele vermoëns van 7-jarige kinders woonagtig in die Noordwes provinsie van Suid-Afrika.

Hierdie navorsingsprojek is goedgekeur deur die Onderwysdepartement sowel as die Etiese komitee van die Noordwes-Universiteit, Potchefstroomkampus. Toestemming is ook by u skoolhoof verkry om voort te gaan met die navorsing.

U kind is deel van die groep wat geselekteer is om aan bogenoemde navorsingsprojek deel te neem.

Die doel van hierdie navorsingsprojek is:

- Om inligting te versamel oor 7-jarige kinders se liggaamsamestelling, perseptueel-motoriese, fisieke en visuele vermoëns en bloeddruk en hieruit strategieë te ontwikkel ter verbetering van gesondheidsbevorderende - sowel as ander agterstande wat kinders se lewenskwaliteit en verdere ontwikkeling kan belemmer. Die fisieke toetse sal deur gekwalifiseerde navorsers uitgevoer word, is veilig om aan deel te neem, ouderdomsgepas en verg min inspanning van die kind. Twee velvoue sal geneem word (een op die arm en een op die kuit).

Deur u kind aan die bogenoemde navorsingsprojek te laat deelneem, kan dit nie net vir u kind tot voordeel wees nie, maar ook vir ouers, onderwysers en kundiges, inligting verleen wat gebruik kan word om kinders van hierdie ouderdom se ontwikkeling te optimaliseer. Ons vra dus dat u dit sterk sal oorweeg om hom/haar te laat deelneem aan die navorsing. U is uiteraard geregtig om u kind op enige stadium, sonder enige verduideliking, te onttrek van die studie. Terugvoering sal aan die betrokke kinders se onderwysers en skole gegee word nadat alle toetsings wat op een dag sal geskied, afgehandel en die inligting verwerk is. Vir enige verdere inligting oor die projek, kan enige van die onderstaande persone gekontak word.

Prof. A.E. Pienaar **Mev. Chanelle Kemp**

Projekleier **Kinderkinetikus, Navorser**

(Skool vir Biokinetika, Rekreasie en Sportwetenskap)

(018) 299 1796 (W)

082 331 1494 / (018) 299 1797 (w)

Stuur asseblief hierdie vorm die VOLGENDE DAG terug skool toe, hetsy dit ingevul is al dan nie.

_____✂_____✂_____✂_____

Ek as ouer verstaan dat ek onder geen verpligting is om my kind aan die navorsingsprojek te laat deelneem nie. Ek verstaan dat daar geen skade aan my kind berokken gaan word, hetsy fisies of geestelik nie. Ek verstaan ook dat daar geen kostes verbonde is aan die evaluering nie en dat dit ook nie sal inmeng met my kind se skoolaktiwiteite nie.

Hiermee gee ek _____ouer/wettige voog van _____ (Kind se volle name en van) _____(Geboortedatum) toestemming dat hy/sy aan die navorsingsprojek mag deelneem.

_____ _____

Handtekening Datum

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOMKAMPUS

Kliniek vir Kinderkinetika
Bussie 616, PU vir CHO, Potchefstroom 2531.
Tel. (018) 299 1794/6

RESEARCH PROJECT – A profile and strategies for improvement of body composition, perceptual-motor, physical and visual abilities of 7-year-old children living in the North-West province of South Africa.

This research project is approved by the Department of Basic Education and the Ethics committee of the North-West University, Potchefstroom Campus. The headmaster of your school has also agreed that we may continue with the project.

Your child is part of a group that were selected to participate in the following research project.

The aim of this research project is:

- To gain information about 7-year-old children's body composition, perceptual-motor, physical and visual abilities and blood pressure and to develop from these strategies to improve health promoting problems and other backlogs that can hamper the quality of life and further development of children in this age group. The physical assessments will be done by qualified researchers, is safe for the children to participate in, is age specific and requires minimal effort of the child. Two skinfolds will be taken (one on the arm and one on the calf).

By allowing your child to take part in this research project, it will not only be beneficial for him/her, but will also provide information for parents, teachers and other specialists that they can use to optimize the development of children in this age group. We therefore would like to ask you to consider it strongly to allow your child to participate in the project. You are, however, entitled to withdraw your child at any time from the study, without any explanation. All testing will be completed in one day and feedback will be given to teachers and schools after the data is processed. For further information about this project, feel free to contact any of the persons indicated below.

Prof. A.E. Pienaar
Project Leader

Mrs. Chanelle Kemp
Kinderkineticist, Researcher

(School for Biokinetics, Recreation and Sport Science)
(018) 299 1796 (W)
082 331 1494 / (018) 299 1797 (w)

Please send this form back to school the NEXT DAY.

