

**A longitudinal study on the effect of overweight, obesity, stunting and
wasting on academic performance of primary school boys: the NW-CHILD
study**

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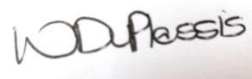
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PREFACE

A master's degree is not easy and thus requires a team to complete. My team was motivated, determined and helpful in every way. I would like to thank every person who was involved (one way or another) with regard to the completion of this dissertation.

Firstly, I would like to thank God for granting me this opportunity and completing it, without Him I could not have done this.

Job 42:2 "I know that you can do all things; no purpose of yours can be thwarted."

The following persons formed part of my wonderful team:

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SUMMARY

Childhood overweight, obesity, stunting and wasting have a definite effect on academic performance. Literature has indicated that these four conditions have a major impact on academic performance, especially among Mathematics, Language, reading and writing. Furthermore, South Africa has contributing challenges such as socio-economic status (SES) that negatively influence children's academic performance.

The purpose of this dissertation was twofold. Firstly, to determine the effect of overweight and obesity on academic performance over a period of seven years (2010-2016) among primary school boys in the North West Province of South Africa, taking into account SES. Secondly, the same effect was focused on among stunted and wasted primary school boys over the same period.

STATISTICA StatSoft (2017) was used to analyse the data. Descriptive data were analysed and means and standard deviations were calculated first. Further, Repeated Measures ANOVA's were used for over time data to determine the difference between the different SES groups and the boys' body composition as well as their academic performance (2010-2016). Two-way tables were used to determine any relationships and changes that may have occurred over time with regard to overweight, obesity, stunting, wasting and SES to compare the classifications of the different quintiles (Quintile 1-3 = schools classified as low SES and Quintile 4 to 5 = schools classified as high SES). Additionally, Pearson Chi-square was used to indicate any significance of these associations (Body Mass Index (BMI), stunting, wasting and academic performance) as well as the level of statistical significance, set at $p \leq 0.05$. Lastly, Spearman rank order correlations were used to determine the relationship between BMI and academic performance. The strength of the correlation was set at $r \approx 0.1$ indicating a small effect, $r \approx 0.3$ indicating a medium effect and $r \approx 0.5$ a large effect.

The results indicate that the BMI, stunting and wasting increased from 2010-2016. Most of the subjects reported a small to large effect related to the association between BMI and academic performance ($r \geq 0.1$ and $r \geq 0.3$), except for Afrikaans in 2013 ($r = -0.06$). Only two subjects (English and Language as tested with the Annual National Assessment (ANA) test) reported medium effects ($r \geq 0.3$), whereas the other subjects only reported small effects ($r \geq 0.1$). Additionally, no statistical significance ($p \geq 0.05$) was observed among the BMI values and academic subjects, however, SES and school subjects reported several statistical significant relationships, especially among

Languages (English and First Additional Language) and Mathematics. Lastly, academic performance, including Language, Mathematics and average academic scores showed relationships of statistical significance among stunting and wasting ($p \leq 0.05$). Over a period of seven years (overall), it was seen that stunting and wasting had an effect on academic performance, especially regarding Language and Mathematic subjects. These results contribute to a better understanding of the effect of overweight, obesity, stunting and wasting on academic performance. The findings are helpful to the Department of Basic Education, schools, teachers, Kinderkinetici and other health-care professions regarding meaningful statistics about overweight, obesity, stunting and wasting, intervention and physical activity or nutritional programmes among children in South Africa. Recommended is more longitudinal studies in South Africa with regard to overweight, obesity, stunting, wasting and academic performance as well as studies in the other eight provinces for intervention programmes to be developed from these findings to help the affected learners.

Keywords: Academic performance, boys, overweight, obesity, primary school, stunting, wasting.

OPSOMMING

Oorgewig, obesiteit, groeibelemming en ondergewig wat teenwoordig is by kinders het 'n definitiewe effek op hul akademiese prestasie. Literatuur het gevind dat hierdie vier kondisies 'n groot impak het op akademiese prestasie wat veral wiskunde, taal, lees en skryf insluit. Suid-Afrika het verder bydraende uitdagings soos sosio-ekonomiese status (SES) wat ook 'n negatiewe impak op akademiese prestasie kan hê.

Die doel van hierdie verhandeling was tweeledig. Eerstens was dit om te bepaal of oorgewig, obesiteit, groeibelemming en ondergewig 'n effek op laerskool seuns in die Noordwes provinsie van Suid-Afrika, se akademiese prestasie sou toon oor 'n tydperk van sewe jaar. Sosio-ekonomiese status is ook in ag geneem. Tweedens, is daar oor dieselfde tydperk gefokus op dieselfde effek, maar slegs by seuns wie se groei belemmer is en wie ondergewig was.

STATISTICA StatSoft (2017) is gebruik om die data te analiseer. Eerstens, is beskrywende data bepaal deur middel van gemiddeldes en standaardafwykings. Verder is variansie-ontleding (ANOVA's) gebruik om te bepaal wat die verskil tussen SES, liggaamsmassa indeks (LMI) en akademiese prestasie oor tyd by seuns was. Twee-rigting frekwensie tabelle is gebruik om die verwantskap tussen oorgewig, obesiteit, groeibelemming, ondergewig en SES te bepaal by die verskillende kwintiele (Kwintiel 1 tot 3 = skole geassosieer met lae SES en Kwintiel 4 tot 5 = skole geassosieer met hoë SES). Die Pearson Chi-Kwadraat is gebruik om die betekenisvolheid van die verskille aan te dui en die vlak van statistiese betekenisvolheid is vasgestel met betrekking tot die verband tussen die vier kondisies (oorgewig, obesiteit, groeibelemming en ondergewig) en akademiese prestasie. Die Chi-kwadraat was gestel op $p \leq 0.05$. Laastens, is die Spearman rangorde korrelasie gebruik om die korrelasie tussen LMI en akademiese prestasie te bepaal. Die effek grootte van die korrelasie was gestel op $r \approx 0.1$ wat 'n klein effek aandui, $r \approx 0.3$ 'n medium effek en $r \approx 0.5$ 'n groot effek.

Die resultate toon dat LMI (oorgewig en obesiteit) 'n verhoging in groeibelemming en ondergewig veroorsaak het vanaf 2010 tot 2016. Meeste van die seuns se skoolvakke het 'n klein tot groot verwantskappe getoon tussen LMI en akademiese prestasie ($r \geq 0.1$ en $r \geq 0.3$), behalwe Afrikaans in 2013 ($r = -0.006$). Slegs twee vakke (Engels en Eerste addisionele taal met die ANA toets) het 'n medium effek getoon ($r \geq 0.3$). Verder is geen statistiese betekenisvolheid tussen LMI en akademiese skoolvakke gevind nie ($p \geq 0.05$), alhoewel SES en die akademiese skoolvakke

verskeie statistiese betekenisvolle verbande getoon het, veral by taal (Engels en Eerste addisionele taal) en wiskunde. Laastens, is statistiese betekenisvolheid gevind by groeibelemming, ondergewig en akademiese prestasie (taal, wiskunde en gemiddelde akademiese tellings). Oor 'n tydperk van sewe jaar (algeheel) is daar gevind dat groeibelemming en ondergewig 'n groot effek getoon het op hierdie seuns se akademiese prestasie. Hierdie resultate dra tot 'n breër begrip van die effek wat oorgewig, obesiteit, groeibelemming en ondergewig op akademiese prestasie het, by. Die bevindinge kan nuttig wees vir die Departement van Basiese Onderwys, skole, onderwysers, Kinderkinetici en ander gesondheidsberoepes met betrekking tot betekenisvolle statistiek oor oorgewig, obesiteit, groeibelemming en ondergewig, asook help met intervensie-programme by Suid-Afrikaanse kinders. Die word aanbeveel dat meer longitudinale studies rakende oorgewig, obesiteit, groeibelemming, ondergewig en akademiese prestasie asook studies in die ander agt provinsies en intervensie-programme wat spesifiek ontwikkel is vir die geaffekteerde kinders.

Sleuteltermes: Akademiese prestasie, groeibelemming, laerskool, ondergewig, oorgewig, obesiteit, seuns.

TABLE OF CONTENTS

CONTRIBUTION OF AUTHORS	i
PREFACE.....	ii
SUMMARY.....	iii
OPSOMMING.....	v
LIST OF TABLES.....	x
LIST OF FIGURES.....	xii
LIST OF ABBREVIATIONS.....	xiii

CHAPTER 1

PROBLEM STATEMENT	1
1.1 Introduction	1
1.2 Objectives.....	6
1.3 Hypothesis.....	6
1.4 Proposed chapters.....	7
References... ..	9

CHAPTER 2

LITERATURE REVIEW:.....	17
OVERWEIGHT, OBESITY, STUNTING AND WASTING'S EFFECT ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS.....	17
2.1 Introduction	17
2.2 Defining relevant terms.....	19
2.3 South African population	22
2.3.1 Population size	22
2.3.2 Population demographics	22
2.3.3 Socio-economic conditions	25
2.4 Overweight and obesity	27
2.4.1 Classifications	28
2.4.2 Prevalence of overweight and obesity among children	28
2.4.2.1 International statistics	29
2.4.2.2 South African statistics	31
2.4.2.3 Race... ..	32
2.4.2.4 Association among overweight and obesity and socio-economic conditions	33
2.5 Stunting and wasting	34
2.5.1 Classification	34

2.5.2 Prevalence of stunting and wasting among children	35
2.5.2.1 International statistics	35
2.5.2.2 South Africa statistics	38
2.6 The effect of overweight, obesity, stunting and wasting on childhood development.....	40
2.6.1 Psychosocial development	40
2.6.1.1 Self-esteem/ self-concept	40
2.6.1.2 Depression	42
2.6.1.3 Peer group relationships.....	43
2.6.2 Health related aspects affected by overweight, obesity, stunting and wasting	44
2.6.2.1 Health related lifestyle/health risk factors.....	44
2.6.2.2 Cardiovascular Disease (CVD)	45
2.6.2.3 Hypertension	45
2.6.2.4 Asthma	47
2.6.2.5 Diabetes Mellitus	48
2.6.2.6 Growth impairment	49
2.6.3 Motor development/physical activity	50
2.7 Academic system: South Africa	51
2.8 The effect of overweight, obesity, stunting and wasting on cognitive and academic performance	53
2.9 Summary... ..	57
References... ..	59

CHAPTER 3

LONGITUDINAL EFFECTS OF OVERWEIGHT AND OBESITY ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS: THE NW-CHILD STUDY.....	83
Abstract.....	85
Introduction.....	86
Research method and design.....	89
Results.....	92
Discussion.....	97
Conclusion... ..	101
Acknowledgements.....	101
References... ..	103

CHAPTER 4

LONGITUDINAL EFFECTS OF STUNTING AND WASTING ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS: THE NW-CHILD STUDY.....

Abstract.....	112
Introduction.....	113
Research methods and design.....	117
Results.....	119
Discussion.....	125
Conclusion.....	126
Acknowledgements.....	126
References.....	128

CHAPTER 5

SUMMARY, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS.....

5.1 Summary.....	134
5.2 Conclusions.....	137
5.2.1 Conclusion 1.....	137
5.2.2 Conclusion 2.....	138
5.3 Recommendations and Limitations	138

APPENDIX A	141
APPENDIX B	143
APPENDIX C	148
APPENDIX D	153
APPENDIX E	157
APPENDIX F.....	159
APPENDIX G.....	162

LIST OF TABLES

CHAPTER 2

OVERWEIGHT, OBESITY, STUNTING AND WASTING'S EFFECT ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS

Table 2.1: Classification criteria for hypertension in children and adolescents (Falkner <i>et al.</i> , 2005:14).....	21
Table 2.2: South Africa mid-year population predictions by population groups and gender for 2016 (Statistics SA, 2017:2).	23
Table 2.3: South Africa mid-year predictions by population group, gender and age for 2017 (Statistics SA, 2017:10).....	23
Table 2.4: South Africa mid-year predictions by province, 2017 (Statistics, 2017:2).....	24
Table 2.5: South Africa's' mid-year predictions for 2017, by province and age (Statistics SA, 2017:18).....	25
Table 2.6: Poverty percentage of population groups in South Africa (Statistics South Africa, 2017:58).....	26
Table 2.7: Poverty percentage per province in South Africa (Statistics South African, 2017:64).....	27
Table 2.8: Age specific BMI cut-off points for overweight and obesity among boys (Cole <i>et al.</i> , 2000:1243).....	28
Table 2.9: International cut-off points for BMI wasting Grades 1, 2, and 3 for boys between six- and 13 years (Cole <i>et al.</i> , 2007:5).	35
Table 2.10: Grading scales for ANA assessments (Department of Basic Education, South Africa, 2015).....	52
Table 2.11: Specific allocated times per subject for Grade 1, 4 and 7 (Department of Basic Education, South Africa, 2015).	53

CHAPTER 3

LONGITUDINAL EFFECTS OF OVERWEIGHT AND OBESITY ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS: THE NW-CHILD STUDY

Tables in Chapter 3

Table 1: Age specific BMI cut-off points for overweight and obesity (Cole et al. 2000).....	91
Table 2: Grading scales for ANA assessments.	92
Table 3: Descriptive statistics from 2010 to 2016 for primary school boys.	93
Table 4: Two-way frequency table for socio-economic status (SES) and BMI categories over time (2010-2016).	94
Table 5: Two-way frequency table for race and BMI over time (2010-2016).	95
Table 6: Repeated measure ANOVA per subject, per year from 2010-2016.	96
Table 7: Spearman rank order correlations on academic performance (per subject) and BMI.....	97

CHAPTER 4

LONGITUDINAL EFFECTS OF STUNTING AND WASTING ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS: THE NW-CHILD STUDY

Tables in Chapter 4

Table 1: Grading scales for ANA assessments.	119
Table 2: Descriptive statistics for primary school boys over the period of seven years (2010-2016).....	120
Table 3: The relationship between socio-economic status, stunting and wasting over seven years.....	121
Table 4: ANOVA's between normal weight, stunting and academic subjects per year.....	122
Table 5: Meaningful differences between normal weight, wasting and academic subjects per year.....	124

LIST OF FIGURES

CHAPTER 2

OVERWEIGHT, OBESITY, STUNTING AND WASTING'S EFFECT ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS

Figure 2.1: Bronfenbrenner ecological model (Bronfenbrenner, 1986:736).	26
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LIST OF ABBREVIATIONS

ADA	American Diabetes Association
ANA	Annual National Assessment
BMI	Body Mass Index
CAPS	National Curriculum and Assessment Policy Statement
DXA	Dual X-ray Absorptiometry
LMI	Liggamsmassa Indeks
NW-CHILD	North West Child Health, Integrated with Learning and Development
SES	Socio-economic status
UNICEF	United Nations International Children's Emergency Fund
USA	United States of America
WHO	World Health Organization

CHAPTER 1

PROBLEM STATEMENT

1.1 Introduction

The prevalence of childhood obesity has increased dramatically since the mid-70s in many countries worldwide (Lobstein *et al.*, 2004:76). In 2012, the World Health Organisation (WHO) estimated that 42 million (6.7%) children under the age of five were overweight or obese, with more than 31 million children representing developing countries (WHO, 2014:40; UNICEF, 2016:36). Overweight or obesity can be defined as excessive or abnormal accumulation of fat and causes health-related risk factors (WHO, 2015:2). According to the WHO (2015:101), countries with different socio-economic status' (SES) have different levels of prevalence of overweight and obesity. The WHO (2015:101) further indicated that it was once considered that only high-income countries had a rising problem with overweight and obesity, but the increase in the prevalence of obesity (30%) is now being observed in low and middle-income countries as well. Anthropometrical measurements like body composition can be used to determine overweight and obesity among children (Krebs *et al.*, 2007:194).

Body composition is the quantitative value of fat, bone and muscle in the body (Lohman *et al.*, 2013:575) and can be evaluated using various methods such as dual energy x-ray absorptiometry (DXA), densitometry, multicomponent models or field methods such as body mass index (BMI) values (Lohman *et al.*, 2013:575). In 2006, the WHO (2006:663) formed new standards for zero to five-year old and five to 19-year old children. The BMI values for overweight and obesity for five to 19-year old boys are 25.4 kg/m² and 29.7 kg/m² respectively (De Onis *et al.*, 2007:663). A study by Goon *et al.* (2013:826) on 120 Andibila children in Nigeria, aged seven to 14 years (76 boys and 44 girls), reported that these children had a low BMI value but no gender differences were found. However, Zhang and Wang's (2013:254) study in Shandong, China on 7 582 children between the ages of seven and 18 years (3 785 boys and 3 797 girls) found that the overall rate of overweight percentages for boys had increased from 6.5% in 1995 to 19.1% in 2010. Furthermore, these researchers found that the obesity rate for boys had increased from 1.6% in 1995 to 9.3% in

2010. In various parts of the world, numerous researchers confirmed higher (than previous years) overweight and obesity prevalence among boys between the ages of five and 18 years (Ahrens *et al.*, 2014:103; Zhang *et al.*, 2015:381; Pangani *et al.*, 2016:3). These researchers further reported that the prevalence for overweight among boys ranged between 11.8% to 16.33% while the prevalence for obesity ranged between 4.9% to 10.69%. With regard to longitudinal studies, overweight and obesity prevalence increased dramatically over time (Chen *et al.*, 2012:430; Cunningham *et al.*, 2014:405; Ells *et al.*, 2014:8). A study done by Armstrong *et al.* (2006:62) on 10 195 South African children aged six to 13 years (5 611 boys and 4 584 girls) found that the prevalence of obesity for boys was 3.2%, whereas the prevalence of overweight for boys was 14.0%. The same researchers (Armstrong *et al.*, 2006:56) found the following differences in ethnic groups of boys regarding overweight and obesity: African children (7.6% overweight and 2.1% obese), Caucasian (15.4% and 4.3%) and Mixed race (8.7% and 3.0%). A longitudinal study conducted by Pienaar (2015:6) in the North West Province indicated that six- to nine-year old primary school boys' prevalence of obesity increased more when compared to primary school girls (3.2% vs. 2.4%). This researcher also found that children in the high SES group had a higher increase in obesity prevalence, compared to low and middle SES groups (Pienaar, 2015:6). Another longitudinal study done by Monyeke *et al.* (2008:412) on children three to 10 years of age (2 225 children) in the Ellisras District indicated that primary school boys had a lower risk of overweight (2.2%) when compared to primary school girls (3.1%). Recent studies found that the approximate obesity prevalence (1999 – 2000 compared to 2009 – 2010) indicated a remarkable increase in male obesity prevalence but not in female obesity (Clark *et al.*, 2009:193; Ogden *et al.*, 2012:487; Van den Berg & Meko, 2015:51). To better understand the prevalence of overweight and obesity among boys, race should also be taken into consideration.

The study of Jacobs *et al.* (2010:418) on 19 African and 34 Caucasian 11-year old South African children found that African children had a lower BMI value of 15.7 kg/m² when compared to Caucasian children's BMI value of 19.3 kg/m². Results of the same study on the 12-year old group indicated that African children (n=29) had a lower BMI value of 16.8 kg/m² when compared to that of the Caucasian children (n=52) of 18.3 kg/m². The same tendency was reported in 13-year old children where African children (n=31) once again presented a lower BMI value of 16.6 kg/m² compared to Caucasian children (n=54) of 19.3 kg/m². A study done by Armstrong *et al.* (2006:57) on 5 603 South African children aged six to 13 years (2 411 African, 931 Mixed race and 2 062 Caucasian) indicated that Caucasian boys at any given age present the highest BMI value when compared to African and Mixed race boys. These researchers (Armstrong *et al.*, 2006:56) also found that six-year-old, Mixed race boys had the lowest BMI value (15.0 kg/m²) when compared

to African (15.8 kg/m²) and Caucasian boys (16.6 kg/m²) and the same tendency was found in boys aged seven to 13 years. In this regard, McVeigh *et al.* (2004:1008) found no significant differences between BMI and body fat percentage between nine- to 10-year old African and Caucasian boys (44 Caucasian and 158 African) in South Africa. Currently, literature indicates that overweight and obesity are not the only global concerns. It seems that stunting and wasting are also concerns in children, especially children from developing countries.

Stunting can be defined when children's Z-scores of height-for-age ratio are below minus two (-2) standard deviations (SD) from the median, according to the WHO Child Growth Standards (WHO, 2014:40; UNICEF, 2016:35; WHO, 2016:3). According to Kruger *et al.* (2014:6) and Walsh *et al.* (2001:8), children living in low SES and rural areas are usually more stunted than children in the urban areas of South Africa. In this regard, Mamabolo *et al.* (2007:1049) found that boys (n=134) had a higher stunting value of 21.6%, when compared to girls' (n=179) value of 12.3%, in the North West Province, South Africa. The study by Kruger *et al.* (2014:3) on 816 Grade 1 learners (419 boys and 397 girls) in the North West Province in South Africa found that stunting among African children was much higher in comparison to Caucasian children (6% vs. 0%). Lastly, a longitudinal study done by Monyeki *et al.* (2008:412) on three- to 10-year old children from the Ellisras District (Limpopo Province) found that primary school boys (43.6%) are more likely to be at risk for developing severe stunting, when compared to primary school girls (37.5%). The same tendency was found among the moderate stunted primary school children. From the above-mentioned, it is clear that stunting is more likely to occur among rural areas and in boys. Stunting is not the only indicator of malnutrition, wasting is another indicator that needs to be taken into consideration (Hioui *et al.*, 2011:879).