_____✂_____✂_____✂___

I, as the parent understand that I am under no obligation to let my child participate in this research project. I understand that my child would not be harmed in any way, physically or spiritually. I understand that there would be no costs involved in the evaluation and that the research will not interfere with my child's school work.

Hereby I _____ parent/ legal caregiver of

_____(full name of child)

_____ (Date of birth) give permission that he/she may participate in the research project.

_____ _____

Signature Date

APPENDIX B

The South African Journal of Sports Medicine

Author Guidelines

Accepted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction, and will delay publication.

AUTHORSHIP

Named authors must consent to publication. Authorship should be based on substantial contribution to: (i) conception, design, analysis and interpretation of data; (ii) drafting or critical revision for important intellectual content; and (iii) approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to **www.icmje.org**).

CONFLICT OF INTEREST

Authors must declare all sources of support for the research and any association with a product or subject that may constitute conflict of interest.

RESEARCH ETHICS COMMITTEE APPROVAL

Provide evidence of Research Ethics Committee approval of the research where relevant.

PROTECTION OF PATIENT'S RIGHTS TO PRIVACY

Identifying information should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives informed written consent for publication. The patient should be shown the manuscript to be published. Refer to **www.icmje.org**.

ETHNIC CLASSIFICATION

References to ethnic classification must indicate the rationale for this.

MANUSCRIPTS

Shorter items are more likely to be accepted for publication, owing to space constraints and reader preferences.

Original articles not exceeding 3 000 words, with up to 6 tables or illustrations, are usually observations or research of relevance to sports medicine and exercise science. References should be limited to 15. Please provide a structured abstract not exceeding 250 words, with

the following recommended headings: *Background, Objectives, Methods, Results,* and *Conclusion.*

Short reports, ***Commentaries*** or ***Case Studies***, should be 1500 words or less, with 1 table or illustration and no more than 6 references. Please provide an accompanying abstract not exceeding 150 words.

Editorials, Opinions, etc. should be about 1000 words and are welcome, but unless invited, will be subjected to the SAJSM peer review process.

Review articles are rarely accepted unless invited.

Letters to the editor, for publication, should be about 400 words with only one illustration or table, and must include a correspondence address.

Obituaries should be about 400 words and may be accompanied by a photograph.

MANUSCRIPT PREPARATION

Refer to articles in recent issues for the presentation of headings and subheadings. If in doubt, refer to 'uniform requirements' - **www.icmje.org**.

Manuscripts must be provided in **UK English**.

Qualification, affiliation and contact details of ALL authors must be provided in the manuscript and in the online submission process.

Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.

Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dl). Litres is denoted with a lowercase 'l' e.g. 'ml' for millilitres). Units should be preceded by a space (except for %), e.g. '40 kg' and '20 cm' but '50%'. Greater/smaller than signs (> and <) should be placed immediately preceding the relevant number, i.e. 'women >40 years of age'. The same applies to ± and º, i.e. '35±6' and '19ºC'.

Statistical methods must be described with sufficient detail to enable a knowledgeable reader with access to the original data to verify the reported results. All data should be presented with appropriate indicators of measurement error or uncertainty (standard

deviations or confidence intervals). Avoid sole reliance on statistical hypothesis testing, such as the use of *p*-values, which fails to convey important quantitative information. Precise *p*-values must be shown as indirect indications (such as $p>0.05$ or p=NS) are unacceptable and difficult for other researchers undertaking meta-analyses.

Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160...

Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'

Round **brackets** (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.

General formatting

The manuscript must be in Microsoft Word or RTF document format. Text must be single-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes, with the exception of Tables).

ILLUSTRATIONS AND TABLES

If tables or illustrations submitted have been published elsewhere, the author(s) should provide consent to republication obtained from the copyright holder.

Tables may be embedded in the manuscript or provided as **'supplementary files'**. They must be numbered in Arabic numerals (1,2,3...) and referred to consecutively in the text (e.g. 'Table 1'). Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged. Tables must be cell-based (i.e. not constructed with text boxes or tabs), and accompanied by a concise title and column headings. Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Fig. 1)'. Figure legends: Fig. 1. 'Title...'

All illustrations/figures/graphs must be of **high resolution/quality**: 300 dpi or more is preferable but images must not be resized to increase resolution. Unformatted and uncompressed images must be attached as '**supplementary files**' upon submission (not embedded in the accompanying manuscript). TIFF and PNG formats are preferable; JPEG and PDF formats are accepted, but authors must be wary of image compression. Illustrations

and graphs prepared in Microsoft Powerpoint or Excel must be accompanied by the original workbook.