Wasting can be defined as the inadequate mass for height (Victora, 1991:1105) and Z-score (less than -2 standard deviations) is determined by using BMI-for-age (De Onis *et al.*, 2007:943). A study done by De Assis *et al.* (2005:1020) found (1 432 girls, 1 504 boys) that the frequency of stunting was low in school children (seven to 10 years old) in Florianopolis, Brazil. Wang *et al.*'s (2002:973) study on children (six- to nine-years of age) and adolescents (10- to 18-years of age) from the United States of America (6 108 children), China (2 688 children), Russia (2 152 children) and Brazil (4 875 children) found that most of these countries' prevalence decreased except in Russia, where the prevalence of stunting or underweight increased, supporting the results of the last-mentioned study. Kruger *et al.*'s (2012:594) study results indicated that 5.8% of South African children (one to nine years old) were wasted in 2005, where borderline significant differences were found among racial groups in South Africa regarding wasting: Caucasian children (n=15) with a

percentage of 6.88% and African children (n=39) with a percentage of 6.88%, with the Caucasian group being more wasted (Kruger *et al.*, 2014:3). Walsh *et al.* (2001:5) and Kruger *et al.* (2014:6) found that the wasting prevalence in rural areas (from 0% to 13.7%) was much lower than in urban (mid-high SES) areas (21.7% for the girls and 21.3% for the boys). Kruger *et al.* (2014:6) further found that wasting occurred more among African Grade 1 learners (n=39) when compared to Caucasian Grade 1 learners (n=15). The prevalence of overweight, obesity, stunting and wasting is not only a global phenomenon but also has major effects on academic performance.

Datar *et al.* (2004:66) found a statistically significant association between childhood overweight and academic test scores (especially mathematic test scores were lower when compared to non-overweight children) in their longitudinal study on 11 192 kindergarten and first grade children from the United States of America. The longitudinal study of Datar and Sturm (2006:1449) on 5 874 children (kindergarten to third grade) found that not only is school life affected but also school attendance and academic performance among overweight children in the United States of America. According to Falkner *et al.* (2001:37) and Clark *et al.* (2009:195), American elementary school children labelled as overweight or obese presented lower academic scores when compared to healthy and underweight children and these researchers further indicated that overweight and obese children had lower grade averages in all the subjects (reading, Mathematics, Language, arts, science and social studies) than the non-obese and healthy children. Supporting the latter findings, Judge and Jahns (2007:676) and Zavodny (2013:141) found that overweight and obese children tended to have lower test scores and teacher assessments. Clark *et al.* (2009:196) further indicated that obese children had significant lower grade averages when compared to overweight children. Supporting these findings, Roberts *et al.* (2010:717) and Donnelly *et al.* (2013:2) indicated that childhood overweight and obesity have a negative impact on academic performance. One other study by Mond *et al.* (2007:1071) found that obese children aged four to eight years had lower cognitive abilities (visual perception, abstraction, memory and concentration) when compared to non-obese children. Lastly, Falkner *et al.* (2001:37) found contradictory results, indicating no observable pattern regarding poor academic performance and overweight or obesity. Zavodny's (2013:145) longitudinal study (children from kindergarten to Grade 8) found that overweight among boys indicated a greater risk regarding academic performance (Mathematics) than health-risk factors (Booth *et al.*, 2014:1337).

Various researchers reported a relationship between cognitive abilities, scholastic achievements, early school failure and stunting (Brown & Pollitt, 1996:38; Scrimshaw, 1998:368; Mendez & Adair, 1999:1555; Victoria *et al.*, 2008:340, 343; Walton & Allen, 2011:418; Rashmi *et al.*,

2015:99). A longitudinal study (The Cebu Longitudinal Health and Nutrition Study) done by Mendez and Adair (1999:1559) in the Philippines on children between the ages of two to 11 years, found that children stunted before the age of two years (1 345 Filipino children) were more likely to drop out of school than non-stunted children. The same tendency was also found by Walker *et al.* (2005:1806). Mendez and Adair (1999:1559) and Black *et al.* (1995:808) also found that children stunted before the age of two years tended to start school later than non-stunted children and had lower Mathematics and English test scores compared to their peers (Hollar *et al.*, 2010:649; Sudfeld *et al.*, 2015:2708; Pearce *et al.*, 2016:89). A study on South African children in the Ellisras District indicated that a positive relationship existed among stunting and Mathematics performance but no relationship was indicated among English performance and stunting (Themane *et al.*, 2003:641; Matabane *et al.*, 2012:917; Casale *et al.*, 2014:908).

Golam *et al.* (2014:80) also indicated an association among underweight and academic performance (Rashmi *et al.*, 2015:99). A study by Cook and Jeng (2009:2) on American children (zero to 18 years) found lower academic achievement and poor concentration not only in pre-school children, but also school-aged children suffering from wasting. The same tendency was showed in children from Sri Lanka, aged six to 12 years, where these children (16 383) indicated poor academic achievement when malnutrition was present (Wisniewski, 2010:325). Adding to the above-mentioned study, the study by Glewwe *et al.* (2001:364) on zero to 13-year old children found that primary school enrolments of malnourished children were delayed due to unpreparedness. The research of Alaimo *et al.* (2001:46) on 15 to 16-year old children in the United States of America, found that children suffering from wasting had negative cognitive and academic development. These children learned at a slower rate, had lower mathematic scores, were more likely to drop out of school and missed more school days when compared to their peers. The same tendency was observed by Hughess and Bryan (2003:419) on children six to 16 years old from different countries (Finland, Australia, Sweden and the United States of America). Confirming the last-mentioned study, Kleinman *et al.* (2002:6) found in an intervention study that children with better nutrient intake were less likely to miss school and showed increased grades (especially in Mathematics). An intervention study by Hollar *et al.* (2010:649) on elementary school children indicated that the intervention (food ingredients and whole food) group had higher Mathematics and reading scores when compared to the control (wasted) group. Supporting these researchers, Jyoti *et al.* (2005:2835) found that food insecurity impairs academic performance like reading and Mathematics. Lastly, a study on South African children, Grades 4 to 7 in the Ellisras District, indicated a strong association between wasting and academic performance (Matabane *et*

al., 2012:917). The same tendency was found by Themane *et al.* (2003:641), where the focus was on English and Mathematics performance.

From the above-mentioned studies, contradicting conclusions were found and research regarding the effect of body composition on academic performance on South African boys is still limited. From the above literature, the following research question can be formulated for this study: what effect will overweight, obesity, stunting and wasting have on academic performance over a period of seven years on primary school boys, taking SES into consideration? These findings will be beneficial for the Department of Basic Education, government, schools, teachers, Kinderkinetici and other health-care professionals with regard to meaningful statistics about overweight, obesity, stunting and wasting, intervention and physical activity or nutritional programmes regarding children in South Africa. These findings will furthermore provide a profile regarding boys' physical development, health and scholastic skills in the North West Province. Furthermore, these findings will help to determine whether these issues are related to SES and race when focusing on primary school boys.

1.2 Objectives

The objectives of this study are to determine:

- 1.2.1 the effect of overweight and obesity on academic performance over a period of seven years among primary school boys in the North West Province of South Africa, taking into account SES; and
- 1.2.2 the effect of stunting and wasting on academic performance over a period of seven years among primary school boys in the North West Province of South Africa, taking SES into account.

1.3 Hypothesis

This study was based on the following hypothesis:

- 1.3.1 Overweight and obesity will affect academic achievement negatively. Primary school boys will have lower academic achievements with regard to the results of 2013 and 2016 when compared to 2010. Furthermore, low SES will negatively affect academic performance among overweight and obese boys.
- 1.3.2 Stunting and wasting will affect academic achievements negatively. Primary school boys will have lower academic achievements with regard to the results of 2013 and 2016 when

compared to 2010. Stunting will have the greatest effect on academic performance like mathematics, reading and writing skills. Additionally, low SES will negatively affect academic achievement among stunted and wasted primary school boys.

1.4 Proposed chapters

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

- 1.4.1 Chapter 1 incorporates the introduction, problem statement and objectives of the study. As proposed by the North-West University, the new Harvard Style guidelines were used for the reference list which follows at the end of Chapter 1.
- 1.4.2 Chapter 2 consists of the literature overview on overweight, obesity, stunting and wasting's effect on the academic performance of primary school boys. The references are in accordance with the North-West University requirements using the new Harvard guidelines and follow at the end of Chapter 2. This chapter provides an overview discussion on the overweight, obesity, stunting and wasting prevalence/occurrence among international and South African children. Furthermore, it provides an overview regarding race, SES, health and psychological risks among overweight, obese, stunted and wasted children. Lastly, an overview is given with regard to academic performance and these four conditions.
- 1.4.3 Chapter 3 is presented in article format, with the title: *Longitudinal effects of overweight and obesity on academic performance of primary school boys: the NW-CHILD study*. This article will be submitted for possible publication to the *South African journal of childhood education* and has been written in accordance with the guidelines set by this journal. The author guidelines of this journal are presented in Appendix D. Amendments have been made to the journal's guidelines for uniformity of this dissertation. Amendments have been made regarding the alignment of the article, line spacing and the inclusion of tables in the article, rather than at the end of the reference list. Therefore, no numbering of the headings will be present in this chapter. These amendments should help with the readability and are consistent with the rest of this dissertation.
- 1.4.4 Chapter 4 has also been written in article format with the title: *Longitudinal effects of stunting and wasting on academic performance of primary school boys: the NW-CHILD study*. This article has been submitted for possible publication to the *South African journal*

of childhood education and has been written according to this journal's guidelines. These author guidelines are presented in Appendix D. Amendments have been made to this journal's guidelines for uniformity and readability of the dissertation. Amendments have been made regarding the alignment of the article, line spacing and the inclusion of tables in the article, rather than at the end of the reference list. Therefore, no numbering of the headings will be present in this chapter.

1.4.5 Chapter 5 consists of a summary, conclusion, limitations and recommendations of the study.

1.4.6 The ethical certificate of the NW-CHILD study is presented in Appendix A. The communication letter to each school principal is provided in Appendix B. The parents' and learner's informed consent forms are placed in Appendix C.

Subsequently, Chapter 2 provides an overview discussion of overweight, obesity, stunting and wasting's effect on the academic performance of primary school boys.

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CHAPTER 2

LITERATURE REVIEW: OVERWEIGHT, OBESITY, STUNTING AND WASTING'S EFFECT ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS

2.1 Introduction

An alarming increase in paediatric body composition research emerged, focusing on the nutritional and growth status, as almost all diseases and conditions are affected by body fat and body composition (Wells, 2001:67). According to research, body composition can be divided into four conditions: overweight, obesity, stunting and wasting (Torpy *et al.*, 2004:648; Daniels *et al.*, 2005:2000). All four these conditions can affect children's health, academic performance (Cawley & Spiess, 2008:388) and motor development (Mendez & Adair, 1999:1555; Cawley & Spiess, 2008:394). Overweight and obesity affect all children of all ages and can be referred to as a global phenomenon (UNICEF, 2016:36).

The prevalence of childhood obesity has, since the mid-70s, increased dramatically in most countries worldwide (Lobstein *et al.*, 2004:76). An estimate of 42 million (6.7%) children below the age of five years are overweight or obese, with more than 31 million children representing developing countries, according to the World Health Organisation (WHO, 2014:40). Additionally, UNICEF (2016:36) reported that, in 2015, 41 million children (below the age of five years) worldwide were overweight. Several researchers reported that overweight and obesity play major roles with regard to academic performance, thus these children will have lower test scores when compared to non-overweight or non-obese children (Falkner *et al.*, 2001:37; Datar *et al.*, 2004:66; Datar & Sturm, 2006:1449; Mond *et al.*, 2007:1071; Clark *et al.*, 2009:195; Zavodny, 2013:141). Overweight and obesity are not the only global concerns. Stunting and wasting are also concerns in children, especially from developing countries.

The prevalence of stunting has also increased over the last decade from 45 million to 60 million children worldwide (De Onis *et al.*, 2011:145). Researchers estimated that, in 2010, 171 million (27%) preschool children were stunted and 167 million of these children were from developing countries. Literature has reported that stunting is increasing among all age groups (Wang *et al.*, 2002:973; Bloss *et al.*, 2004:263; De Assis *et al.*, 2005:1020; Dutta *et al.*, 2009:79; Padmapriyadarsini *et al.*, 2009:3; Mushtaq *et al.*, 2011:795; Ene-Obong *et al.*, 2012:245). Recent studies established that children below the age of five years, had a variation in prevalence of wasting among the different demographic areas: Egypt with 7.2%, Australia with 6% and Argentina with 11.3% (Nuñez *et al.*, 2016:723; Pearce *et al.*, 2016:89; Sharaf & Rashad, 2016:11). The same tendencies were found with regard to wasting, where various researchers indicated that wasting prevalence ranges from 13% to 34% (Ene-Obong *et al.*, 2012:245; Kuringen & Nieuwerkerken, 2015:15; Rashmi *et al.*, 2015:99). Researchers further indicated that wasting was significantly more prevalent among children (19.0%) than adolescents (8.3%) and was the highest among the seven-year-old group (28.6%) (Ene-Obong *et al.*, 2012:245). Adding to this, wasting prevalence has been found to vary between moderate (ranging between 2.3% to 70%) and severe (ranging between 1% to 10%) (Kuringen & Nieuwerkerken, 2015:15; Rashmi *et al.*, 2015:99). Furthermore, Rashmi *et al.* (2015:99) reported that more boys were wasted compared to girls. Prevalence of wasting and stunting as well as overweight and obesity is a global phenomenon, however, the effect of these four conditions on academic performance is a major concern.

Various studies from all over the world have found a significant association between overweight, obesity and academic performance, where Language (Clark *et al.*, 2009:196), reading, science and Mathematics (Judge & Jahns, 2007:676; Roberts *et al.*, 2010:717; Zavodny, 2013:141) are mostly affected. Further to this, Mond *et al.* (2007:1071) reported lower cognitive abilities (memory, visual perception, concentration and abstraction) among obese children when compared to normal weight children. The same tendency was found in longitudinal studies, where overweight and obesity affected school attendance and academic performance (Datar *et al.*, 2004:66; Datar & Sturm, 2006:1449; Donnelly *et al.*, 2013:308; Zavodny, 2013:145). Overweight and obesity are not the only two conditions that affect children's academic performance. Numerous studies worldwide have reported that wasted children are academically delayed due to un-readiness and negative cognitive development (Glewwe *et al.*, 2001:364). Furthermore, these children have a decreased learning rate, lower mathematic scores, higher dropout prevalence and a lower school attendance rate when compared to their peers (Alaimo *et al.*, 2001:46; Hughes & Bryan, 2003:419; Cook & Jeng, 2009:2; Wisniewski, 2010:325). Furthermore, stunting was also associated with poor academic performance (Berkman *et al.*, 2002:567; Golam *et al.*, 2014:80; Patil *et al.*, 2016:3;

Rashmi *et al.*, 2015:99;), especially with regard to Mathematics (Kleinman *et al.*, 2002:6; Jyoti *et al.*, 2005:2835; Hollar *et al.*, 2010:649; Miller *et al.*, 2015:1344), reading and spelling (Chang *et al.*, 2010:834; Pearce *et al.*, 2016:89), lower communication and cognitive abilities (Prendergast & Humphrey, 2014:257; Sudfeld *et al.*, 2015:2708). The same tendency was reported in South African longitudinal studies, where academic performances (such as English and Mathematics) were positively associated with stunting and wasting (Themane *et al.*, 2003:641; Matabane *et al.*, 2012:917). Casale *et al.* (2014:908) also reported that stunting affects cognitive abilities as well as school achievements.

The following paragraph elucidates the aim of this study. A clear introduction has been provided regarding these four conditions (overweight, obesity, stunting and wasting) and their possible impact on academic performance. Thus, the purpose of this study was firstly, to determine the effect of overweight and obesity on the academic performance of primary school boys over a period of seven years, taking into consideration their race and SES and secondly, to determine the effect of stunting and wasting on the academic performance of primary school boys over a period of seven years, also taking into consideration their SES, in the North West Province of South Africa. With these objectives in mind, it was important to reflect on the findings of relevant literature starting with a literature overview regarding the South African population in order to understand the prevalence of overweight, obesity, wasting and stunting among South African boys. Following the above-mentioned, the classification and prevalence of overweight and obesity among boys according to international statistics and South African statistics, the effect of overweight and obesity on the child's development, as well as the health risks of overweight and obesity are discussed. Additionally, the classification of stunting and wasting among boys, the prevalence of stunting and wasting, the effect of stunting and wasting on childhood development as well as the health risks of stunting and wasting are discussed. This literature overview concludes with a discussion of the possible relationship between overweight, obesity, stunting and wasting on the academic performance of primary school boys. With this as background, the relevant terms used in this chapter are defined next, to ensure clear distinction between the terms.

2.2 Defining relevant terms

When studying the well-being of children, there are different aspects that must be understood, especially the difference between the terms used in this chapter. Subsequently, all relevant terms related to this dissertation are discussed next.

Body composition can be defined as the quantitative value of fat, bone and muscle in the body (Lohman *et al.*, 2013:575) and can be evaluated by a variety of methods such as dual energy x-ray absorptiometry (DXA), densitometry, multicomponent models or field methods such as body mass index values (BMI) (Lohman *et al.*, 2013:575).

Body Mass Index (BMI) can be seen as an index of weight-for-height that is commonly used to classify underweight, overweight and obesity (WHO, 1998:9) and is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2).

Overweight is defined when the BMI value is greater than 25.0 kg/m^2 for adults (18 years and older) (WHO, 1998:8). Cole *et al.* (2000:1244) have indicated that children have different BMI values for overweight when compared to adults and that children's BMI values differ regarding gender and age. These researchers (Cole *et al.*, 2000:1244) have further indicated that seven-year-old boys with a BMI value of 17.92 kg/m^2 are classified as overweight, while the same classification method for the nine-, 10- and 13-year-old boys with BMI values of 19.10 kg/m^2 , 19.84 kg/m^2 and 21.91 kg/m^2 respectively is being used.

Obesity can be defined as excessive or abnormal accumulation of fat (WHO, 2015:2). The WHO (1998:9) defines obesity when the BMI values for adults (18 years and older) are greater than 30.0 kg/m^2 . However, according to Cole *et al.* (2000:1244), the BMI values for children differ regarding age and gender, thus the BMI values regarding obesity for boys aged seven-, nine-, 10- and 13 years are 20.63 kg/m^2 , 22.77 kg/m^2 , 24.00 kg/m^2 and 26.84 kg/m^2 respectively.

Stunting, refers to impaired growth or development and can be defined when a child's Z-score for height-for-age ratio is below minus two (-2) standard deviation (SD) from the median, according to the WHO Child Growth Standards (WHO, 2014:40).

Wasting, also known as thinness, refers to the inadequate weight-for-height (Victora, 1991:1105; WHO, 2016:4). Z-scores (less than -2 standard deviations) can be used to determine wasting by using BMI-for-age as well as percentiles below five from the median, set by the International reference population (De Onis *et al.*, 2006:943), however this is only valid for children under the age of 10 years. References used for children 10 to 19 years old are weight-for-age ratio (WHO, 2007).

Depression, as defined by the WHO (2017:7), refers to a common mental disorder. Depression can be long lasting or recurrent, affecting a person's ability to function at school or work or cope with daily life. This disorder can be characterised by sadness, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, feelings of tiredness and poor concentration. Depressive disorders (WHO, 2017:7) include two main sub-categories: major depressive disorder / depressive episode (number of symptoms determines severity of disorder) and dysthymia (a persistent or chronic form of mild depression).

Psycho-emotional development describes the psychological interaction with the emotions (Mosby's Medical Dictionary, 2002:1).

Psychosocial development can be defined as the interrelation of social factors and the individual thought and behaviour (Mosby's Medical Dictionary, 2002:1).

Cardiovascular disease (CVD) refers to disorders of the blood vessels and the heart, including coronary heart disease, cerebrovascular disease and rheumatic heart disease (WHO, 2011:2).

Hypertension (also known as high blood pressure) is defined as having a systolic blood pressure ≥ 140 mm Hg and/or a diastolic blood pressure ≥ 90 mm Hg, compared to the normal blood pressure of 120 mm Hg, systolic blood pressure and 80 mm Hg, diastolic blood pressure for adults (WHO, 2013:17). However, children and adolescents have different diagnostic values compared to adults. Table 2.1 indicates the classification criteria for hypertension in children and adolescents.

Table 2.1: Classification criteria for hypertension in children and adolescents (Falkner *et al.*, 2005:14)

Classification	Systolic or diastolic blood pressure
Normal	< 90th percentile
Prehypertension	90th- to <95th percentile Or exceeds 120/80mm Hg
Hypertension Stage 1	95th- to 99th percentile
Hypertension Stage 2	>99th percentile

Asthma can be defined as (EAACI, 2013:2) an inflammatory disorder of the lungs, which leads to widespread airflow limitation, thus resulting in different symptoms like dyspnoea, discomfort, anxiety, wheezing, panic, chest tightness, coughing and occasionally fatal respiratory arrest (Pescatello *et al.*, 2014:122).

Diabetes Mellitus is defined as a chronic metabolic and autoimmune disorder (WHO, 1999:2), that occurs either when the pancreas does not produce enough insulin (the hormone that regulates blood sugar) or when the body cannot effectively use the insulin it produces (fasting plasma glucose, $\geq 7.0\text{mmol/l}$ or $\geq 11.1\text{mmol/l}$) (WHO, 2006:3). Accordingly, two type of diabetes have been reported, namely Type 1 and Type 2 diabetes. Type 1 diabetes (previously known as insulin-dependent or childhood-onset diabetes) refers to deficient insulin production and requires daily administration of insulin to regulate the glucose levels in their blood. The second type of diabetes is the most common type in the world due to poor lifestyle habits. Type 2 diabetes (previously known as non-insulin-dependent or adult-onset diabetes) refers to the inefficient use of insulin in the body (WHO, 2016:11).

With a clear understanding of the above-mentioned terms, a broad perspective regarding South Africa's population and background is provided next.

2.3 South African population

South Africa is a diverse country and an overview regarding population size, population demographics and SES is given. After the broad overview of the South African population, statistics are narrowed down to more specific provincial statistics which all played an important role in this study.

2.3.1 Population size

According to the mid-year predictions for 2017 by Statistics South Africa (2017), the South African population stands at 56.52 million people. This figure has increased from the 2011 census survey, when the population numbers were 44.8 million (Statistics SA, 2011). Only 29.6% of the population is zero to 15 years of age (Statistics SA, 2017:3).

2.3.2 Population demographics

The South African population is composed of various racial groups. Table 2.2 reflects the main racial groups of South Africa, regarding the 2017 mid-year predictions of the percentage of the various groups in the total population (male, female and children included) and according to gender. In Table 2.2, it can be seen that the female population groups' estimates for the Mixed race group (8.9%) and the Caucasian group (8.0%) were higher when compared to the males' estimates of 8.7% representing the Mixed race group and 7.9% representing the Caucasian group respectively. The opposite tendency was found among the Indian/Asian population group, where the females indicated

to have a lower population percentage of 2.4% when compared to the male population percentage of 2.6%. Furthermore, Table 2.2 indicates that the race with the highest estimates is the African population, thus classifying them as the fastest growing population. (Statistics SA, 2017:2).

Table 2.2: South Africa mid-year population predictions by population groups and gender for 2016 (Statistics SA, 2017:2).

Population	Male		Female		Total	
	Number	% of total population	Number	% of total population	Number	% of total population
African	22 311 400	80.8	23 345 000	80.8	45 656 400	80.8
Caucasian	2 186 500	7.9	2 307 100	8.0	4 493 500	8.0
Mixed race	2 403 400	8.7	2 559 500	8.9	4 962 900	8.8
Indian/Asian	719 300	2.6	689 800	2.4	1 409 100	2.5
Total	27 620 600	100.0	28 901 400	100.0	56 521 900	100.0

%= Percentage

Table 2.3 reflects the mid-year predictions for South Africa in 2017, indicating the main age groups (focusing on zero- to 14 years) that formed part of this dissertation by population group and gender. Focusing on age, the zero- to four-year-old age group (males and females) indicates the highest estimates for 2017 when compared to the other age groups (five- to 14 years). The African group indicates to be the highest population group for 2017 (Statistics SA, 2017:10) of all age groups (including males and females).

Table 2.3: South Africa mid-year predictions by population group, gender and age for 2017 (Statistics SA, 2017:10).

Population	Gender	0-4 years	5-9 years	10-14 years
African	Male	2 532 777	2 475 454	2 161 893
	Female	2 517 270	2 472 427	2 170 234
	Total	5 040 047	4 947 881	4 332 127
Caucasian	Male	120 067	130 514	126 751
	Female	115 269	125 605	122 386
	Total	455 336	256 119	249 137
Mixed race	Male	244 218	234 935	214 174
	Female	240 284	231 744	211 581
	Total	484 502	466 679	425 755
Indian/Asian	Male	49 250	48 022	44 441
	Female	47 438	45 875	42 220
	Total	96 688	93 897	89 661

Table 2.4 reflects the mid-year predictions by provincial estimates for 2017. For this study, the focus was on the North West Province. Table 2.4 indicates that the North West Province is one of the smallest growing populations and that this province is seventh overall when compared to the

other eight provinces, with only a 6.8% growing rate when compared to the other provinces with higher percentages (Statistics, 2017:2).

Table 2.4: South Africa mid-year predictions by province, 2017 (Statistics, 2017:2).

Province	Population estimate	Percentage (%) of total population
Gauteng	14 278 700	25.3
KwaZulu-Natal	11 074 800	19.6
Eastern Cape	6 498 700	11.5
Western Cape	6 510 300	11.5
Limpopo	5 778 400	10.2
Mpumalanga	4 444 200	7.9
North West	3 856 200	6.8
Free State	2 866 700	5.1
Northern Cape	1 214 000	2.1
Total	56 521 900	100.0

Table 2.5 indicates the provincial estimates, focusing more on the estimates for the North West Province of South Africa, by age (zero- to 14 years) and gender for 2016. In Table 2.5, it can be seen that the North West Province once again has one of the lowest estimates for 2017 regarding age when compared to the other provinces in South Africa (Statistics SA, 2017:18).

Table 2.5: South Africa's' mid-year predictions for 2017, by province and age (Statistics SA, 2017:18).

Province	Gender	0-4 years	5-9 years	10-14 years
Kwazulu-Natal	Male	619 472	598 735	556 619
	Female	611 579	595 552	554 779
	Total	1 231 051	1 194 287	1 111 398
Gauteng	Male	654 763	595 656	510 813
	Female	649 380	594 164	511 706
	Total	1 304 143	1 189 820	1 022 519
Eastern Cape	Male	361 319	385 456	351 989
	Female	357 865	379 819	348 090
	Total	719 184	765 275	700 079
Limpopo	Male	360 481	356 122	307 312
	Female	356 429	351 964	302 886
	Total	716 910	707 086	610 198
Western Cape	Male	285 875	300 105	252 365
	Female	280 963	296 357	251 307
	Total	566 838	596 462	403 666
Mpumalanga	Male	254 387	237 670	208 197
	Female	254 201	238 967	210 471
	Total	508 588	476 637	418 668
North West	Male	201 064	206 049	173 296
	Female	201 691	208 246	176 722
	Total	402 755	414 295	350 018
Free state	Male	146 170	147 829	132 481
	Female	145 480	149 303	135 169
	Total	291 650	297 132	267 650
Northern Cape	Male	62 828	61 340	54 216
	Female	62 684	61 279	55 321
	Total	125 512	122 619	109 537

With the South African population discussed as a broad perspective, a more specific view regarding SES follows to highlight its effect on the people living in South Africa.

2.3.3 Socio-economic conditions

Many different aspects (systems) affect a child's growth and development. Bronfenbrenner (1989:723) developed the ecological systems theory, where he explains how the environment and the child play an interlinking role in his/her growth and development. This theory can be divided into five major components, namely micro-, meso-, exo-, macro- and chrono-system. These five components can interdependently affect a child's development, referring to the micro-system as the child's immediate surroundings, relationships and interactions, the meso-system, where all the micro-system aspects work together for the sake of the child. The exo-system refers to aspects not directly affecting a child (not interacting very often, such as the parent's workplace), however these aspects still have an effect on their development and the macro-system refers to the aspects the child has no control over (such as the government, religious beliefs, etc.). Lastly, the chrono-system refers to the child's chronological age, thus the patterns of change over the years

(Bronfenbrenner, 1989:736). The above is a summary of the ecological model set by Bronfenbrenner (1989:736), however, this is an overview of how interaction (of all the systems), individually or together can play an important role in a child's development and growth.

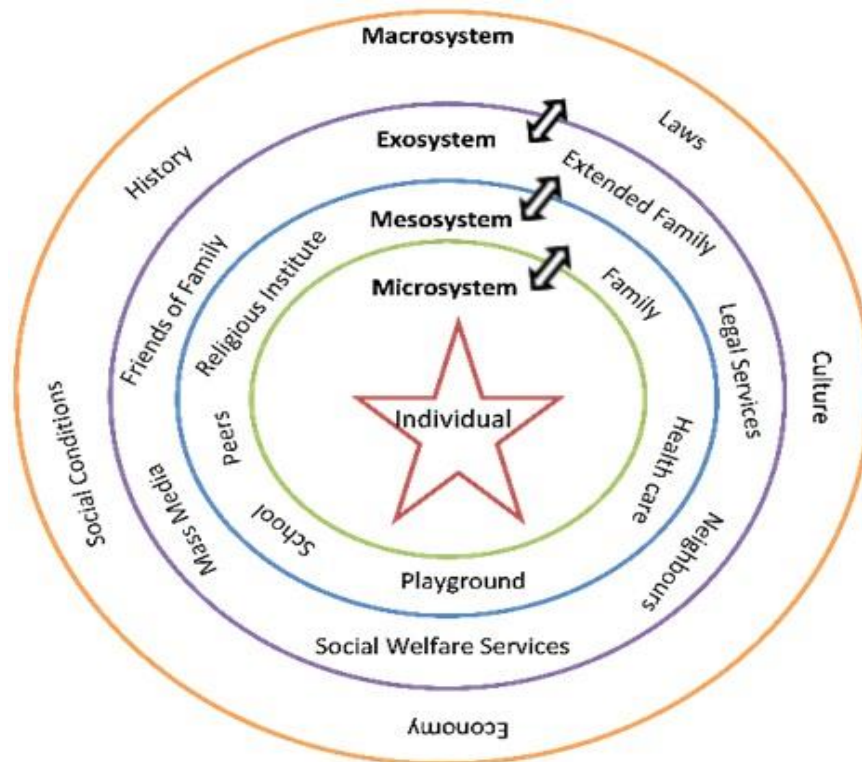


Figure 2.1: Bronfenbrenner ecological model (Bronfenbrenner, 1986:736).

South Africa is also known as a developing and upper-middle income country with various SES inequities (WHO, 2015:161). In the 2011 Census, it was reported that 45.5% of the South African population was living in poverty (Statistics South Africa, 2014:15), thus indicating nearly 23 million people living below the upper-bound poverty line in South Africa. Furthermore, Statistics South Africa (2017:57) indicates that 37.3% of females and 33.8% of males are living in poverty, as concluded in Census 2011. Table 2.6 indicates the poverty percentages of the different population groups of South Africa, reporting that the African population group has the highest percentage of 20.1% and the Caucasian population the least of 0.2%.

Table 2.6: Poverty percentage of population groups in South Africa (Statistics South Africa, 2017:58).

Population group	Poverty percentage (%)
African	20.1
Caucasian	0.2
Mixed Race	9.0
Indian/Asian	0.5

The provincial poverty percentages are indicated below to get a clear understanding of the distribution in South Africa. Table 2.7 indicates the poverty distribution among the provinces of South Africa, reporting the Eastern Cape Province with the highest poverty percentage of 72.9% and Gauteng Province with the lowest poverty percentage of 33.3%. The North West Province presents the fourth highest percentage, namely 64.3%, compared to all nine provinces (Statistics SA, 2017:64).

Table 2.7: Poverty percentage per province in South Africa (Statistics South African, 2017:64).

Province	Poverty percentage (%)
Eastern Cape	72.9
Limpopo	72.4
Kwazulu-Natal	68.1
North West	64.3
Mpumalanga	59.3
Northern Cape	59.0
Free State	54.9
Western Cape	37.1
Gauteng	33.3

Lastly, Statistics South Africa (2017:68) indicated percentages of poverty among the different settlements in South Africa: 81.6% of rural residents were still living in poverty as compared to the 40.6% residents living in urban areas. According to Statistics South Africa (2017:69), females had a higher poverty gap (23.7%) when compared to males (26.5%) in 2015. A significant difference was found among population groups in South Africa (Statistics South Africa, 2017:69) regarding poverty, indicating that 64.2% of African, 41.3% of Mixed race, 5.9% Indian/Asian and 1.0% of Caucasian population was living under the upper-bound poverty line. Furthermore, Statistics South Africa (2017:68) indicates that poverty differs from province to province and for the sake of this study, poverty in the North West Province is highlighted, where 64.3% of the population is currently living below the upper-bound poverty line. In the past, poverty was associated with the type of settlement (urban or rural), focusing more on the rural area. With South Africa's poverty statistics as background, a discussion follows next with regard to how overweight and obesity prevalence might be influenced by poverty (referred to as socio-economic status) and the classification of overweight and obesity.

2.4 Overweight and obesity

The WHO (2006:663) stipulated that overweight and obesity are increasing at an alarming rate. Therefore, overweight and obesity are discussed in detail. Firstly, how overweight and obesity are classified and secondly, what the prevalence of overweight and obesity is internationally and

nationally (South Africa), are investigated. Thereafter, the effect of overweight and obesity on childhood development is discussed.

2.4.1 Classifications

In 2006, the WHO (2006:663) formed new standards for zero to five-year-old children which are now referred to as growth references and five- to 19-year old children, using BMI values for boys and girls (De Onis *et al.*, 2007:663). The overweight BMI value for the five- to 19-year old boys is 25.4 kg/m². Furthermore, the obesity BMI value for the same age group is 29.7 kg/m² (De Onis *et al.*, 2007:663). Cole *et al.* (2000:1243) indicated that boys have a higher risk for overweight if their BMI values are on the 85th percentile and obesity if their BMI values are on the 95th percentile or higher than the 95th percentile, according to age and gender respectively. BMI cut-off points are used to identify overweight and obesity in boys. These cut-off points are indicated in Table 2.8: for boys between the ages six to 13 years only because this gender was the focus of this study.

Table 2.8: Age specific BMI cut-off points for overweight and obesity among boys (Cole *et al.*, 2000:1243).

Age (yrs.)	Body mass index: Overweight (25 kg/m ²)	Body mass index: Obesity (30 kg/m ²)
	Boys	Boys
6	17.55	19.78
6.5	17.71	20.23
7	17.92	20.63
7.5	18.16	21.09
8	18.44	21.60
8.5	18.76	22.17
9	19.10	22.77
9.5	19.46	23.39
10	19.84	24.00
10.5	20.20	24.57
11	20.55	25.10
11.5	20.89	25.58
12	21.22	26.02
12.5	21.56	26.43
13	21.91	26.84
13.5	22.27	27.25

2.4.2 Prevalence of overweight and obesity among children

Obesity is a global phenomenon, not only among adults but also among children (WHO, 2014:40). The WHO (2014:40) indicates that the latest figure for global prevalence of overweight and obesity among children has grown from around 5% in 1990 to 7% in 2012. Focusing more on the African Region alone, the number of overweight children increased from four to 10 million over the same period (1990 to 2012) (WHO, 2014:40). The United Nations International Children's Emergency

Fund (UNICEF) and the WHO (2016:3) reported that 42 million children worldwide were overweight in 2015 and more specific 48% of these children were from Asia and 25% from the African region.

2.4.2.1 International statistics

A trend analysis (from 1974 to 2006) by Wang and Lobstein (2006:15) on six- to 18-year old children (25 countries for school-aged and 42 countries for pre-school children) reported that, from 1970 to the end of the 1990s, the prevalence of overweight and/or obesity has doubled or tripled in large countries. These countries included North America (United States of America (USA) and Canada), South America (Brazil and Chile), Western Pacific region (Japan and Australia) and Europe (Finland, Germany, Spain and Greece). Wang and Lobstein (2006:18) also added that the prevalence of overweight and obesity varies worldwide, reporting that North America, Europe and parts of the Western Pacific had the highest prevalence of overweight among children (approximately 20% or 30%). Studies have further found that the approximate obesity prevalence indicates a remarkable increase in male obesity but not in female obesity (Clark *et al.*, 2009:193).

Supporting these researchers, a study done by Zhang and Wang (2013:254) in Shandong, China on 7 582 children, seven to 18 years of age (3 785 boys and 3 797 girls) found that the overall rate of overweight percentages in boys increased from 6.5% in 1995 to 19.1% in 2010. Furthermore, these researchers also found that the obesity rate increased for boys from 1.6% in 1995 to 9.3% in 2010. Adding to the last-mentioned study, Pengpid and Peltzer (2013:453) reported in their study on 2 758 children in Thailand, that the prevalence of overweight and obesity increased among boys between the ages of 12 to 15 years. These researchers found that the overall prevalence of overweight and obesity was about 10.0% and 4.4% respectively for boys. Badawi *et al.* (2013:33) study in Port Said City, Egypt, on 852 six- to 12-year-old children, indicated that 17.7% of these children were overweight and 13.5% were obese. These researchers added that the prevalence of overweight increased with age, while the obesity prevalence decreased with age. Supporting this research, Ahrens *et al.* (2014:102) reported in their study on 16 228 children aged two to nine years in Europe (including Spain, Cyprus, Sweden, Belgium, Germany, Hungary, Italy and Estonia), that the boys' overall prevalence of overweight was 11.8% and obesity was 6.8%. Ahrens *et al.* (2014:103) further indicated that the highest overall prevalence of overweight and obesity was observed in Italy (42.4%), Cyprus (23.4%) and Spain (21.2%), whereas the lowest prevalence was observed in Belgium (9.4%) and Sweden (11.0%).

A study by Ogden *et al.* (2014:808) on 9 120 children and adolescents (aged two to 19 years of age) in the USA indicated that, in 2011 to 2012, a higher percentage of the boys (six to 11 years old) was either overweight (33.2%) or obese (16.4%). Furthermore, these researchers found that more than 8% of the two- to five-year-old group were obese compared to the 17.7% of the six- to 11-year-old group and 20.5% of the 12- to 19-year-old group that were reported to be obese. Zang *et al.* (2015:381) point out in their study on 42 348 children from seven to 18 years of age from 16 districts in China that the boys (16.33% vs. 6.41%) had higher percentages regarding overweight and obesity when compared to the girls (10.69% vs. 2.12%). Contradicting results by Pangani *et al.* (2016:3) on 1 781 children aged eight to 13 years in Tanzania indicated that the prevalence of overweight and obesity was higher among the girls (18.7% vs. 8.0%) when compared to the boys (12.1% vs. 4.9%). These researchers also indicated that the overall prevalence for overweight and obesity was 15.9% and 6.7% respectively. Chebet *et al.* (2014:1370) also found in their study on 958 children (435 boys and 523 girls), eight to 12 years of age in Kampala, Uganda that the girls had a higher prevalence of overweight (64.4%) and obesity (52.9%) when compared to the boys (35.6% and 47.1%, respectively). Confirming these high prevalence, Cunningham *et al.* (2014:405) reported in their longitudinal study on 7 736 children aged five to 14 years, in the USA, that 14.9% of kindergarten children were overweight and 12.4% were obese, while 17% of the children in Grade 8 were overweight and 20.8% were obese. The overall incidence of obesity decreased from 5.4% during kindergarten to 1.9% among boys between Grade 5 and 8. Among these children (five- and 14 years old) who became obese (13.7% boys), nearly half of them were previously overweight.

Additionally, another longitudinal study done by Ells *et al.* (2016:8) on children in England aged four to five years and 10 to 11 years reported that the prevalence of obesity among the four- to five-year-old group (9.7% boys) was lower when compared to the 10- to 11-year-old group (20.4% boys). The same group (four- to five-year-old group) during the 2006/2007 period reported lower obesity prevalence when compared to 2012/2013. The prevalence of severe obesity was higher among boys (2.3%) compared to the girls (1.9%) for the four- to five-year-old group and the same tendency was seen among the 10- to 11-year-old group with boys 3.9% and girls 2.9% respectively. Supporting the last-mentioned researchers, Salehiniya *et al.* (2016:2) found that children under the age of five in Tehran, Iran, also had a high prevalence of overweight and obesity (12% vs. 23.7%). These researchers added that the boys (n=2 364) reported lower prevalence of overweight (13.6% vs. 10.6%) when compared to the girls (n=2 292). Furthermore, the same tendency was reported where boys had a significant higher prevalence of obesity when compared to girls, 26.4% vs. 20.9% respectively.

With the above-mentioned statistics in mind, a more specific discussion on South African data of overweight and obesity prevalence follows next.

2.4.2.2 South African statistics

Changes in dietary (higher fat intake) and lower physical activity participation are contributing factors to higher incidences of obesity in South Africa (Kruger *et al.*, 2005:491). Rossouw *et al.* (2012:1) indicated that, in South Africa, overweight and obesity among children are increasing, however, the prevalence varies according to gender, age and population group. These researchers also indicate that overweight and obesity not only have an influence during childhood and adolescence, but can persist into adulthood.