REFERENCES

Authors must verify references from the original sources. *Only complete, correctly formatted reference lists will be accepted.* Reference lists must be generated manually and **not** with the use of reference manager software.

References should be inserted in the text as superscript numbers, e.g. These regulations are endorsed by the World Health Organization,[2] and others.[3,4,6]

All references should be listed at the end of the article in numerical order of appearance in the **Vancouver style** (not alphabetical order). Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus.

Names and initials of all authors should be given; if there are more than six authors, the first three names should be given followed by et al. First and last page, volume and issue numbers should be given.

Wherever possible, references must be accompanied by a digital object identifier (DOI) link and PubMed ID (PMID)/PubMed Central ID (PMCID). Authors are encouraged to use the DOI lookup service offered by **CrossRef**.

Journal references:

Price NC, Jacobs NN, Roberts DA, et al. Importance of asking about glaucoma. Stat Med 1998;289:350-355. [http://dx.doi.org/10.1000/hgjr.182] [PMID: 2764753]

Book references:

Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975:96-101.

Chapter/section in a book:

Weinstein L, Swartz MN. Pathogenic properties of invading microorganisms. In: Sodeman WA jun, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974:457-472.

Internet references:

World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting

Healthy Life. Geneva: World Health Organization, 2002. http://www.who.int/whr/2002 (accessed 16 January 2010).

Other references (e.g. reports) should follow the same format:
Author(s). Title. Publisher place: publisher name, year; pages.

Cited manuscripts that have been accepted but not yet published can be included as references followed by '(in press)'.

Unpublished observations and personal communications in the text must not appear in the reference list. The full name of the source person must be provided for personal communications e.g. '...(Prof. Michael Jones, personal communication)'.

PROOFS

A PDF proof of an article may be sent to the corresponding author before publication to resolve remaining queries. At that stage, **only** typographical changes are permitted; the corresponding author is required, having conferred with his/her co-authors, to reply within 2 working days in order for the article to be published in the issue for which it has been scheduled.

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1. Named authors consent to publication and meet the requirements of authorship as set out by the journal.
2. The submission has not been previously published, nor is it before another journal for consideration.
3. The text complies with the stylistic and bibliographic requirements in **Author Guidelines**.
4. The manuscript is in Microsoft Word or RTF document format. The text is single-spaced, in 12-point Times New Roman font, and contains no unnecessary formatting.
5. Illustrations/figures are high resolution/quality (not compressed) and in an acceptable format (preferably TIFF or PNG). These must be submitted as 'supplementary files' (not in the manuscript).
6. For illustrations/figures or tables that have been published elsewhere, the author has obtained written consent to republication from the copyright holder.
7. Where possible, references are accompanied by a digital object identifier (DOI) and PubMed ID (PMID)/PubMed Central ID (PMCID).
8. An abstract has been included where applicable.
9. The research was approved by a Research Ethics Committee (if applicable)
10. Any conflict of interest (or competing interests) is indicated by the author(s).

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APPENDIX C

HEALTH SA GESONDHEID AUTHOR GUIDELINES

Requirements to which the authors of articles must conform

- **Nature of the publication**

  Health SA Gesondheid is an accredited interdisciplinary research journal that publishes only selected articles of the highest scientific standard, with human health as main theme. The journal accepts research and review articles on this theme. Journal articles express the authors' views and are not necessarily the views of Health SA Gesondheid. Articles may be written in either Afrikaans or English.

- **Copyright reserved**

  The submission of an article to the editorial staff of **Health SA Gesondheid** shall be deemed as tacit consent that the copyright to the article be reserved by **Health SA Gesondheid**. In addition, it is assumed that the article is an original work that has not been published before, nor is it being submitted elsewhere for publication. Requests for permission to reprint material from this journal should be directed to the Editor at the address below. The editorial staff shall not accept responsibility for any printouts or data discs ("stiffies/cd's/flash disks/etc.") of an article being damaged or lost.

The following statement, to be signed by ALL the authors, must accompany articles submitted for evaluation:

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- **Authorship**

  Authorship should be based only on substantial contribution to: (i) conception and design, or analysis and interpretation of data; (ii) drafting the article or revising it critically for important intellectual content; and (iii) final approval of the version to be published. All three of these conditions must be met. All contributors who do not meet the criteria for authorship should be listed in an acknowledgments section.

  The following statement should be typed on a separate piece of paper and signed by ALL the authors:

  "I have participated sufficiently in the conception and design of this work, the data analysis (when applicable), and the writing of this article to take public responsibility for it. I have reviewed the final version of the article and approve it for submission for possible publication".

  An explanation for the addition or removal of an author(s) name must be provided with direct verification from the added/removed author(s).

- **Review**

  Each article shall be reviewed on a double-blind basis by at least two reviewers. Articles written by any editorial members will also be subjected to a double-blind peer review.

  Articles will not be reviewed by colleagues or editorial board members from the same institution as the author.

  The editor reserves the right to withdraw an article from the publishing process at any time.

- **Article preparation**
  - Body text paragraphs should be in double spacing, **not** indented, left aligned (not justified) and an open (empty) paragraph after each text paragraph.
  - Body text font type and size should be Arial size 10 .
  - Article must be submitted in MS Word format or recent compatible software format.
  - Abstracts in English and Afrikaans of no more than 200 words must be included in the article. The abstract must accurately reflect the content of the article.
  - Five keywords describing the contents of the article should be submitted.
  - The article itself may not compromise more than 20 pages (including abstract and reference list; excluding figures and tables) and authors must supply a word count. In exceptional cases longer articles may be accepted.
  - The journal has a policy of anonymous peer review. Authors' names are withheld from the referees, but it is the authors' responsibility to ensure that any identifying material is removed from the article.

- The article must be ready for the press, in other words, it must have been revised for grammar and style. The author must provide a letter from a language editor confirming this.
- The article must be written in clear English (South African/UK style) or in Afrikaans.
- All abbreviations should be written out when first used in the text and thereafter used consistently.
- All references to source books must be acknowledged according to the revised Harvard method (see examples at the end of the author guidelines).
- It is the author's responsibility to verify references from the original sources.
- All illustrations, figures and tables must be numbered and provided with titles. Each illustration, figure and table must, in addition, appear on a separate page and must be graphically prepared (be press ready). Illustrations, figures and tables must be black and white - **NOT in colour.** The author is responsible for obtaining written permission from the author(s) and publisher for the use of any material (tables, figures, forms or photographs) previously published or printed elsewhere. Original letters granting this permission must be forwarded with the final article.
- Headings are **not** numbered. Their order of importance is indicated as follows: Main Headings in **CAPITALS** and bold print; sub-headings in UPPER and lower case and bold letters; sub-sub headings in upper and lower case, bold and italic letters (see examples at the end of the author guidelines).
- Refer to articles in recent issues for guidance on the presentation of headings and subheadings.

- **Requirements for publication**
  - Articles should preferably be submitted via email to charlened@uj.ac.za
  - If the article is not submitted electronically, one printout of the article must be submitted. In addition to the above-mentioned printout, a cd containing the full article must also be submitted. The latter disc must clearly be marked with the name of each author and co-author and the name of the file.
  - A further copy of the article should be retained by the corresponding author.
  - The article must be accompanied by a cover letter.
  - The title page must be submitted on a separate page and must give the following particulars:
    - The title of the article.
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BBC ONLINE 2004: Radical autumn shake-up. Available from: http://www.bbc.co.uk/news10276.htm (Accessed 8 December 2004).

DE VOS, AS; STRYDOM, H; FOUCHE, CB; POGGENPOEL, M & SCHURINK, W 1998: Research at grass roots. A primer for the caring professions. Pretoria: Van Schaik Academic.

DURRHEIM, K 1997: Social constructionism, discourse and psychology. **South African Journal of Psychology**, 27(3):175-182.

FOUCAULT, M 1984: Nietzsche, genealogy, history. (**In:** Rainbow, P ed**.** 1984: The Foucault reader. Harmondsworth: Penguin, pp 76-100).

HOLMES, A 1998: Greenpeace wins media war. Available from: http://www.independent.co.uk/international/green25.htm (Accessed 25 November 1998).

Examples of text references:

The ethical measures adhered to during this research process are those set out by DENOSA (Democratic Nurses Association of South Africa, 1998:3-7).

Stein, Brailowsky and Will (1995:105), however, note that points of divergence are seen even within rodents of the same species. Yet sex differences do occur both in response to injury and in recovery of function, female rats in normal oestrus showing less oedema following frontal cortical contusions than males, and more severe oedema than females who are not in oestrus (Stein *et al.* 1995:105).

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APPENDIX D

APPENDIX D

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To: "Anita Pienaar" <anita.pienaar@nwu.ac.za>
Cc:
Date: Tue, 23 Apr 2013 16:26:29 +0200
Subject: [SAJSM] Submission Acknowledgement
Anita Pienaar:

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Date: Mon, 22 Apr 2013 13:47:30 +0200
Subject: HSAG Submission - 744: Confirming Receipt
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