A study by Armstrong *et al.* (2006:62) on 10 195 South African children from five provinces aged six to 13 years (5 611 boys and 4 584 girls) found that the prevalence of obesity for boys was 3.2%, whereas the prevalence of overweight was 14.0%. One in five children were found to be overweight or obese in a study conducted by Truter *et al.* (2010:227) on 280 children aged nine to 12 years in Potchefstroom, South Africa. These researchers further indicated that the incidence of overweight and obesity was nearly double among girls (4%) when compared to boys (2.5%). A study by Kemp *et al.* (2011:119) reported an 11.6% overall (7.8% overweight and 3.8% obese) incidence of overweight and obesity on 816 seven-year-old children in the North West Province. Furthermore, the incidence of overweight and obesity was once again higher among girls (overweight 9.3% and obese 4.3%) when compared to boys (overweight 6.4% and obese 3.3%). One of the few longitudinal studies done in South Africa by Monyeki *et al.* (2008:412) on children three to 10 years of age (2 225 children), in the Ellisras District, Limpopo Province, found that primary school boys had a lower risk of overweight (2.2%) when compared to primary school girls (3.1%). Another longitudinal study on obesity over time (2010-2013) found that six- to nine-year old primary school boys from the North West Province had a higher obesity prevalence when compared to primary school girls (3.2% vs. 2.4%), although the girls reported the highest increase in overall prevalence of 18.5% (Pienaar, 2015:6). Added by this researcher, overweight among boys increased from 6.7% in 2010 to 7.8% in 2013. The same tendency was also observed with obesity among boys of 3.9% in 2010 and 7.1% in 2013 (Pienaar, 2015:5). Symington *et al.* (2016:68) stated in their study on 519 children aged three to nine years in Gauteng and Mpumalanga, South Africa, that 8.3% of the children in their study were overweight and 3.7% were obese (with 4.6% of the boys' overweight and 0.8% obese). The same tendency was found regarding obesity in Gauteng with 4.8% and Mpumalanga with 0.7%. Additionally, a study on

Grade 1 learners in the North West Province indicated an overweight prevalence of 7.5% and 3.6% obesity prevalence (Pienaar & Kruger, 2014:110). Although the seven-year-old group showed significant higher prevalence of overweight (10.5%) than the six-year-old group (6.3%), obesity levels were more prevalent among the six-year-old group (4.7%) than the seven-year-old group (2.3%). Furthermore, these researchers indicated that girls had a higher prevalence of overweight (9.3% vs. 6.4%) and obesity (4.3% vs. 3.3%) when compared to boys. Van den Berg and Meko (2015:51) reported in their study in Mangaung, South Africa on 99 six-year-old children that 24.2% of the children were overweight and obese, with 10.9% of the boys reported as being overweight and obese.

It is clear from the above literature that overweight and obesity are not just worldwide occurrences, but also a problem in South Africa. As seen from the literature, it seems that limited data is available regarding longitudinal studies on childhood overweight and obesity. However, international statistics as well as South African statistics both indicate an increase in the prevalence of overweight and obesity among schoolboys. A discussion regarding the important effect of overweight, obesity and race follows next.

2.4.2.3 Race

Various studies have reported that children from different racial groups have different overweight and obesity prevalence. Some of these studies, however, did not differentiate between boys and girls. Instead, the genders were combined to form a general overview. Zere and McIntyre (2003:9) reported that Caucasian children (14.2%) had higher BMI values, compared to African children (7.1%), Indian children (6.4%) and children of Mixed race (2.9%). Whitaker and Orzol (2006:581), in contrast, reported that African children (16.2%) had higher obesity prevalence when compared to Caucasian children (14.8%) in 20 cities in the USA. Confirming the last-mentioned study, Kimbro *et al.* (2007:303) reported in their study, which was also conducted in the USA, that African boys had higher obesity percentage (17%) when compared to Caucasian boys (14%), where the opposite was reported for overweight, namely that Caucasian boys had a higher prevalence (18%) when compared to African boys (15%). Another study done in the USA reported the same tendency regarding African children (22.7%) being more obese when compared to Caucasian children (17.94%) (Kuku *et al.*, 2012:2671). The same tendency was found by Fradkin *et al.*'s (2015:5) longitudinal study in Birmingham, Alabama, Los Angeles County, California and Houston, Texas, that African boys (27.2%) had higher obesity prevalence when compared to Caucasian boys (14.2%). Zilanawala *et al.* (2015:526) examined the data from the Early Childhood Longitudinal Study (ECLS-B) and reported that African children (13.5%) had higher obesity

prevalence than Caucasian children (11.3%) in the USA and the United Kingdom (11.1% vs 5.5% respectively). Furthermore, Asieba (2016:6) reported coherent results in which the African boys had higher overweight prevalence when compared to Caucasian boys.

It is also clear from the literature that overweight and obesity are more prevalent among the Caucasian racial group compared to the African racial group in South Africa (Jinabhai *et al.*, 2003:358; Kruger *et al.*, 2005:351; Armstrong *et al.*, 2006:442; Reddy *et al.*, 2008:206; Kemp *et al.*, 2011:119). Kruger *et al.*'s (2005:354) study on 1 257 children aged 10 to 15 years in the North West Province of South Africa, indicated that the Caucasian racial group had higher overweight (11.6%) and obesity (2.6%) values when compared to the values of the African racial groups (5.7% and 1.4% respectively). These researchers also indicated that the Indian racial group had lower overweight prevalence (3.8%) when compared to the Caucasian and African racial groups, however, the Indian group had the same value of obesity as the Caucasian population group. Supporting the above-mentioned researchers, Armstrong *et al.* (2006:56) found gender differences among the ethnic groups regarding overweight and obesity. These researchers' results regarding the boys' data indicated that Caucasian boys had a higher prevalence for overweight (15.4%), followed by the Mixed race population (8.7%), with the African population having the lowest prevalence of 7.6%. The same tendency was reported for obesity with 4.3% of the Caucasian boys being obese, 3.0% of the Mixed race boys and 2.1% of the African race boys being obese. Furthermore, Pienaar and Kruger (2014:114) reported in their study that more than 10% of Grade 1 learners in the North West Province of South Africa were overweight or obese, with the prevalence significantly lower among African children (8.8%) when compared to Caucasian children (19.7%).

2.4.2.4 Association among overweight and obesity and socio-economic conditions

According to the WHO (1998:17), both developed and developing countries are affected by the increasing rate of overweight and obesity. To provide a general overview, no gender differentiation was specified. In this regard, Whitaker and Orzol (2006:581) reported that children (which include boys and girls) from low SES groups (13.4%) had lower overweight percentages when compared to children from high SES groups (18.6%). In contrast, Kuku *et al.* (2012:2671) found in their study on 100 children in Iowa, USA, that children from lower SES groups (living in poverty) had a higher obesity prevalence when compared to children from higher SES groups. Supporting these findings, Rogers *et al.* (2015:693) reported that children from low SES groups had a higher overweight and obesity prevalence. Confirming the last-mentioned study, a study conducted in the USA and the United Kingdom reported that children from low SES groups had higher prevalence

of obesity when compared to high SES groups. Additionally, Fradkin *et al.* (2015:4) confirmed in their longitudinal study in the USA that boys from high SES groups had lower obesity (18.7%) prevalence among fifth and seventh grade boys.

South Africa is a diverse country with regard to its population, income and nutritional status (Jinabhai *et al.*, 2003:363), which guide children and young adults to report different variations in the body composition due to race, SES, gender (some studies did not report gender differences) and food availability as well as lifestyle (Popkin, 1994:285). Zere and McIntyre (2003:8) reported that 46.3% of people (children and adults) in South Africa lived in low SES and 53.7% of people lived in middle to high SES. These researchers also reported that children from urban areas presented higher mean BMI values when compared to rural areas. Pienaar and Kruger (2014:114) reported in their study that more than 10% of Grade 1 learners (boys and girls) in the North West Province of South Africa were overweight or obese. Furthermore, the prevalence for overweight and obesity was significantly lower in low SES (ranging from 6.1% to 5.1% respectively) schools compared to high SES (ranging from 18.1% to 21.2% respectively) schools. Additionally, it was found that children in high SES groups had a higher increase in obesity prevalence (18.3%), compared to low (3.3%) and middle (6.2%) SES (Pienaar, 2015:6). Several researchers found the prevalence (for boys and girls) of overweight and obesity to be lower in rural areas when compared to urban areas (Moneyki *et al.*, 1999:287; Steyn *et al.*, 2005:9; Pienaar, 2015:6), however, no gender differences were reported.

Overweight and obesity are global concerns, however, these conditions are not the only body composition conditions that affect children. Stunting and wasting are other conditions that affect millions of children globally, which is a major concern (UNICEF, 2016:36).

2.5 Stunting and wasting

UNICEF (2016:36) reported that, globally, 159 million children are stunted and 50 million children are wasted, with all of these children being under the age of five years. Stunting and wasting are major public health concerns (De Onis *et al.*, 2011:145) that affect many aspects among children and adults. A detailed discussion follows next with regard to understanding stunting and wasting.

2.5.1 Classification

Stunting's classification has been constant throughout the years and the same classification norm since 1997 has been used by the WHO (1997:10), confirming the norms for stunting at less than -

2 standard deviations and severe stunting at less than -3 standard deviations for height-for-age ratio (WHO, 2016:84). Furthermore, the WHO (2012:1) indicated that wasting refers to weight-for-height less than -2 standard deviation (-2 SD) of the WHO Child Growth Standards median. Furthermore, less than -3 standard deviation refers to severe wasting. Table 2.9 indicates the cut-off points used to classify between the three grades of wasting (Cole *et al.*, 2007:5).

Table 2.9: International cut-off points for BMI wasting Grades 1, 2, and 3 for boys between six- and 13 years (Cole *et al.*, 2007:5).

Age (yrs.)	BMI 16 kg/m ² Grade 1	BMI 17 kg/m ² Grade 2	BMI 18.5 kg/m ² Grade 3
6	12.50	13.15	14.07
6.5	12.45	13.10	14.04
7	12.42	13.08	14.04
7.5	12.41	13.09	14.08
8	12.42	13.11	14.15
8.5	12.45	13.17	14.24
9	12.50	13.24	14.35
9.5	12.57	13.34	14.49
10	12.66	13.45	14.64
10.5	12.77	13.58	14.80
11	12.89	13.72	14.97
11.5	13.03	13.87	15.16
12	13.18	14.05	15.35
12.5	13.37	14.25	15.58
13	13.59	14.48	15.84
13.5	13.83	14.74	16.12

Grade 1=BMI less than 16kg/m²; Grade 2= BMI less than 17kg/m²; Grade 3= BMI less than 18.5kg/m²

2.5.2 Prevalence of stunting and wasting among children

Stunting and wasting are global concerns and affect millions of children worldwide (UNICEF, 2016:35). In the following section, the prevalence of stunting and wasting among children internationally and nationally is discussed.

2.5.2.1 International statistics

A study done by Bloss *et al.* (2004:267) on 175 children below five years in Western Kenya, indicated that 47% of all children who participated in their study were classified as stunted, with 46.7% of the boys in the study being stunted. The same tendency of a high stunting prevalence (overall group 58%) was found in South Indian children below the age of five years, with the boys' stunting prevalence being 64% (Padmapriyadarsini *et al.*, 2009:6). These researchers further reported more age specific stunting percentages for the whole group which includes the following: below three years of age (62%), three to five years of age (64%), five to ten years of age (60%)

and older than 10 years (73%). Another study done in West Bengal, India, conducted by Bose *et al.* (2007:219) on 533 children (254 boys; 279 girls), aged three to five years showed that 26.5% of the boys were stunted and more specifically, that stunting increased as age increased in both genders. Adding to the last-mentioned study, Senbanjo *et al.* (2011:366) reported in their study on 570 children in Southwest Nigeria, aged five to 19 years, that 17.4% learners were stunted and 22.2% were severely stunted. These researchers further indicated that the prevalence for stunting among boys for the different age groups was as follows: five to nine years (6.3%), 10 to 14 years (20.9%) and lastly, the 15- to 19-year-old group (22.3%). De Onis *et al.* (2011:145) estimated in 2010 that 171 million (27%) pre-school children (overall group, as no gender difference data were stipulated) were stunted, with 167 million of these children coming from developing countries. These researchers added that, between 1990 and 2010, Africa had a stunting prevalence of 40%, but stunting among children has increased from 45 million children in 1990 to 60 million children in 2010. Asia indicated a decrease in stunting from 49% in 1990 (190 million) to 28% in 2010 (100 million). Although De Onis *et al.* (2011:146) did not focus on gender, they furthermore reported estimates for the increase of stunting from 2015 to 2020 for Africa (62.9 million and 64.1 million), Asia (83.9 million and 68.4 million), Caribbean and Latin America (5.9 million and 4.9 million) on pre-school children. These researchers also provided rough calculations for developing- (153.2 million) and developed countries (137.9 million) as a whole, estimating stunting at 157.3 million for 2015 and 142 million for 2020.

Jiang *et al.* (2014:47) indicated in their study on 1 260 children, aged two to three years in China, that the prevalence of stunting was 27% and 13.2% for severe stunting. The WHO (2015:34) reported in 2015 that, globally, almost one in every four children below the age of five years was affected by stunting, more specifically a percentage of 23% (156 million children). Additionally, the WHO (2015:34) point out that the highest prevalence of stunting was observed in the WHO African Region (38%), followed by the WHO South-East Asia Region (33%). Adding to the WHO predictions, Kuringen and Nieuwerkerken (2015:15) reported in their study that 26% of the children (below five years of age) were moderately stunted and 13.7% severely stunted in the Jimma region of Ethiopia. These researchers also reported that 50.7% of the boys were moderately stunted and 59.8% severely stunted. In India, the Anganwadi children (three to six years) presented a stunting prevalence of 37% in the rural areas and 22% in the urban areas (Patil *et al.*, 2016:2). No gender differences were reported. Verdisco *et al.* (2016:10) reported in their study in Costa Rica, Peru, Nicaragua and Paraguay on two- to four-year-old children (no gender differences were reported), that the prevalence for stunting among these four countries was 13.89%.

Arnold *et al.* (2016:98) indicate that one third of the world's stunted population is from India. Also specified by these researchers, is that stunting rates (8.7%) are more prevalent among males than females worldwide and that 23.9% of children under the age of five years are stunted (Arnold *et al.*, 2016:140). Confirming the last-mentioned study, Nuñez *et al.* (2016:723) reported in their longitudinal study of nine years on nearly 13 million children in Argentina, below the age of five, that the prevalence for stunting was 11.3% and among the rural communities higher (13.7%) when compared to the urban communities (11.1%). In addition, these researchers indicated that stunting was more prevalent among boys (12.7%) than girls (9.9%) and the boys' overall stunting prevalence decreased over nine years from 22.0% (2005) to 12.7% (2013). With the prevalence of stunting being high, wasting is another condition with high prevalence.

Malnutrition among children and adolescents are reported to be a serious public health concern (Cole *et al.*, 2000:1243). Wasting is a symptom of acute under-nutrition that is usually the consequence of a high incidence of infectious diseases (especially diarrhoea) or insufficient food intake. Furthermore, wasting impairs the functioning of the immune system and can lead to increased severity, duration and susceptibility to infectious diseases and an increased risk for death (WHO, 2012:1). A study by Wang *et al.* (2002:973) on children (six to nine years of age) and adolescents (10 to 18 years of age) from the USA (6 108 children), China (2 688 children), Russia (2 152 children) and Brazil (4 875 children) found that most of these countries' prevalence for wasting among boys decreased with age, except in Russia where the prevalence of wasting increased. These researchers also found that the USA (3.3%) and China (7.7%) had the highest prevalence of wasting. Adding to the last-mentioned study, Bloss *et al.* (2004:263) reported in their study on 175 children aged five (88 boys and 87 girls) in Western Kenya, that 29.9% of the boys were classified as wasted. In contrast, a study done by De Assis *et al.* (2005:1020) on 1 432 girls and 1 504 boys (seven- to 10 years old) found that the frequency of wasting was low in boys in Florianopolis, Brazil. These researchers reported that the wasting percentages for boys seven, eight, nine and 10 years, as 1.2%, 1.8%, 3.6% and 3.6% respectively. Another study done in India by Padmapriyadarsini *et al.* (2009:3) on 231 children, under the age of five years, found a wasting prevalence of 63%, with 42% being boys. Supporting the last-mentioned study, Dutta *et al.* (2009:79) found in their study on 353 children (zero to 12 years of age) in Garhwal Himalayas, that boys had a wasting prevalence of 13%, moderately wasting prevalence of 17.7% and a severe wasting prevalence of 10.5%.

On the other hand, Mushtaq *et al.* (2011:795) indicated in their study on 1 860 children (977 boys and 883 girls) in Pakistan, aged five to 12 years, that 10% were wasted and that prevalence among

the five- to six-year-old boys (11.8%) was higher when compared to girls (10.7%). A study done in South Nigeria on 1 599 children aged five to 18 years indicated a wasting prevalence of 13.1% among boys (Ene-Obong *et al.*, 2012:245). According to these researchers, wasting was significantly more prevalent among children (19.0%) than adolescents (8.3%), with boys being 13.1% classified as wasted and the highest prevalence was 28.6% at seven years of age. Kuringen and Nieuwerkerken (2015:15) reported in their study on 819 children, five years or younger, that 2.3% and 1% of these children were moderately (63.7% of the boys) or severely wasted (75% of the boys), respectively. Furthermore, Rashmi *et al.* (2015:99) reported on 582 children between the ages of five to 14 years, in Bangalore, India, that 34% (n=197) of their study population was wasted. They further stated that 70% (n=139) of the boys had mild to moderate wasting whereas only 10% (n=58) had severe wasting. A study done by Patil *et al.* (2016:3) on 200 children (aged three to six years) reported that the prevalence of wasting found was 33% for rural areas and 20% for urban areas. Recent studies established that children below the age of five years had a variation in the prevalence of wasting. Among the different demographic areas, Egypt (7.2%) reported a decrease in wasting prevalence among boys from 2005 (4.3%) to 2012 (2.8%), Australia had an overall prevalence of 6% and Argentina (11.3%) reported that 2.8% of the boys were wasted (Nuñez *et al.*, 2016:723; Pearce *et al.*, 2016:89; Sharaf & Rashad, 2016:11).

As can be concluded from the above-mentioned literature, stunting and wasting are worldwide occurrences with various statistics globally, however, stunting and wasting's prevalence in South Africa plays a very important role in this dissertation.

2.5.2.2 South Africa statistics

According to Walsh *et al.* (2001:8) and Kruger *et al.* (2014:6), children living in poor SES and rural areas are usually more affected than children in the urban areas in South Africa with regard to stunting. Furthermore, Walsh *et al.* (2001:8) indicated in their study on 815 children in the Free State and Northern Cape Provinces in South Africa, that the prevalence of stunting and wasting was higher in rural areas than urban areas. These researchers also conveyed that boys' stunting and wasting prevalence was 27.6% and 34.8% respectively (Walsh *et al.*, 2001:4). Mukuddem-Petersen and Kruger (2004:845) reported that the highest prevalence of stunting was found among boys from rural areas (26.7%) and the lowest prevalence of stunting among boys from urban areas (17.1%).

In this regard, Mamabolo *et al.* (2007:1049) found that boys (n=134) had a higher stunting value of 21.6%, when compared to girls (n=179; 12.3%) in the North West Province of South Africa.

Motswagole *et al.* (2012:65) reported that the prevalence of stunting in the Transition and Health during Urbanisation of South African (THUSA BANA) study in the North West Province was 29% (with boys reported 15.9% stunted) and 6.1% (boys reported 13.7% as stunted) in the Ellisras Longitudinal Growth and Health Study (ELS) in the Limpopo Province of South Africa. Kruger *et al.*'s (2014:3) study on 816 Grade 1 learners (419 boys and 397 girls) in the North West Province in South Africa found that stunting among African children was higher in comparison to Caucasian children (6% vs. 0%). These researchers also reported that 4.06% of boys were stunted. A longitudinal study done by Monyeki *et al.* (2008:412) on three- to 10-year old children from the Ellisras District found that primary school boys (43.6%) were more likely to be at risk for developing severe stunting, when compared to primary school girls (37.5%) and the same tendency was found among the moderate stunting of primary school children.

The study of Shisana (2014:118) stated that boys from Cape Town, Durban and Johannesburg, aged from zero to three years had the highest prevalence (26.9%) of stunting, while the seven- to nine-year old (10%) age group reported a lower stunting prevalence. Furthermore, these researchers reported that stunting was more significant among boys from rural areas (23.2%) when compared to boys from urban areas (13.6%). Adding to their research, these researchers reported that the boys living in the North West (23.7%), Mpumalanga (23.1%) and Northern Cape (22.8%) Provinces had the highest prevalence of stunting. Another study performed in South Africa (Steenkamp *et al.*, 2016:29) found that 58% of the children (five years of age) in their study were stunted, however, these researchers further indicated that 47% were moderately stunted and 32% severely stunted, with no gender differences being indicated. Symington *et al.* (2016:67) conveyed in their study on 519 children, aged three to nine years, in South Africa, that the overall prevalence for stunting was 17%, with a 15.4% of the boys being stunted. Stunting in South Africa is not the only condition that affects children, as is wasting.

A longitudinal study done by Monyeki *et al.* (2008:410) on 2 225 children aged three to 10 years in Ellisras, South Africa indicated that severe (43.6% boys and 37.5% girls), moderate (14.9% boys and 12.2% girls) and mild (23.6% boys and 25.6% girls) wasting were observed. The boys presented higher wasting percentages when compared to the girls. Kruger *et al.*'s (2012:596) study results indicated that 5.8% of South African children (one- to nine-years-old) were among the wasting population in 2005. Borderline significant differences were found among racial groups, reporting that Caucasian children (n=15) had a percentage of 6.88% and African children (n=39) a percentage of 6.88%, with the Caucasian group being more wasted (Kruger *et al.*, 2014:3). Furthermore, these researchers reported that the Caucasian (99.54%) boys had a higher wasting

prevalence when compared to the African (94.53%) boys. Walsh *et al.* (2001:5) and Kruger *et al.* (2014:6) found that the wasting prevalence in rural areas (from 0% to 13.7%) was much lower than in urban (mid-high SES) areas (21.3% for the boys). Brink *et al.* (2014:115) reported in their study on 222 children, aged zero to 14 years, that 23.4% were wasted and 2.6% were severely wasted. A study done in Cape Town, South Africa, by Tomlinson *et al.* (2016:216) on 8 715 children aged zero to six years indicated that a total of 1.4% of children (boys and girls included) were wasted. Steenkamp *et al.* (2016:29) showed in their study on 225 children from the Free State, Western Cape and Northern Cape Provinces, South Africa, that a total of 34% children were wasted (29% were moderately wasted and 5% severely wasted).

A broad overview was given regarding international and national statistics of overweight, obesity, stunting and wasting. With this being said, only a few longitudinal studies have been done on this topic, focusing on the different genders, thus leaving a gap in the literature. However, an overview was given about the available data. With the statistics of these four conditions in mind, the effect that they have on childhood development (physically, psychologically and cognitively) is discussed next.

2.6 The effect of overweight, obesity, stunting and wasting on childhood development

Literature emphasises that overweight, obesity, stunting and wasting have a negative effect on different areas of a child's development. Some of the relevant areas like psychosocial development such as self-esteem/self-concept, depression and peer group relationships are discussed in detail next.

2.6.1 Psychosocial development

A number of potential psychological health issues are associated with overweight, obese, stunted and wasted children. Saunders and Smith (2010:625) reported that children suffering from malnutrition (including overweight, obesity, stunting and wasting) are likely to develop psychosocial effects, such as anxiety, apathy, depression and self-neglect. These children tend to suffer from poor self-image, low self-confidence and even depression – all of which that can continue into adolescence and adult life. The following psychosocial developments are briefly discussed next: self-esteem/self-concept, depression and peer group relationships.

2.6.1.1 Self-esteem/ self-concept

Self-esteem is the attitude towards the self and is related to personal beliefs, specifically referring to the skills, abilities, social relationships and future outcomes (Heatherton & Wyland, 2003:220).

Self-concept is the image of oneself and self-confidence is the amount of value for oneself (Dreyer & Egan, 2008:160). Strauss (2000:15) has added that overweight children have lower self-image when compared to the non-overweight peer group, thus leading to increased feelings of sadness, loneliness and anxiety. Another study by Goldfield *et al.* (2010:190) reported that overweight and obese adolescents had higher scores of negative self-esteem when compared to normal weight adolescents. Supporting the last-mentioned study, Lee and Yen (2014:629) indicated in their study on 5 254 adolescents aged 13 to 18 years, that adolescents characterised as overweight and obese, had lower levels of self-esteem when compared to average weight adolescents. Arenas and Martínez (2015:41) reported the same tendency in their study on 270 children, aged eight to 11 years, where 12.22% of the children were obese, of whom 94% had a low self-esteem and body image, further confirming a relationship between perceived body image and self-esteem. The American Academy of Child and Adolescent Psychiatry (AACAP, 2016) indicates that children and teens suffering from overweight and obesity tend to have a lower self-image and are more likely to be less popular than non-overweight and non-obese children from their peer group and this may lead to anxiety, suicide attempts and depression.

Saunders and Smith (2010:625) reported that children suffering from malnutrition have a tendency to develop psychosocial effects, such as anxiety, apathy, depression and self-neglect. Van Grieken *et al.* (2013:5) indicated in their study on 2 372, five- to seven-year-old children, in Rotterdam, the Netherlands, that children with severe wasting presented lower levels of happiness and higher levels of insecurity when compared to normal weight children. Potterton *et al.* (2016:413) reported in their study in South Africa that wasting affected personal-social development of children (between three and five years old). Pearce *et al.* (2016:89) indicated in their study on 7 533 four- to six-year-old children in Australia that 8.4% of the children with wasting reported lower social competency and 9.4% reported lower emotional maturity.

According to Prendergast and Humphrey (2014:257), stunted children showed less exploratory behaviour, lower self-esteem and increased levels of depression and anxiety. Kuringen and Nieuwerkerken (2015:19) have indicated that stunting has a significant effect on children's personal-social skills and Language development. In contrast, Miller *et al.* (2015:1344) found no clear association between stunting and socio-emotional development among children in their study. Supporting the last-mentioned study, Prado *et al.* (2016:3) reported that stunting was significantly associated with personal-social development but not socio-emotional development. Supporting the last-mentioned study, Erfanti *et al.* (2016:61) reported in their study on 200 children (aged 11 to 14 years) in Indonesia, that psycho-social problems like anxiety, low self-

esteem, family problems and bullying are present among stunted and severely stunted children. Additionally, these researchers indicated that psychopathology symptoms, like anxiety disorder, concentration problems, hyperactivity, Attention Deficit Hyperactivity Disorder and depression disorder occur among these children (Erfanti *et al.*, 2016:61).

2.6.1.2 Depression

Erickson *et al.* (2000:934) found that other factors, like how the child feels about their weight, rather than the high BMI value, play an important role in the development of depression. Bosch *et al.* (2004:354) have indicated that it is not only the weight status or the BMI value that leads to depression, but rather the negative view about themselves. Faith *et al.* (2011:451) found a positive association between obesity and depression. Adding to their research, they found a more common association among obesity-to-depression than depression-to-obesity among children and adolescence. Supporting the last-mentioned study, Sjöberg *et al.* (2013:391) performed a study on adolescents in Sweden and found an association between BMI and depressive symptoms. Furthermore, these researchers also indicated that the group with the highest BMI (obesity group) significantly suffered from major depression as determined by the DSM-IV A-criteria, which were used in their study. Added by these researchers' study, obesity was associated with shame, among both genders. Esposito *et al.* (2014:1899) reported in their study on 148 obese children in the Campania region of Italy, aged eight to 17 years, that the obesity group had higher levels of depressive symptoms and anxiety when compared to the normal weight group. Morrison *et al.* (2014:20) also found the same tendency among 244 children aged eight to 17 years. Assari and Caldwell (2015:486) focused more on the African population and found a greater association between obesity and major depression among Caribbean girls (aged 13- to 17 years) when compared to Caribbean boys. Adding to the last-mentioned study, the most depression symptoms were found among overweight girls when compared to boys, but in contrast, boys' longitudinal weight patterns were not associated with depression symptoms (Martin-Storey & Crosnoe, 2015:1008). Lastly, confirming the above-mentioned studies, children who are classified as overweight or obese are more likely to be at risk for high levels of depression, anxiety and peer victimisation (Pryor *et al.*, 2016:206). Depression does not only occur among overweight and obese children but also among stunted and wasted children.

Children who were classified as stunted during the first two years of their life reported poorer psychological functioning in their late adolescence, when compared to non-stunted children (Walker *et al.*, 2007:2465). These researchers reported that stunted children (two to 17 years old) from Kingston, Jamaica, had more depressed symptoms and anxiety. Galler *et al.*'s (2010:796)

study in Barbados, on children 11 to 17 years of age, found similar results. The prevalence of depressive symptoms was higher among previously stunted children compared to normal weight children and younger children reported to be more depressive than older children (Galler *et al.*, 2010:796). Children suffering from malnutrition are also more likely to develop anxiety and/or depression (Saunders & Smith, 2010:625; Saunders *et al.*, 2014:114) when compared to normal weight children.

From the above, it is clear that overweight, obesity, stunting and wasting are associated with depression or depressive behaviour. Not only is this aspect affected by overweight and obesity but also children's peer group relationships.

2.6.1.3 Peer group relationships

According to Dreyer and Egan (2008:160), good relationships with classmates during childhood and adolescence are not only essential for healthy cognitive development but also social development. Interaction with class members and peer group learners teaches children how to develop and maintain relationships with other children in their class or school and helps develop problem solving skills and social skills. Hartup's (1996:1) study supported the above-mentioned study by finding that healthy relationships with classmates can provide meaningful social and cognitive aids, especially during stressful situations. Adding, the study of Zeller *et al.* (2008:759) on 90 obese children and 76 non-overweight children aged six to 18 years, found that obese children are rated as less peer accepted than non-overweight or non-obese children. These researchers further found that overweight and obese children are less often regarded as popular and as "best friends" by their classmates. Moreover, these researchers indicated that overweight and obese children show less leadership behaviour and are more likely to show disruptive and aggressive behaviour.

Further research by Dreyer and Egan (2008:161) has found that problematic social functioning is more likely to appear among obese children than in their peers. Additionally, Hestetun *et al.* (2015:322) indicated in their study on 744 children aged 12 to 13 years, that children who were overweight reported peer problems and that these issues later led to mental health problems. Pryor *et al.* (2016:206) reported that overweight children (six to 12 years old) have higher levels of peer-victimisation and a desire to be thinner. Not only are peer group relationships affected but also behaviour. Confirming this, Kagawa *et al.* (2016:6) reported that overweight or obese boys (one to five years) showed more internal behavioural problems than normal weight boys at the age of six. Peer group relationships are affected by overweight, obesity, stunting and wasting. Stunted

children (during the first two years) reported antisocial behaviour in their late adolescent years, as reported by a study in Kingston, Jamaica (Walker *et al.*, 2007:2466). Malnutrition among children may affect their relationships with other children, because they feel self-neglected (Saunders & Smith, 2010:626; Saunders *et al.*, 2014:114).

Psychosocial development is not the only affected development area among overweight, obese, stunted and wasted children. There are health related aspects as well.

2.6.2 Health related aspects affected by overweight, obesity, stunting and wasting

Overweight, obesity, stunting and wasting affect health related aspects such as health related lifestyle/risk factors, hypertension, asthma and diabetes, which are discussed below.

2.6.2.1 Health related lifestyle/health risk factors

Restricted quality of life may indicate an inability to perform and complete daily or physical activities (WHO, 2012:8). Quality of life indicates the all-inclusive standards of children's lifestyles, referring to whether the population can accommodate the child's basic needs (housing, food and health care) (WHO, 2012:8). The quality of life for children suffering from obesity can deteriorate five and a half times compared to that of normal weight children (Schwimmer *et al.*, 2003:1813). Dreyer and Egan (2008:161) indicated that obese children's quality of life might deteriorate due to a poor lifestyle and should regularly be evaluated or monitored to prevent future shortcomings. Gouveia *et al.* (2014:2633) indicated in their study that obese youth, regardless of their gender, have a poorer quality of life when compared to normal weight children. Supporting the last-mentioned study, Morrison *et al.* (2015:20) indicated that children (including boys and girls) classified as obese reported a lower quality of life score (based on a questionnaire) as compared to normal weight children. The WHO (2014:40) further indicates that the increased risk of becoming an overweight child or adult is more often to be diagnosed with at least one additional risk factor for cardiovascular disease, such as elevated blood pressure or higher blood cholesterol levels. Moreover, the fact that Type 2 diabetes is increasingly prevalent in young children who have a lack of physical exercise and unhealthy diet, is among the typical risk factors. More health complications can arise, like joint problems and breathing difficulties (dyspnea). Stunting and wasting can also lead to different health related issues such as high blood pressure (Olivares *et al.*, 2014:114), cardiac problems (Saunders *et al.*, 2014:114), asthma (Hawladar *et al.*, 2012:1575) and more. Hence, a full discussion regarding the associations between the above-mentioned health-related issues and overweight, obesity, stunting and wasting follows next.

2.6.2.2 Cardiovascular Disease (CVD)

A study by Poirier *et al.* (2006:899) reported an association among obesity and cardiovascular diseases. Additionally, the population-based study of Ogden *et al.* (2010:4) on five- to 17-year-old children reported that obese children and adolescents present more risk factors for cardiovascular disease (CVD), including high cholesterol levels, abnormal glucose tolerance and high blood pressure. These researchers also indicated that 39% of obese children had two or more CVD risk factors. Supporting these researchers, Friedemann *et al.* (2012:4) have found in their study on children five to 15 years of age, that children with higher BMI values have a higher risk to develop CVD. These researchers also reported that overweight and obesity among boys affect cholesterol and insulin levels more when compared to normal weight children. A review by Sahoo *et al.* (2015:190) reported that CVD, hypertension, asthma and diabetes (especially Type 2) are mostly affected by overweight and obesity. Cardiovascular diseases can also affect overweight/obesity and stunting/wasting in children.

A longitudinal study by Hoffman *et al.* (2000:643) reported that stunted children (eight to 11 years of age) in Brazil, entering puberty, started to gain weight and were at risk to develop chronic diseases leading to CVD. The same tendency was indicated by Vorster and Kruger (2007:323) regarding South African children. Confirming the last-mentioned study, Badham and Sweet (2010:43) stated that stunting mostly occurs during the first two years of childhood, thus indicating that rapid weight gain during childhood and adolescence will result in chronic disease development such as CVD. Furthermore, stunting indirectly causes CVD in adulthood due to the above-mentioned (Uauy *et al.*, 2011:1760). Children who were wasted at the age of one, who later gained a lot of weight (during the catch-up growth phase) led to the development of CVD among these children (Sawaga *et al.*, 2003:171). Sauders *et al.* (2014:114) and Olivares *et al.* (2014:667) reported in their studies that some children suffering from malnutrition reported heart diseases (47.3%) and/or cardiovascular problems due to reduced cardiac muscle mass, resulting in poor cardiac functioning and causing cardiac failure. The same tendency was reported by Silverman (2015:15), however, this researcher added that children (in Malawi) diagnosed with severe wasting reported a higher cardiac index (higher heart rate, myocardial contractility, etc.) and heart failure when compared to normal weight children.

2.6.2.3 Hypertension

Daniels (2006:49) indicated that the prevalence of hypertension among the paediatric population in the United States of America is between 2-4%. Hypertension can be defined by the presence of the chronic elevation of systemic arterial pressure above a certain threshold value of 120/80

mm/Hg (Giles *et al.*, 2009:611). Hypertension among children is not very common, but childhood overweight and obesity are some of the main factors why children develop paediatric hypertension (Speiser *et al.*, 2005:1877). Researchers found significant relationships between overweight and obesity and the development of hypertension (Stein & Colditz, 2004:2523; Daniels, 2006:5). Tran *et al.* (2012:297) reported in their longitudinal study on children aged two to 18 years that paediatric hospitalisation (overall) and hospitalisation among boys with hypertension were increasing over time (1997, 2000, 2003 and 2006). These researchers also indicated that a small number of all paediatric hospitalisation cases are associated with hypertension has increased from 1997 and 2006, with 2.2% to 4.0% respectively. Supporting these researchers, Rodríguez-Morán *et al.* (2012:20) indicated that the prevalence of pre-hypertension (43.5% among boys) can significantly be associated with obesity among children. Zou *et al.*'s (2016:46) study on 782 eight- to 17-year-old children reported in their study a significant association between BMI, systolic and diastolic blood pressure among girls and boys. These researchers further reported that boys had a significant higher BMI and systolic blood pressure when compared to girls. Overweight and obesity are associated with high blood pressure, however, stunting and wasting can also be associated with hypertension.

Gaskin *et al.* (2000:565) reported in their study on 120 stunted children (aged seven to eight years), that higher levels of systolic blood pressure were present when compared to non-stunted children. Sixty stunted children (two to seven years of age) in Brazil reported to be at risk of developing hypertension during adolescence and adulthood (Febba *et al.*, 2008:382). These researchers also indicated in their study that the stunted children had higher blood pressure levels when compared to normal weight children. Confirming these findings in Brazil, Clemente *et al.* (2012:8) stated that mild stunting affected systolic and diastolic blood pressures (of children seven to 17 years of age). Rachmi *et al.* (2017:156) reported on Indonesian children (aged two to five years), that children who were stunted during early childhood were likely to become overweight or obese as they got older and thus developed hypertension due to this occurrence. These findings are also observed among wasted children. These children tend to develop hypertension as they get older (adolescents and older) and have higher diastolic blood pressure when compared to normal weight children (Tennant *et al.*, 2014:666). Furthermore, Olivares *et al.* (2014:114) reported that malnutrition among children was higher (42%) when compared to normal weight children. Adekanmbi *et al.* (2016:86) have more specifically reported that wasted children have or are starting to develop pre-hypertension, hypertension and stage 1 hypertension.

It is clear that overweight, obesity, stunting and wasting affect hypertension or high blood pressure. The same tendency is discussed next regarding asthma.

2.6.2.4 Asthma

A study by Figueroa-Muñoz *et al.* (2001:135) on 14 908 children aged four to 11 years, in the United Kingdom, indicated that levels of obesity (regarding BMI values) were associated with asthma symptoms, regardless the ethnic group. Supporting the last-mentioned study, a longitudinal study on 3 792 participants (aged seven to 18 years) in Southern California, indicated that, over four years, 288 new cases of asthma diagnosis occurred and that overweight and obese children were more likely to be associated with higher risks of new-onset asthma when compared to normal weight children (Gilliland *et al.*, 2003:410). Furthermore, Kajbaf *et al.* (2011:6) reported in their study on 903 children, aged seven to 11 years that the prevalence of wheezing among overweight and obese children was 37.0% and 68.7% respectively. These researchers also indicated that overweight children had a higher prevalence of wheezing when compared to normal weight children, i.e. 37% and 0.53% respectively. The same tendency was found regarding obesity. These researchers lastly indicated that exercise-induced wheezing was more prevalent among overweight (15.5%) and obese (23.4%) children when compared to normal (0.4%) weight children. Chen *et al.* (2014:1199) reported on 2 758 children aged nine to 11 years, that central obesity accurately predicted asthma. These researchers also reported that low physical fitness levels increased the risk of central obesity (accumulation of fat around the centre of the body), which later led to the development of asthma. Furthermore, obesity can also lead to a reduction in pulmonary function that is a possible mechanism in the pathway from central obesity to asthma. Sivapalana *et al.* (2015:84) found that overweight and obesity were important risk factors for asthma, while weight reduction tended to lead to an overall improvement in asthma. Papoutsakis *et al.* (2015:131) indicated in their study on 514 children, aged five to 11 years that a higher proportion of the children with asthma had central obesity and these children were more likely to have asthma or be asthmatic. The same tendency was found among overweight children. Obesity among children and adolescents increases the risk for new asthma diagnosis by 60% (Keller & Quigley, 2016:1). Supporting the last-mentioned study, Lu *et al.* (2016:269) indicated that children and adolescents with obesity are more likely to have obesity-related asthma or physician diagnosed asthma.

Stunting was significantly associated with wheezing in the chest among four- to five-year-old children in Bangladesh (Hawlder *et al.*, 2012:1575). Oraiby *et al.* (2013:381) indicated in their study on 100 asthmatic children (five to 15 years of age) in Iraq, that a significant association was found among asthma and growth impairment. These researchers indicated that asthma more

specifically affected height impairment. Supporting the last-mentioned study, Giannini *et al.* (2014:7) reported that children suffering from chronic asthma were at a higher risk of growth impairment. Wang and Dietz (2002:83) found that the two most common conditions associated with obesity were asthma and diabetes. A study on wasted children (two to seven years of age) in Quezon City further reported that these children had higher susceptibility to suffer from respiratory symptoms and poor lung functioning. (Nisperos *et al.*, 2014:697). Saunders *et al.* (2014:114) reported that the consequence of malnutrition among children was poor respiratory muscle functioning which could lead to respiratory infections and/or asthma.

2.6.2.5 Diabetes Mellitus

In 2012, the American Diabetes Association (ADA) reported that Type 2 diabetes was diagnosed among nearly a third of American children (ADA, 2012:2) and that Type 1 diabetes was no longer the only type of diabetes among children. The ADA (2012:3) has further indicated that obesity is a very common condition among children with Type 1 and Type 2 diabetes and supporting these findings, the ADA performed a cohort study in Pima, India and found that 85% of children with Type 2 diabetes were obese. Goran *et al.* (2003:1424) indicated that paediatric obesity-associated diseases, especially cardiovascular risk and Type 2 diabetes, were emerging problems for this population (aged six to 17 years). A study conducted by Somers *et al.* (2006:16) on 401 learners (randomly selected primary and secondary schools in Western Cape, South Africa), indicated that the incidence of diabetes mellitus was increasing among all population groups in South Africa. Viner *et al.* (2008:1059) specified in their longitudinal study that higher BMI among children predicted the risk of developing Type 1 diabetes later in life. Rodríguez-Morán *et al.* (2012:20) reported a significant association between obesity and increased insulin levels. Supporting the last-mentioned study, Berquist (2015:81) indicated that excessive weight in children was accompanied by high circulating insulin, high circulating free fatty acids and increasing blood glucose, which could lead to either Type of diabetes.

According to the American Heart Association (Go *et al.*, 2014:117), the prevalence estimate for diabetes mellitus for all age groups worldwide was 2.8% for the year 2000, but the increased prevalence estimate for 2030 will be 4.4%. The American Heart Association (Go *et al.*, 2014:117) has reported that approximately 186 000 people younger than 20 years of age have diabetes mellitus and approximately 15 000 people, younger than 20 years of age are diagnosed with Type 1 diabetes mellitus per year in the United States of America. These researchers have also found that healthcare providers are diagnosing more children with Type 2 diabetes mellitus and these children are typically overweight (10.4%) or obese (79.4%). Du Bose *et al.* (2015:629) reported

in their study on 11 435 children aged two to 18 years, in Austria, Germany and USA, that excessive weight and Type 1 diabetes were common problems among children in these countries, but more specifically in the USA. Adding to the last-mentioned study, Liang *et al.* (2015:4) reported in their study on 1 209 children, aged six to 18 years, that overweight or obese children had significant risks in developing diabetes. Atay and Bereket (2016:4) reported that various metabolic complications were affected by overweight and obesity, which included insulin resistance, metabolic syndrome, pre-diabetes and Type 2 diabetes. Overweight and obese children are at risk to develop diabetes and the same tendency can be seen among the stunted and wasted groups as well.

Children with low BMI values may be at risk to develop Type 1 and 2 diabetes (Laksir *et al.*, 2017:5) and “malnutrition related diabetes mellitus” (Taksande *et al.*, 2008:23; Klimek *et al.*, 2014:505; George *et al.*, 2015:614). Stunted adolescents (61 learners) displayed lower insulin levels, however insulin sensitivity levels were higher, therefore these children are at risk of developing Type 2 diabetes when compared to non-stunted children in São Paulo, Brazil (Martins & Sawaya, 2006:998). Additionally, Febba *et al.* (2008:382) reported that stunting indirectly caused diabetes, due to stunting being more prevalent during the first two years, thereafter the children gained weight and thus developed chronic diseases. Furthermore, Suresh *et al.* (2011:74) reported in their study (39 children and adolescents) in India, that stunting might be associated with Type 1 diabetes. Confirming this, Mozhgan Khatibi *et al.* (2016:257) indicated in their study on 443 children (4-6 years of age) in Iran that stunted children were at risk to develop diabetes mellitus later in life.

It is clear that overweight, obesity, stunting and wasting have an association with diabetes mellitus (Type 1 and 2) and are growing and affecting not only adults but children as well. Furthermore, overweight and obesity affect not only the health aspects of children but also their physical development, this may have an effect on their academic performance.

2.6.2.6 Growth impairment

Growth concerns regarding overweight and obesity among children include spine complications (lower and cervical back pain) due to lower (12-13%) bone minerals (Reilly *et al.*, 2003:750), sprains and fracture risks (Dowling *et al.*, 2004:1517). Other complications due to overweight and obesity are a lack of musculoskeletal strength, joint problems (hips, knees and feet), postural abnormalities (scoliosis and genu valgum), arthritis, tendonitis and postural imbalance (Dos Santos *et al.*, 2015:1080).

Branca and Ferrari (2002:13) reported in their study that stunting resulted in a lower or decreased height when compared to peers. These researchers also reported that stunted children tended to look younger (usually 2–3 years younger) and presented developmental delays (retarded achievement of the main child development milestones, such as walking). Adding to the last-mentioned finding, the long-term consequences of stunting include decreased work productivity and capacity and a short body stature (Dewey & Begum, 2011:11; Steward *et al.*, 2011:29; Prendergast & Humphrey, 2014:257). Wasting has been found to have an influence on children's growth by means of affecting their muscle mass. These children have a lower muscle mass (also referred to as muscle wasting) when compared to normal weight children. Wasting and/or repeated episodes of wasting have an effect on attained height-for-age (Briend *et al.*, 2015:16; Khara, 2016:23). This researcher further reported that body size deviation and low fat mass were also present among these children. A study by Kyle *et al.* (2015:229) reported that wasting led to growth impairment due to poor nutritional intake, which means the body does not have the necessary proteins/vitamins/minerals to ensure growth and development.

Growth among these conditions as well as motor skills development get affected because of body composition.

2.6.3 Motor development/physical activity

Overweight and obesity have been reported to influence children's motor skills development and physical activity. Cheng *et al.* (2016:34) reported in their study on 688 children, aged five to 10 years that five-year-old children with a higher BMI reported lower motor skills between the ages of five to 10 years, however, boys had higher motor skills scores when compared to girls. Obesity at the age of five years also predicted a decline in motor skills proficiency. Furthermore, these researchers reported that obese children (at five and 10 years) had significantly lower gross motor skills when compared with normal weight children. Lastly, also indicated by these researchers, small differences for fine motor skills were noted between obese and non-obese children at the age of five years (Cheng *et al.*, 2016:34).

Reviewing the literature regarding overweight and obesity, it can be concluded that many aspects, from psychosocial, health and development aspects are affected, however this does not just apply to overweight and obesity but also to stunting and wasting. Chang *et al.* (2010:833) reported in their study on 80 non-stunted children (37 girls and 43 boys) and 116 stunted children (49 girls and 67 boys), aged seven to eight years and 11 to 12 years, that rapid sequential continuous

movements and dexterity scores were lower in the stunted group than in the non-stunted group. Stunting among children reported lower motor (Stewart *et al.*, 2011:29) and locomotor skills development (Prendergast & Humphrey, 2014:275). Supporting these researchers, Miller *et al.* (2015:1344) reported in their study on 58 513 children (aged three to five years) in 15 low to middle income countries, that stunting and severe stunting were negatively associated with physical development among these children (no gender differences were stipulated). Kuringen and Nieuwerkerken (2015:19) reported in their study on 819 children, aged five years and younger, that stunting significantly affected gross motor development and fine motor development. These researchers also reported that boys did not perform as well as girls. Confirming the last-mentioned study, Prado *et al.* (2016:3) indicated in their study on 3 700 children, from birth to the age of 18 months, that stunting was significantly associated with Language and poor motor development. Sudfeld *et al.* (2015:2708) reported on 1 036 children (aged one and a half to three years) that stunting significantly associated with motor development, with no indication of gender differences.

Grantham-McGregor *et al.* (1999:70) have indicated that under nutrition causes a decrease in motor skills development, subsequently leading to lower levels of activity. Furthermore, Subasinghe and Wijesinghe (2006:5) reported in their study on Sri-Lankan children (three to four and a half years of age) that wasted children presented significantly lower fine and gross motor skills when compared to non-wasted children. The same tendency was found by Sudfeld *et al.* (2015:2708), indicating that wasting was significantly associated with lower levels of motor skills development. Stunting has been reported to have short-term or current consequences. The short-term consequences include increased mortality, morbidity, health expenditure and decreased motor, cognitive and Language development (Sudfeld *et al.*, 2015:2708). As a result, the effect that obesity, overweight, stunting and wasting might have on children's academic skills is discussed next, starting off by explaining the South African academic system in detail.

2.7 Academic system: South Africa

In South Africa, a National Curriculum and Assessment Policy Statement (CAPS document) is being use for Grade R-12 learners and is a single, comprehensive and concise policy document used by the department and educators (Department of Basic Education, South Africa, 2015). The CAPS document provides a detailed program and promotion requirements for Grades R–12 learners, which describe the number of subjects to be offered in each Grade and the promotion requirements to be obtained by each learner. A four-point scale is used for Grade 1 to 3 learners during examination grading, with (1) indicating not achieved, (2) partially achieved, (3) achieved

and (4) outstanding achievement. Lastly, a cluster point is calculated from three variables: reading, writing and Mathematics (Department of Basic Education, South Africa, 2015).

In Grade 4 to 6, the learning areas according to the CAPS document are: Mathematics, Home Language, Second Additional Language, Life Orientation (LO), Natural Science (NS), Social Science and Technology. For Grade 7 learners the subjects include: Home Language, First Additional Language, Mathematics, LO, NS, Social Science, Technology, Economic Management Science and Creative Arts. Lastly, a seven-point rating code is used to code each subject's marks (Department of Basic Education, South Africa, 2015). Additionally, academic performances are measured by the Department of Basic Education (2015) by means of the Annual National Assessments (ANA assessments) which occur once a year in September. All six learning areas as mentioned above are assessed with the ANA grading scales (See Table 2.10).

Table 2.10: Grading scales for ANA assessments (Department of Basic Education, South Africa, 2015).

Rating code	Description of Competence	Percentage
7	Outstanding achievement	80-100
6	Meritorious achievement	70-79
5	Substantial achievement	60-69
4	Adequate achievement	50-59
3	Moderate Achievement	40-49
2	Elementary achievement	30-39
1	Not achieved	0-29

The CAPS document further requires specific allocated times per subject (Department of Basic Education, South Africa, 2015) and for the purpose of this study, only the Grade 1, 4 and 7 times per subject will be highlighted. Table 2.11 stipulates the required times per subject for Grade 1, 4 and 7 as set by the Department of Basic Education (Department of Basic Education, South Africa, 2015).

Table 2.11: Specific allocated times per subject for Grade 1, 4 and 7 (Department of Basic Education, South Africa, 2015).

Subjects	Grade 1	Grade 4	Grade 7
Home Language	7-8	6	5
First Additional Language	2-3	5	4
Mathematics	7	6	4.5
Life Skills	6	4	0
Beginning Knowledge	1	0	0
Creative Arts	2	1.5	0
Physical Education	2	1	0
Personal and Social Well-being	1	1.5	0
Natural Sciences	0	1.75	3
Social Science	0	3	3
Technology	0	1.75	2
Economic Management Sciences	0	0	2
Life Orientation	0	0	2
Creative Arts	0	0	2
Total hours per week	23	27.5	27.5

Assessments are important to ensure progress and to help reaching the minimum academic performance requirements, thus formal and informal assessments should be done to ensure the required feedback (Department of Basic Education, South Africa, 2015).

2.8 The effect of overweight, obesity, stunting and wasting on cognitive and academic performance

According to the literature, it is clear that overweight, obesity, stunting and wasting affect many areas of development among children. Therefore, it is important to discuss what effects overweight, obesity, stunting and wasting have on the cognitive development and academic performance of a child. Various studies did, however not focus on differentiating between boys and girls, but instead the combined groups were formed to give a general overview.

Datar *et al.* (2004:66) found a statistically significant association among childhood overweight and academic test scores (especially mathematic test scores) in their longitudinal study on 11 192 kindergarten to fifth Grade children from the USA. These researchers also found that boys had lower test scores for reading in kindergarten and Grade 5 boys and that these boys reported lower test scores in reading than Mathematics. Another longitudinal study by Datar and Sturm (2006:1449) on 5 874 children (kindergarten to third grade) found that overweight children's school life was affected, as well as their school attendance and academic performance. These researchers also found that boys in the third grade had lower test scores in Mathematics than reading. Joining the later findings, Judge and Jahns (2007:676) and Zavodny (2013:141) found

that overweight and obese boys (from kindergarten to eighth grade in the USA) tended to have lower test scores (in reading, Mathematics and science) and teacher assessments (Mathematics). Clark *et al.* (2009:196) further reported in their study on 9 471 elementary school children (2 227 first grade, 1 361 second grade, 2 311 third grade, 1 323 fourth grade and 2 249 fifth grade students), that obese children (no gender difference reported) had significantly lower grade averages in all the subjects (Mathematics, Science, social studies, reading and Language) when compared to overweight children in Texas, USA.

Mond *et al.* (2007:1071) also established that obese children in lower Bavaria in Germany (aged four to eight years) had lower cognitive abilities (visual perception, memory, abstraction and concentration) when compared to non-obese children and boys had higher impairment percentages when compared to girls. Supporting these findings, Roberts *et al.* (2010:717) reported that overweight boys (>85th BMI percentile but <95th BMI percentile) also scored lower in the standardised test than the normal weight children. Adding to the above-mentioned study, Donnelly *et al.*'s (2013:308) longitudinal study on 687 (370 learners received intervention and 317 learners were used as the control group) elementary school learners in Northeast Kansas, USA, indicated that childhood overweight and obesity had a negative impact on academic performance. The longitudinal study of Zavodny (2013:145) involving children from kindergarten to eighth grade in the USA, also indicated no significant association among weight and standardised test scores (Mathematics, reading and science) in children, but found a significant association among teachers' assessments. In contrast with the above-mentioned studies, Falkner *et al.*'s (2001:37) study on 4 742 male and 5 201 female learners in the seventh, ninth and 11th grades in Connecticut, USA, found contradictory results, indicating no observable pattern regarding poor academic performance and overweight or obesity. These researchers also found that overweight among boys indicated a greater risk regarding academic performance than health-risk factors (Falkner *et al.*, 2001:37).

When considering SES groups, various researchers have found that SES plays an important role with regard to children's academic performance. A study by Sirin (2005:436) on 101 157 school aged children in the USA, reported that SES had a strong impact on children's academic achievements. Confirming this study, Caro *et al.* (2009:566) found in their study on Canadian children seven to 15 years of age, that children from high SES groups had higher academic achievements when compared to low SES groups (boys did not perform as well as girls in Mathematics). These researchers further reported that, as children (no matter the gender) got older, the more the SES affected them. Thus, children from low SES groups performed lower as they

progressed to the higher grades, with no gender differences stipulated (Caro *et al.*, 2009:566). Furthermore, Hair *et al.* (2015:427) found in their longitudinal cohort study on 301 children in the USA that children from low SES groups scored between 4% and 7% less on the standardised test than normal weight children. These researchers further found that children from low SES groups scored up to 20% less regarding academic achievements. Furthermore, Bhat *et al.*'s (2016:36) study on 120 children from the Ganderbal District of Jammu and Kashmir State, indicated that the children from high SES groups performed much better when compared to low SES groups, however, there was no significant differences between low and middle SES groups. Overweight and obesity are not the only conditions that affect children's academic performance, but stunting and wasting also do.

A study by Glewwe *et al.* (2001:364) on zero- to 13-year old Filipino children found that primary school enrolments of wasted children were delayed due to not being ready for school and boys tended to repeat grades more than girls. Alaimo *et al.*'s (2001:46) study on 15- to 16-year old children in the USA, found that children suffering from wasting showed negative cognitive and academic development. Furthermore, these children learned at a slower rate, had lower mathematic scores, were more likely to drop out of school and missed more school days when compared to their peers, with no gender differences reported. The same tendency was observed by Hughess and Bryan's (2003:419) systematic review on children six to 16 years old from different counties (Finland, Australia, Sweden and the USA) indicating that malnourished children tended to fail or drop out of school, because nutritional factors affected learning and academic achievement (iron, vitamin A and iodine deficits). A study by Cook & Jeng (2009:2) on American children (zero to 18 years) found that children suffering from wasting had lower academic achievement and depraved concentration (not only pre-school children but also school-aged children, with no gender differences indicated). The same tendency was found in children from Sri Lanka, aged six to 12 years of age, where these children (n=16 383) indicated poor academic achievement when wasting was present (Wisniewski, 2010:325).

Children suffering from severe stunting tested up to 10 points lower on the Weshsler Intelligence Scale for Children-Revised test (WISC-R) and that these children especially struggled with spelling and reading (Berkman *et al.*, 2002:567; Chang *et al.*, 2010:834). Golam *et al.* (2014:80) performed a study on primary school children in Bangladeshi, which indicated an association among wasting and academic performance and also showed that children with malnutrition performed not as well as normal weight children. Once again, no gender differences were highlighted. Furthermore, Sudfeld *et al.* (2015:2708) also reported that wasting and stunting were

positively associated with cognitive and communication development delays. Rashmi *et al.* (2015:99) found that the nutritional status of children (n=582) between the ages of five to 14 years, in Bangalore, India, was strongly associated with their academic performance and further indicated that children with wasting presented lower grades in Mathematics and their First Language subjects.

An intervention (breakfast program to ensure higher energy intake) study in Boston for learners in fourth to sixth grade, conducted by Kleinman *et al.* (2002:6), found that children with better nutrient intake were less likely to miss school and showed better grades (especially in Mathematics). Supporting these findings, Jyoti *et al.* (2005:2835) found that food insecurity would impair academic performance in aspects like reading and Mathematics among boys. Another intervention study on elementary school children (4 588 children) in Osceola, Florida reported that the intervention (food ingredients and whole food) group had higher Mathematics and reading scores when compared to the control (wasted) group (Hollar *et al.*, 2010:649). Prendergast and Humphrey (2014:257) also confirmed that children (from age two to adolescence) affected by stunting had lower cognition development and that these children tended not to enrol for school or enrolled later. This might be because these children looked immature. Additionally, they reported that these children had lower grades and poorer memory when compared to non-stunted children (Prendergast & Humphrey, 2014:257). Miller *et al.* (2015:1344) stated that stunting and severe stunting (among children in low- to middle income countries) were negatively associated with learning and affected not only these children's literacy skills, but also their numeracy development. Adding to this, Patil *et al.* (2016:3) indicated in their study (in Central India, on 200 children aged three to six years) that significant differences between academic grades, stunting and wasting among rural and urban children were found. Pearce *et al.* (2016:89) found the same tendency in their study on four- to six-year-old Australian children who were wasted. These researchers also reported that 4.1% of these children presented problems with Language, cognitive development, general knowledge and communication. The above-mentioned studies did not focus on gender differences, thus no gender differences could be highlighted.

Overweight, obesity, stunting and wasting are not only problems in the rest of the world, but also in South Africa. Themane *et al.*'s (2003:641) study on 1 033 children (464 girls and 569 boys) aged seven to 14 years, found an association between malnutrition, English and Mathematics performance only among the boys. The same tendency was found by Matabane *et al.* (2012:917) on 390 (180 girls and 210 boys) South African children, in Grade 4 to 7, in the Ellisras District, which also indicated a strong association between wasting and academic performance among boys

and girls, with the boys scoring less than the girls. Additionally, indicated by the last-mentioned researchers, stunting was only positively related to Mathematics and not to English performance. Casale *et al.* (2014:908) performed a study on South African children aged two, four and five years and reported that stunting affected schooling and cognitive performance during early school years. Additionally, these researchers reported that the impact of stunting on cognitive development among infants and preschool children was less known because of the challenges to measure in low and middle income countries. Furthermore, Skosana (2016:1) reported that stunted South African children showed lower cognitive development and that these children also achieved lower academic achievements when compared to non-stunted children.

From the literature, it seems that boys in general show lower academic achievements with regard to overweight or obesity. It is clear from the above that limited research has been done regarding the effect of overweight, obesity, stunting and wasting on academic performance, especially taking into account gender differences.

2.9 Summary

The objectives of this literature review were to provide an overview of overweight, obesity, stunting and wasting as well as the relevant terminology. The prevalence of overweight and obesity, the statistics regarding the classification thereof, internationally and nationally (South Africa), were discussed as well as the association between overweight/obesity and SES. From the literature, it is clear that the prevalence of overweight and obesity has shown a major increase globally. It was furthermore reported that overweight/obesity was more prevalent among the high SES groups as well as among Caucasian children when compared to other SES groups and ethnic groups. Furthermore, the prevalence of stunting and wasting was discussed with regard to international and South African statistics and the association thereof with SES. In contrast with overweight and obesity, stunting and wasting have overall shown a decrease regarding global prevalence, however, the prevalence among developing countries is still a major concern. With regard to ethnic groups and SES, the prevalence among African children and low SES groups was higher when compared to the other ethnic groups and SES groups.

The literature review has affirmed that overweight, obesity, stunting and wasting have significant associations with various aspects during childhood development. Psychosocial development, which further can be divided into subsections such as self-esteem/self-concept, depression and peer group relationships, is one of the aspects that are affected by overweight, obesity, stunting and wasting. The other aspects are health related, which were discussed in more detail:

lifestyle/health-related factors, cardiovascular diseases, asthma, diabetes, growth impairment and motor development.

Several psychological and health factors are associated with overweight, obesity, stunting and wasting. From the literature review, it is clear that overweight and obesity affect these children's self-esteem/self-confidence, peer group relationships and depression levels. It is reported that these children have lower self-esteem levels and peer group relationships which lead to higher levels of anxiety and depression. Psychological effects among stunted and wasted children are also an important aspect to take into consideration. Overweight and obese children may suffer from numerous health-related factors such as cardiovascular diseases, hypertension, diabetes, asthma and growth impairment. The literature has confirmed that overweight or obese children have a higher risk to develop the above-mentioned conditions when compared to normal weight children. The same tendency was found among stunted and wasted children as they are also at risk to develop the above psychological and health conditions.

Lastly, this literature review has revealed that overweight, obesity, stunting and wasting have major effects regarding academic performance or cognitive development. Overweight and obese children were reported to achieve lower academic scores, especially with regard to reading, Mathematics and English. Children who are stunted or wasted reported to also achieve lower academic scores, due to poor school attendance, late enrolment, low motivation and cognitive immaturity. These (overweight, obese, stunted and wasted) children's health and psychological conditions should also be taken into consideration with regard to their low academic achievements. The different researchers have reported controversial findings, however, children (not focusing on gender differences) who are overweight, obese, stunted or wasted are more likely to perform poorly in academics when compared to normal weight peers.

This literature review serves as background. Chapter 3 and 4 discuss the results accordingly.

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CHAPTER 3

LONGITUDINAL EFFECTS OF OVERWEIGHT AND OBESITY ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS: THE NW-CHILD STUDY

Longitudinal effects of overweight and obesity on academic performance of primary school boys: the NW-CHILD study

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Longitudinal effects of overweight and obesity on academic performance of primary school boys: the NW-CHILD study

Abstract

Background

Overweight and obesity affects millions of children worldwide, including their academic performance. The purpose of this study was to determine the effect of overweight and obesity on academic performance over a period of seven years among primary school boys in the North West Province of South Africa, taking into account socio-economic status (SES).

Methods

The study forms part of a seven year (2010-2016) longitudinal study, the North-West Child-Health-Integrated-Learning and Development (NW-CHILD) study, which includes a baseline measurement and two follow-up measurements of the 181 participating boys in different areas in the North West Province. Two-way frequency tables, repeated measure ANOVA's and Spearman rank order correlations were used to analyse the data.

Results

The Body Mass Index (BMI) reported an increase from 2010-2016. Nearly all the school subjects reported a small to large effect between BMI and academic performance ($r \geq 0.1$ and $r \geq 0.3$), except for Afrikaans in 2013 ($r = -0.06$). Only two subjects (English and Language as tested with the ANA test) reported medium effects ($r \geq 0.3$), whereas the other subjects only reported small effects ($r \geq 0.1$). No statistical significant relationships ($p \geq 0.05$) were observed between the BMI values and academic subjects, however SES and school subjects scores reported several statistical significant relationships, especially regarding Language (English and First Additional Language) and Mathematics ($p = 0.02$).

Conclusion

Overweight and obese primary school boys in the North West Province of South Africa reported higher academic performance when compared to normal weight boys even though SES was taken into consideration. Further studies are recommended to verify current findings with regard to overweight, obesity and academic performance.

Keywords: Academic performance, Boys, Obesity, Overweight, Primary school.

Introduction

Forty-two million children (under the age of five years) worldwide are overweight and obese; a global occurrence affecting children and adults (WHO 2014; UNICEF 2016). Overweight and obesity can be defined as excessive or abnormal accumulation of fat in the adipose tissue, which may lead to health related problems (WHO 2015). The prevalence of overweight and obesity is a problem locally (South Africa) and internationally.

Various researchers have confirmed a high prevalence of overweight and obesity among boys between the ages of five and 18 years in various parts of the world (Ahrens, Pigeot, Pohlabeln, De Henauw, Lissner, Molnár, Moreno, Tornaritis, Veidebaum, & Siani 2014; Pangani, Kiplamai, Kamau, & Onywera 2016; Zhang et al. 2015). These researchers have also reported prevalences for overweight among boys ranging from 11.8% - 16.33%, while the prevalence for obesity were slightly lower, ranging from 4.9% - 10.69%. Zhang and Wang (2013) did a trend analysis and reported that the prevalence for overweight in seven- to 18-year old boys in Shandong, China, increased from 6.5% in 1995 to 19.1% in 2010 and for obesity from 1.6% to 9.3% in the same period. Several longitudinal studies reported the increase in the prevalence of overweight and obesity over time (Chen, Fox, Ku, & Wang 2012; Cunningham, Kramer, & Venkat Narayan 2014; Ells et al. 2014). In this regard, Chen et al. (2012) reported that the prevalence of overweight/obesity increased over the period of six years among Taiwanese boys (from 18.8% at baseline to 35.0%). Furthermore, Cunningham et al.'s (2014) longitudinal study in the United States of America (USA) on children aged five to 14 years indicated that overweight and obesity prevalence (1.9%) was lower among the older boys, while kindergarten boys' prevalence of overweight and obesity (13.7%) were much higher. These researchers also found that if the boys were overweight at the age of five years, they are four times more likely to become obese, compared to normal weight children. In contrast, another longitudinal study conducted by Ells et al. (2014) on four- to five- and 10- to 11-year-old children in England, reported that the four- to five-year-old boys had a lower obesity prevalence (9.7%) compared to the 10- to 11-year-old boys (20.4%). With regard to race, overweight and obesity, various studies from the USA reported that African children had a higher overweight and obesity prevalence (ranging from 11.1% to 27.2%) when compared to Caucasian children (ranging from 5.5% to 17.94%) (Asieba 2016; Fradkin, Wallender, Elliott, Tortolero, Cuccaro, & Schuster 2015; Kuku, Garasky, & Gundersen 2012; Zinalawala, Davis-Kean, Nazroo, Sacker, Simonton, & Kelly 2015). Not only is race a contributing factor of overweight and obesity prevalence but so is SES. Researchers in the USA and the United Kingdom reported that children from low SES groups had higher overweight and obesity prevalence when compared to high SES groups (Fradkin et al. 2015; Rogers et al. 2015;

Zilanawala et al. 2015). Overweight and obesity is a worldwide epidemic, affecting developed and developing countries such as South Africa.

The South African prevalence of overweight and obesity is currently following the same trend as the rest of the world, although it is slightly lower. Various researchers have reported the prevalence for overweight in boys ranging from 6.4% - 15.6%, while the prevalence for obesity has been ranging from 3.2% - 10.9% (Armstrong, Lambert, Sharwood, Lambert 2006; Kemp, Pienaar, & Schutte 2011; Pienaar & Kruger 2014; Puckree, Naidoo, Pillay, & Naidoo 2011; Truter, Pienaar, & Du Toit 2010; Van den Berg & Meko 2015). This is in agreement with worldwide studies. Only a few longitudinal studies could be found that studied the prevalence of overweight and obesity in South Africa. One such study was done by Monyeki, Monyeki, Brits, Kemper and Makgae (2008) in the Ellisras District, Limpopo Province, on children three to 10 years old. These researchers found that the risk of overweight among primary school boys was 2.2%. They further indicated that 14.5% of pre-school boys (four to six years old) were overweight and none were obese, however, the results changed dramatically for primary school boys (nine- to 14 years old), with 24.6% being overweight and 1.2% obese (Monyeki et al. 2008). Pienaar (2015) also indicated that boys aged six to nine years, showed high obesity prevalence (3.2%). The Physical Activity and Health Longitudinal Study (PAHLS) on adolescents reported that an overall overweight/obesity prevalence of 15.4% was found and boys specifically reported a prevalence of overweight/obesity of 10.3% (Monyeki, Awotidebe Moss, Sparks, Wushe, Coetzee, Pienaar, Bruwer, de Ridder, Swanepoel, Du Toit, Glapa, Kemper, & Twisk 2017).

South Africa is a diverse country, regarding race, culture and SES. In the North West Province, the prevalence for overweight and obesity for boys ranged from 4.1% - 6.4% (overweight) and 1.5% - 4.0% (obese) (Kemp et al. 2011; Kruger, Kruger, & MacIntyre 2006; Pienaar & Kruger 2014; Truter et al. 2010). Furthermore, these researchers reported that overweight and obesity were more prevalent among Caucasian boys (ranging between 11.6% - 13.3% vs. 2.6% - 6.4%) when compared to African boys (ranging between 5.7% - 6.0% vs. 1.4% - 2.8%), all ranging between the ages of six to 13 years. Other researchers also reported the same tendency of Caucasian boys (ranging between 0.4% - 20.2% vs. 3.0% - 9.8%) representing a higher incidence of overweight and obesity when compared to African boys (ranging between 5.3% - 11.4% vs. 1.9% - 4.3%) in other provinces in South Africa (Armstrong et al. 2006; Jinabhai, Taylor, & Sullivan 2003; Kruger, Puoane, Senekal, & van der Merwe 2005; Reddy, Resnicow, James, Kambaran, Omardien, & MBewu 2008).

SES plays an important role in South Africa. Several studies in South Africa found that the occurrence of overweight and obesity among boys between the ages of one and 10 years was lower (15.3% vs. 3.7%) in rural areas or lower SES groups (Monyeki, van Lenthe, & Steyn 1999; Pienaar, Barhost, & Twisk 2013; Pienaar 2015; Steyn, Labadarios, Maunder, Nel, & Lombard 2005), when compared to high SES groups or urban areas (18.6% vs. 6.1%). The same tendency was found where children from lower SES groups (7.7% to 10%) had a lower occurrence of overweight and obesity compared to high SES groups (25.9% to 31.7%) in a longitudinal study in the North West Province among Grade 1 boys and six- to nine-year-old children (Pienaar 2015). This researcher also reported that the boys had lower overweight and obesity prevalence in 2010 (6.7% vs. 3.9%) when compared to 2013 (7.8% vs. 7.1%). From the above-mentioned literature, it can be seen that race and SES groups have a major effect on overweight and obesity in South Africa. It is further reported that overweight and obesity have a negative effect on academic performance (Donnelly et al. 2013; Geier et al. 2007; Zavodny 2013).

Various studies in the USA, Germany and Canada have found an association between childhood (children aged seven- to 16 years) overweight or obesity and poor overall academic results (specific subjects are Mathematics, reading and science) (Clark, Slate, & Vigliette 2009; Donnelly et al. 2013; Florin, Shults, & Stettler 2011; Geier et al. 2007; Judge & Jahns 2007; Mond, Stich, Kraemer, & Baune 2007; Roberts, Freed, & McCarthy 2010; Zavodny 2013). These studies also found an association between overweight and obesity, school attendance and lower cognitive abilities (visual perception, abstraction, memory and concentration). In contrast with the above-mentioned studies, Falkner, Neumark-Sztainer, Story, Jeffery, Beuhring, & Resnick (2001) found results, indicating no observable pattern regarding poor academic performance and overweight or obesity among boys in Grade 7, 9 and 11 in Connecticut, USA. Longitudinal studies on pre-school (four to six years old) and primary school (seven to 13 years of age) children found a significant association between childhood overweight and academic test scores, especially mathematic test scores (Datar, Sturm, & Magnaboscho 2004; Datar & Sturm 2006). These researchers also found that overweight boys' school life and attendance were affected negatively and these children tended to achieve lower grades compared to normal weight boys. Furthermore, another longitudinal study (Avon Longitudinal Study of Parents and Children) reported that overweight and obese children (eight- to 16 years old) had lower academic achievements when compared to normal weight children (Booth et al. 2014). Sirin (2005) reported that SES has a positive and strong impact on children's academic achievements. Various studies reported the same tendencies and added that high SES groups achieved higher academic marks compared to middle and low SES groups (Bhat, Joshi, & Wani 2016; Caro, McDonal, & Willms 2009; Hair, Hanson, Wolfe, &

Pollak 2015). Significant association between childhood overweight/obesity and academic performance was found thus internationally (although gender differences were not the main focus), however, to the researchers' knowledge, no published data regarding overweight and obesity's effect on academic performance in South Africa are available.

It is clear that overweight and obesity are not just worldwide phenomena, it is also a problem in South Africa. International statistics as well as South African statistics both indicate an increase in the prevalence of overweight and obesity among school children (especially boys). Overweight and obesity also have a severe impact on boys' academic performance, however, to the researchers' knowledge, there is no data to confirm or deny these findings among South African children. Only a few longitudinal studies have been done in this regard. Thus, the aim of this study was to determine the effect of overweight and obesity on academic performance over a period of seven years on primary school boys in the North West Province of South Africa, taking into account socio-economic status (SES).

Research method and design

The study formed part of a longitudinal research design, the North-West Child-Health-Integrated-Learning and Development (NW-CHILD) study and stretched over a period of seven years (2010-2016) which included a baseline measurement and two follow-up measurements. The baseline data was collected in 2010, the first follow-up measurement was done in 2013 and the second follow-up in 2016, in the different areas of the North West Province of South Africa. Only the data of the boys that took part in all three measurements was utilised for the purposes of this study.

A total of 419 Grade 1 boys in the North West Province of South Africa initially participated in this study as the target population in 2010. This group consisted of Caucasian, African, Mixed race and Indian boys. The boys were randomly selected from this list with regard to population density and school status, where Quintile 1 represented schools from poor SES areas and Quintile 5 represented schools from affluent SES areas. For the purpose of this study, Quintile 1 to 3 (n=92) were grouped together as the low SES group and Quintile 4 to 5 (n=89) as the high SES group. During the first follow-up measurements in 2013, only 282 boys were available. The last follow-up measurements were conducted in 2016, with the learners mainly in Grade 7. This group consisted of 181 (63 Caucasian and 118 African and Mixed race) boys. Furthermore, these boys were divided into Quintiles with 30 of the boys in Quintile 1, 33 in Quintile 2, 29 in Quintile 3, 48 in Quintile 4 and 41 in Quintile 5.

The anthropometric measurements included body mass (kg), height (cm), waist circumference (cm) and three skinfolds (sub-scapular, triceps and medial calf) (mm). The last-mentioned variables were measured by trained postgraduate students in Human Movement Sciences, specialising in Kinderkinetics. The anthropometrist took anthropometric measurements in each year throughout the study to ensure quality and for inter-tester reliability, in accordance with the protocol of the International Society for the Advancement of Kinanthropometry (Stewart, Marfell-Jones, Olds, & de Ridder 2011). Height was measured with a portable stadiometer to the nearest 0.1 cm and body mass was measured to the nearest 0.1 kg with an electronic scale (BF 511, Omron). Three skinfolds were taken, namely the sub-scapular (two centimetres from the sub-scapular landmark, running obliquely and laterally downwards) (Stewart et al. 2011) the triceps (is a parallel skinfold, taken along the long axis of the upper arm at the triceps skinfold site (Stewart et al. 2011) and medial calf (is a vertical measurement on the medial calf skinfold site) (Stewart et al. 2011). These skinfolds were measured with a pair of Harpenden skinfold callipers and each was measured twice to calculate an average measurement that was used for analysis. Each participant's body mass index (BMI) $[(\text{kg}/\text{height (m)}^2)]$ was calculated from the individual height and body mass measurements. The cut-off for indicating overweight was $21.9 \text{ kg}/\text{m}^2$ and $27.76 \text{ kg}/\text{m}^2$ for obesity (Cole et al. 2000). The prevalence of overweight and obesity was determined by using the International age and gender-specific cut-off points provided by Cole, Bellizzi, Flegal, & Dietz (2000) (see Table 1). Boys have a risk for overweight (85th), obesity (95th) and severe obesity (98th) when the BMI is on the mentioned percentile for age and gender. A BMI of $35 \text{ kg}/\text{m}^2$ was used in this study to determine severe obesity.

Table 1: Age specific BMI cut-off points for overweight and obesity (Cole et al. 2000).

Age (yrs.)	Body mass index: overweight 21.9 kg/m ²	Body mass index: Obesity 27.76 kg/m ²
	Boys	Boys
6	17.55	19.78
6.5	17.71	20.23
7	17.92	20.63
7.5	18.16	21.09
8	18.44	21.60
8.5	18.76	22.17
9	19.10	22.77
9.5	19.46	23.39
10	19.84	24.00
10.5	20.20	24.57
11	20.55	25.10
11.5	20.89	25.58
12	21.22	26.02
12.5	21.56	26.43
13	21.91	26.84
13.5	22.27	27.25

In Grade 1 (2010), during the June examinations, “The Mastery of Basic Learning Areas Questionnaire” was used to determine the academic performance of the different learning areas. A four-point scale was used, with (1) indicating not achieved, (2) partially achieved, (3) achieved and (4) outstanding achievement. Lastly, a cluster point was calculated from three variables: reading, writing and Mathematics. In Grade 4 (2013), the June examination results were collected from all participating schools and the same procedure was followed in 2016, when most learners were in Grade 7. The learning areas according to the Department of Basic Education’s Curriculum and Assessment Policy Statements (CAPS) are: Mathematics, Home Language, Second Additional Language, Life Orientation (LO), Natural Science (NS), Social Science Technology, Creative Arts and Economic Management Science. Academic performances regarding Annual National Assessments (ANA) of September 2010 and 2013 were collected from all the learners who participated in this study. The ANA results of 2016 were also collected after the learners had completed the ANA examination in September 2016. The Language and Mathematics results of the learners were made available by the Department of Basic Education. All learning areas mentioned were assessed with the ANA grading scales (See Table 2). The rating code and percentages were used according to the ANA assessments.

Table 2: Grading scales for ANA assessments.

Rating code	Description of competence	Percentage
7	Outstanding achievement	80-100
6	Meritorious achievement	70-79
5	Substantial achievement	60-69
4	Adequate achievement	50-59
3	Moderate Achievement	40-49
2	Elementary achievement	30-39
1	Not achieved	0-29

During this study, STATISTICA StatSoft (2017) was used to analyse the data. Firstly, descriptive data was analysed and means and standard deviations were calculated. Repeated Measures ANOVA's were used for over time data to determine the difference between the different socio-economic status (SES) and the boys' body composition (BMI) as well as their academic performance (2010-2016). Two-way tables were used to determine any relationships and changes that may have occurred over time regarding overweight, obesity, SES and to compare the classifications of the different quintiles. Pearson Chi-square was used to indicate the significance of these associations (BMI and academic performance) and the level of statistical significance was set at $p \leq 0.05$. The strength of the relationship was indicated by phi-coefficient, with $w \approx 0.1$ indicating a small effect, $w \approx 0.3$ a medium effect and $w \geq 0.5$ a large effect. Lastly, Spearman rank order correlations between BMI and academic performance were determined. The strength of the correlation was set at $r \approx 0.1$, indicating a small effect, $r \approx 0.3$, indicating a medium effect and $r \approx 0.5$, indicating a large effect (Cohen 1988).

Results

The group of boys ($n=181$) consisted of 63 Caucasian and 118 African and Mixed race boys (last two groups were combined to a small sample size). Table 3 reports descriptive statistics for 2010, 2013 and 2016, with regard to age, stature, weight and BMI. Table 3 reports that boys' stature and BMI gradually increased with every measurement (from 2010 to 2016). Also reported in this table is the fact that the weight had a greater increase between 2013 ($M=32.6$) and 2016 ($M=45.3$) when compared to 2010 ($M=23.1$).

Table 3: Descriptive statistics from 2010 to 2016.

Variable	N	Mean	Minimum	Maximum	SD
2010					
Age	181	6.9	6.0	7.8	0.4
Stature	181	120.8	102.1	141.7	6.5
Weight	181	23.1	16.4	45.9	5.0
BMI	181	15.7	12.6	26.8	2.2
2013					
Age	181	9.9	9.0	10.7	0.4
Stature	181	136.1	117.0	161.0	6.9
Weight	181	32.6	19.6	65.6	8.8
BMI	181	17.5	12.9	30.8	3.4
2016					
Age	181	12.9	11.9	13.7	0.4
Stature	181	152.6	131.9	178.8	9.2
Weight	181	45.3	23.1	100.8	13.5
BMI	181	19.3	14.0	36.5	4.2

N= number of participants; SD standard deviation

Two-way tables were used to determine changes that might have occurred over time between SES and BMI. Table 4 reports that, in 2010, the high SES group had higher overweight (17.98%) and obesity (4.49%) prevalence when compared to the low SES group. The same tendency was found in 2013 and 2016, however, more boys were obese in 2013 (12.36%) among the high SES group when compared to 2010 (4.49%). Furthermore, in 2016, the high SES group had more boys who were overweight (23.06%) compared to 2010 and 2013. Table 4 displays that, in 2013, one less overweight boy was reported, when compared to 2010, however, the overweight percentage was higher in 2016 when compared to 2013. Furthermore, the percentage of normal weight boys decreased from 2010 to 2013. The same tendency was reported from 2013 to 2016. Lastly, obesity showed an increase from 2010-2013, however, a decrease was observed from 2013-2016. Statistical and practical significance was found among the high SES group ($p \leq 0.001$ and $w = 0.28$) and obese boys in 2010, in 2013 ($p \leq 0.001$ and $w = 0.34$) and 2016 ($p \leq 0.001$ and $w = 0.35$).

Table 4: Two-way frequency table for socio-economic status (SES) and BMI categories over time (2010-2016).

2010	Normal	Overweight	Obese	Overall	2013	Normal	Overweight	Obese	Overall
Low	88	2	2	92	Low	87	1	4	92
SES	95.65%	2.17%	2.17%	50.83%	SES	94.57%	1.09%	4.35%	50.83%
High	69	16	4	89	High	62	16	11	89
SES	77.53%	17.98%	4.49% ^{▲#}	49.17%	SES	69.66%	17.98%	12.36% ^{▲#}	49.17%
Overall	157	18	6	181	Overall	149	17	15	181
	86.74%	9.94%	3.32%	100%		82.30%	9.40%	8.30%	100%
2016	Normal	Overweight	Obese	Overall					
Low	86	2	4	92					
SES	93.48%	2.17%	4.35%	50.83%					
High	60	21	8	89					
SES	67.42%	23.60%	8.99% ^{▲#}	49.17%					
Overall	146	23	12	181					
	80.66%	12.71%	6.63%	100%					

p≤0.05^{*}; p≤0.01[▲]; and w≥0.3[#] SES = socio-economic status

Two-way frequency tables were also used to determine the changes of overweight and obesity among the racial groups (Caucasian, African and Mixed race). Table 5 indicates that, in 2010 (17.46%), 2013 (15.87%) and 2016 (25.40%), Caucasian boys were more overweight and obese when compared to both African and Mixed race boys (5.98%, 5.93% and 5.93% respectively). Furthermore, Caucasian boys showed a decrease in their normal weight from 2010 (79.37%) to 2016 (65.08%) and these boys' overweight prevalence decreased from 2010 to 2013 (17.46% to 15.87%), however, an increase in 2016 (15.85% to 25.40%) was evident in this group. The obesity prevalence among Caucasian boys showed an increase from 2010 (3.17%) to 2013 (11.11%) but a decrease in 2016 (11.11% to 9.52%). African and Mixed race boys indicated a decrease from 2010 (90.68%) to 2013 (87.29%) in their normal weight, with a slight increase in 2016 (87.29% to 88.98%). Table 4 indicates that African and Mixed race boys had a consistent number of overweight boys (n=7), however, their obesity prevalence increased from 2010 (3.39%) to 2013 (6.78%), but showed a decrease in 2016 (6.78% to 5.08%). Furthermore, statistical and practical significance was found among the African and Mixed race group (p=0.05 and w=0.18) and obesity group in 2010. The same tendency was found in 2013 (p=0.05 and w=0.19) and 2016 (p=0≤.001 and w=0.30).

Table 5: Two-way frequency table for race and BMI over time (2010-2016).

2010	Normal	Overweight	Obese	Overall	2013	Normal	Overweight	Obese	Overall
Caucasian	50	11	2	63	Caucasian	46	10	7	63
	79.37%	17.46%	3.17%	34.8%		73.02%	15.87%	11.11%	34.8%
African					African				
and	107	7	4	118	and	103	7	8	118
Mixed	90.68%	5.98%	3.39%*	65.2%	Mixed	87.29%	5.93%	6.78%*	65.2%
race					race				
Overall	157	18	6	181	Overall	149	17	15	181
	86.74%	9.9%	3.3%	100%		82.32%	9.4%	8.3%	100%
2016	Normal	Overweight	Obese	Overall					
Caucasian	41	16	6	63					
	65.08%	25.40%	9.52%	34.8%					
African									
and	105	7	6	118					
Mixed	88.98%	5.93%	5.08% [▲]	65.2%					
race									
Overall	146	23	12	181					
	80.66%	12.71%	6.62%	100%					

p≤0.05*, p≤0.001[▲] and w≥0.3[#]

Repeated measure ANOVA's were used to determine the longitudinal effect of BMI and academic performance, taking into consideration SES. A positive correlation was observed between BMI and SES ($r=0.74$) and not race, therefore only SES is discussed. Table 6 shows a statistical significance in 2010 between numeracy ($p=0.03$), reading ($p=0.03$), writing ($p=0.05$) and the average academic mark ($p=0.02$) with SES. In 2013, only one subject reported a statistical significance with SES, namely English ($p=0.02$). Various subjects in 2016 reported a statistical significance with SES: Mathematics ($p=0.02$), average academic mark ($p=0.001$), First Additional Language (department) ($p=0.002$), Mathematics (department) ($p=0.02$) and average academic mark (department) ($p=0.00$). Furthermore, only one subject reported a statistical significance with SES and BMI: First Additional Language (department) ($p=0.04$). Effect sizes were further determined to establish the effect among normal weight, overweight, obesity and SES. Only reading reported a medium effect ($d=0.52$) among normal weight boys and SES. The same was reported in 2013, where only one subject reported a medium effect ($d=0.57$), however, this time between Mathematics and SES. In 2016, Mathematics and Mathematics (department) reported a large effect among normal weight ($d=0.84$ and $d=0.87$ respectively). Furthermore, a medium effect ($d=0.55$) was reported between Home Language (department) and normal weight. The same tendency was reported among the average academic mark and obesity ($d=0.57$). Lastly, a small effect size was reported between Home Language and overweight boys ($d=0.26$).

Table 6: Repeated measure ANOVA per subject, per year from 2010-2016.

	Subjects	Normal		Overweight		Obesity		MSE	p-values			Effect size of SES		
		Low SES	High SES	Low SES	High SES	Low SES	High SES		BMI	SES	BMI & SES	Normal	Overweight	Obesity
2010	Numeracy	69.32	83.33	62.50	89.06	87.50	93.75	337.4	0.21	0.03*	0.59	0.76	1.45	0.34
	Reading	62.22	73.19	50.00	85.94	75.00	81.25	447.5	0.54	0.03*	0.29	0.52▲	1.70	0.30
	Writing	67.61	74.28	62.50	89.06	75.00	87.50	398.9	0.43	0.05*	0.42	0.33	1.33	0.63
	Average	66.38	76.93	58.33	88.02	79.17	87.50	324.1	0.34	0.02*	0.38	0.59	1.65	0.46
2013	English	42.48	67.45	58.00	65.50	47.50	58.18	247.8	0.63	0.02*	0.20	1.59	0.48	0.68
	Mathematics	56.52	65.57	57.00	69.19	48.25	60.82	256.1	0.39	0.08	0.92	0.57▲	0.76	0.79
	Language (ANA)	41.68	69.50	-	67.75	40.00	64.91	271.5	0.58	-	0.79	1.69	-	1.51
	Mathematics (dep.)	39.36	59.70	80.00	65.25	47.33	53.82	308.8	0.05	0.58	0.09	1.16	0.84	0.37
	Home Language	56.99	63.34	56.50	59.95	54.25	54.43	178.4	0.39	0.45	0.75	0.48	0.26•	0.01
2016	1 st Additional Language	49.02	63.44	47.00	64.40	60.25	52.86	222.5	0.99	0.10	0.08	0.97	1.17	0.50
	Mathematics	44.20	58.00	48.00	59.70	36.25	47.71	269.1	0.20	0.02*	0.96	0.84■	0.71	0.70
	Average	49.29	62.83	47.22	63.45	48.10	55.21	126.6	0.48	0.001*	0.64	1.20	1.44	0.63
	Home Language (dep.)	51.36	59.42	47.99	61.80	52.00	49.97	217.3	0.66	0.17	0.49	0.55▲	0.94	0.14
	1 st Add. Language (dep.)	44.52	56.77	24.00	62.26	51.50	50.54	250.2	0.46	0.002*	0.04	0.77	2.42	0.06
	Mathematics (dep.)	41.03	57.71	38.50	58.73	36.75	43.19	364.0	0.32	0.02*	0.68	0.87■	1.06	0.34
	Average	41.80	58.00	33.33	60.85	41.54	47.72	117.9	0.28	0.00*	0.13	1.49	2.53	0.57▲

p≤0.05*; SES- socio-economic status; • small effect size; ▲ medium effect size; ■ large effect size; 1st Add. Language (dep) = First Additional Language

(department); dep. – department

Lastly, Spearman Correlations were used to determine the relationship between academic performance and BMI. Race had no significant correlation ($r \leq 0.1$) to academic achievements, thus, only BMI is reported. Table 7 indicates a positive correlation between BMI and academic subjects. Statistical ($p < 0.05$) and small ($r \geq 0.1$) to medium ($r \geq 0.3$) practical significant correlations were found between most of the subjects and BMI of the boys. Only Afrikaans (2013) did not have a positive correlation ($r = -0.06$) with BMI. Table 7 also indicates that boys with a higher BMI value performed better in their academic subjects when compared to their other peers. In 2013, the Language (ANA), English and BMI association was much higher with a medium ($r \geq 0.3$) practical effect, when compared to 2010 and 2016. All the other subjects indicated a small ($r \geq 0.1$) practical significance.

Table 7: Spearman rank order correlations on academic performance (per subject) and BMI.

Year	Academic subjects	High BMI
1 (2010)	ANA Numeracy (%)	0.19 [#]
	ANA Reading (%)	0.17 [#]
	ANA Writing (%)	0.19 [#]
	Average	0.21 [#]
2 (2013)	Language (ANA)	0.30 ^{##}
	Mathematics (%)	0.28 [#]
	Afrikaans	-0.06
	English	0.31 ^{##}
	Mathematics	0.16 [#]
	Average	0.28 [#]
3 (2016)	ANA Home Language	0.13 [#]
	ANA First Additional Language	0.28 [#]
	ANA Mathematics	0.20 [#]
	Average	0.31 ^{##}
	Home Language (department)	0.16 [#]
	First Additional Language (department)	0.29 [#]
	Mathematics (department)	0.27 [#]
	Average	0.37 ^{##}

* $p < .05$; Practical significance: $r = 0.1$ # small effect, $r = 0.3$ ## medium effect; BMI- Body Mass Index

Discussion

The aim of this study was to determine the effect of overweight and obesity on the academic performance of primary school boys in the North West Province of South Africa over a period of seven years (2010-2016), taking SES into account.

In this study, it has become prevalent that the BMI values of the boys increased over a period of seven years (2010-2016) from 15.7 in 2010 to 17.5 in 2013 and 19.3 in 2016. These findings are consistent with 25 other countries' results (school-aged children) such as North America (USA and Canada), South America (Brazil and Chile), Western Pacific region (Japan and Australia) and

Europe (Finland, Germany, Spain and Greece) (Wang & Lobstein 2006). The same tendency was also reported by Zhang and Wang (2013) in Shandong, China, with the prevalence of overweight in boys (seven- to 18 years of age) increasing from 6.5% in 1995 to 19.1% in 2010. Additionally, a study done in Thailand, reported that there was an increase in the prevalence of overweight (10.0%) and obesity (4.4%) among older boys between the ages of 12 to 15 years (Pengpid & Peltzer 2013). A supporting study, The IDEFICS (Identification and prevention of Dietary- and lifestyle-induced health Effects in Children and infants study), done on two- to nine-year old children in Spain, Cyprus, Sweden, Belgium, Germany, Hungary, Italy and Estonia found that the overall prevalence for overweight and obesity among boys was 11.8% and 6.8% respectively (Ahrens et al. 2014). In the same study, it was found that the overall overweight and obesity prevalence was higher among the following countries: Italy (42.4%), Cyprus (23.4%) and Spain (21.2%), whereas Belgium (9.4%) and Sweden (11.0%) had the lowest prevalence of overweight and obesity. These results support the current findings as most of these countries are mainly have different socio-economic challenges, similar to South Africa (Ahrens et al. 2014). These findings strengthen this study as none are longitudinal and this study focused specifically on the changes that occurred over time (seven years).

The incidence of overweight and obesity in this study between the different SES groups has indicated that boys from higher SES groups had higher overweight (ranging from 17.98% - 23.60%) and obesity (ranging from 4.49% - 8.99%) percentages when compared to low SES groups (overweight: 1.09% - 2.17% and obesity: 2.17% - 4.35%). This study showed that the boys' overweight percentages increased with nearly 6% from 2010 (17.98%) to 2016 (23.60%) among the high SES group while the boys from the low SES groups showed a consistent percentage (2.17%). Furthermore, this study reveals that the obesity percentages have increased with nearly 8%, from 2010 (4.49%) to 2013 (12.36%). However, from 2013 (12.36%) to 2016 (8.99%), a 3.35% decrease in obesity among boys from the high SES groups was observed, whereas the boys from the low SES groups reported an increase in obesity from 2010 (2.17%) to 2013 (4.35%). The results further indicate that, even though there was a decrease in the obesity in the high SES boys, their prevalence was still higher than boys from low SES. The findings in this study may be due to the high SES groups having more availability to food and/or having the financial support to purchase food when compared to the low SES groups. Furthermore, the slight decrease in overweight among the high SES groups might have been due to more physical activity or knowledge with regard to healthy living. These findings are in agreement with other South African studies with regard to boys from high SES groups who tend to report higher overweight and obesity

levels when compared to low SES groups (Pienaar 2015; Steyn et al. 2005). Steyn et al. (2005:9) reported that overweight and obesity prevalence from lower SES groups (9.63% and 15.3% respectively) were lower when compared to high SES groups (9.97% and 18.6% respectively). Pienaar (2015), with regard to BMI values, observed the same tendency and reported that lower SES (16.7%) groups had lower BMI values when compared to high SES groups (18.6%).

This study further revealed that Caucasian boys had higher overweight and obesity percentages when compared to the African and Mixed race boys. Caucasian boys reported a slight decrease in their overweight percentages from 2010 (17.46%) to 2013 (15.87%), however in 2016 (25.40%) the overweight percentages increased with nearly 10%, while the African and Mixed race boys showed a consistent percentage from 2010-2016 (5.93%). Obesity on the other hand showed an increase by 8% from 2010 (3.17%) to 2013 (11.11%) and a decrease of percentage from 2013 (11.11%) to 2016 (9.52%) among the Caucasian boys, while the same tendency was observed among the African and Mixed race boys, a slight increase from 2010 (3.39%) to 2013 (6.78%) and then a decrease in 2016 (5.08%). Obesity awareness and risk factors associated with obesity, more physical education and exercise exposure for children in school and home environment with dietary guidelines and intervention might have been possible reasons for the decline in the obesity prevalence (American Academy of Pediatrics 2006; Chang, Gertel-Rosenberg, & Snyder 2014; Guerra, da Silveira, & Salvador 2016). These results are coherent with previous studies done in South Africa, reporting that Caucasian boys have higher overweight and obese prevalence when compared to other racial groups such as African and Mixed race boys (Jinabhai et al. 2003; Kemp et al. 2011; Pienaar & Kruger 2014; Reddy et al. 2008). Kruger et al.'s (2005) study reported that Caucasian boys 10 to 15 years old had a higher overweight (11.6%) and obesity (2.6%) prevalence compared to African boys from the same age group (5.7% and 1.4% respectively). Although these boys were a bit older, it still provides a clear indication of the prevalence. In a study done by Armstrong et al. (2006) on six- to 13-year-old children, the prevalence of overweight and obesity among the Caucasian boys (15.4% and 4.3%) was higher than those of African (7.6% and 2.1%) and Mixed race boys (8.7% and 3.0%) boys.

The repeated measure ANOVA reported that SES had a greater significance ($r=0.74$) than race when associated with academic subjects. During the first measurement in 2010, all subjects (numeracy, reading and writing) reported significance with SES overall. In 2013, only English had a significance, while in 2016, Mathematics, average academic score, First Additional Language (department), Mathematics (department) and average academic marks reported significance with

regard to low SES. To confirm the findings of a significant association between academic performance and SES, Caro et al. (2009) reported on seven- to 15-year old children (Canada's National Longitudinal Study of Children and Youth) that low SES has a major effect on academic performance, especially Mathematics. The same tendency was reported among primary school boys in the United States of America (Hair et al. 2015; Sirin 2005) and the Ganderbal District in India (Bhat et al. 2016). Lastly, concerning the academic performance and the effect that BMI might have on it, it was clear that the boys with higher BMI values performed better in Language and Mathematic subjects. In 2010, a positive correlation with a small effect ($r=0.1$) was observed in all three major assessment areas (literacy, numeracy and reading) and BMI. The same tendency was observed in 2013, where nearly all the subjects reported a small effect with a positive correlation ($r=0.1$). Language (as tested with the ANA test) and English was the only two subjects that had a positive correlation with a medium effect ($r=0.3$). However, Afrikaans is the only subject that reported no correlation ($r=-0.06$) with regard to the BMI values. Furthermore, in 2016, all the subjects reported a small effect ($r=0.1$). The results of this study are contradicting with other studies (Booth et al. 2014; Clark et al. 2009; Datar et al. 2004; Datar & Sturm 2006; Donnelly et al. 2013; Florin et al. 2011; Geier et al. 2007; Judge & Jahns 2007; Mond et al. 2007; Roberts et al. 2010) with regard to overweight and obese children (in this study, boys) where the results reported a higher the BMI value, performed better at school. Supporting our findings, a study in Connecticut, USA, on 4 742 male learners in the 7th grade reported no noticeable pattern regarding poor academic performance and overweight/obesity (Falkner et al. 2001). Additionally, Kaestnera and Grossman (2009) found in their study on children aged five to 12 years, that overweight or obese boys had no significant association with academic test scores and the same tendency was reported among fifth grade boys from Kuwait (Abdelalim, Ajaj, Al-Tmimy, Alyousefi, Al-Rashaidan, Hammoud, & Al-Taiar 2011). Baxter, Guinn, Tebbs, & Royer (2013) also reported in their study in Columbia, South Carolina, on 1 504 children in fourth grade (808 girls and 696 boys), that no significant association was found regarding BMI and poor academic performance, however, an association among boys between academic performance, SES and race was found. Furthermore, a study by Shah and Maiya (2017) on 1 034 school children (aged five to 11 years and 12 to 18 years) in the Anand District reported that the boys, five to 11 years with high BMI values, had lower academic performance. Confirming the last-mentioned study in Saudi Arabia, on the same age group, no correlation between the BMI and school performance was found (Alswat, Al-Shehri, Aljuaid, Alzaidi, & Alasmari 2017).

Conclusion

This study was conducted over the course of seven years (2010-2016), thus being one of the few longitudinal studies in South Africa, regarding overweight, obesity and academic performance, taking into consideration SES. The study reported that primary school boys with high BMI values (thus being overweight or obese) had higher academic achievements when compared to normal weight boys, however BMI is not the only factor contributing to academic performance, as SES also had an influence. In this study, it is found that SES had a greater influence on academic performance when compared to BMI. Boys from low SES groups had lower academic performance when compared to boys from high SES groups. The study also found only one subject that reported to have significance with BMI and SES. This study reported valuable findings, however, strengths and limitations formed part of all studies. The study selected learners on a random selection basis, which helped with generalisation of the results, but was have been challenging due to the small sample size of only 181 boys. Valuable data was obtained with regard to overweight/obesity and academic performance due to the longitudinal effect of the study, which followed the boys throughout their primary school career. More studies are recommended among all nine provinces in South Africa as the current study only focused on the North West Province. As seen from the literature, it is clear that overweight and obesity affect academic performance, however, the findings reported the contrary. It is thus recommended that further studies be conducted, especially longitudinal studies in the South African setting with regard to overweight, obesity and academic performance to support the findings.

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CHAPTER 4

LONGITUDINAL EFFECTS OF STUNTING AND WASTING ON ACADEMIC PERFORMANCE OF PRIMARY SCHOOL BOYS: THE NW-CHILD STUDY

Longitudinal effects of stunting and wasting on academic performance of primary school boys: the NW-CHILD study

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Longitudinal effects of stunting and wasting on academic performance of primary school boys: the NW-CHILD study

Abstract

Background

A worldwide occurrence like stunting and wasting affects both children's health and academic performance. This study focused on determining the effect of stunting and wasting on academic performance among primary school boys over a period of seven years (2010-2016) in the North West Province of South Africa.

Methods

The study forms part of a longitudinal research design, the North-West Child-Health-Integrated-Learning and Development (NW-CHILD) study and stretched over a period of seven years from 2010-2016. Baseline measurements and two follow-up measurements of boys (n=181) formed part of this study. Two-way frequency tables and ANOVA's were used to analyse the data ($p \leq 0.05$).

Results

The prevalence of stunting (3.32% to 6.63%) and wasting (3.86% to 6.63%) increased each year from 2010-2016. Language, Mathematics and overall average academic scores were affected statistically by stunting and wasting ($p \leq 0.05$). Over a period of seven years (overall), it was found that stunting and wasting had an effect on academic performance, especially concerning Language and Mathematic subjects.

Conclusion

Stunted and wasted primary school boys in the North West Province of South Africa reported a strong negative association with academic performance, especially Language and Mathematic subjects. Limited data is available concerning stunting, wasting and academic performance and further studies are therefore recommended to strengthen and support the findings of this study with regard to a better understanding of the effect.

Keywords: Academic performance, Boys, Primary school, Stunting, Wasting.

Introduction

Fifty million children under the age of five years worldwide are affected by wasting while 16 million of these children are severely wasted (WHO 2016). Wasting refers to the inadequate mass for height (too thin for height) (Victora 1991; WHO 2016) and can be indicated by a Z-score (less than -2 standard deviations) using BMI-for-age and percentiles below five (De Onis, Onyango, Borghi, Garza, & Yang 2006). In recent years it seems as though wasting is decreasing worldwide, however, the prevalence of wasting remains a problem (UNICEF 2016).

Several studies reported that the prevalence of wasting among boys between the ages of five and 12 years, from different countries (South Nigeria, Ethiopia, Pakistan, Australia and Egypt), is still a major concern (Ene-Obong, Ibeanu, Onuoha, & Ejekwu 2012; Kuringen & Nieuwerkerken 2015; Mushtaq, Gull, Khurshid, Shahid, Shad, & Siddiqui 2011; Pearce, Scalzia, Lyncha, & Smithers 2016; Rashmi, Shweta, Fathima, Agrawal, Shah, & Sequeira 2015; Sharaf & Rashad 2016). These researchers indicated that the overall prevalence of wasting ranges from 6.0% - 54.3%, while children (19.0%) tend to have a higher prevalence of wasting compared to adolescents (8.3%). Furthermore, children younger than five years may suffer from moderate to severe wasting. Additionally, various researchers reported that children from rural areas (33.0%) had a higher prevalence of wasting when compared to children from urban areas (20.0%) in Pakistan and Central India (Mushtaq et al. 2011; Patil, Thakre, Khamgaonkar, & Thakre 2016). In a trend analysis, it was confirmed that wasting was more prevalent among boys (8.6% in 2009) when compared to girls (5.6% in 2009) (Matanda, Mittelmark, & Kigaru 2014). These researchers also reported that the boys from rural areas (8.8%) had higher wasting prevalence when compared to urban areas (7.4%). However, these researchers indicated that wasting among the different demographic settings (in Kenya) decreased from 1998-2009 (9.4% to 8.8%). Confirming the latter results, higher wasting prevalence was found among boys (2.8%) in rural areas (13.7%) when compared to urban areas (11.1%) in Argentina (Nuñez, Fernández-Slezak, Farall, Szretter, Salomón, & Vallengia 2016).

Various researchers have reported that the prevalence of wasting in South Africa (North West Province, Northern Cape Province and South Africa based on consensus data) ranges from 1.4% to 23.4% (Kruger et al. 2012; Kruger, Pienaar, Coetzee, & Kruger 2014; Walsh, Dannhauser, & Joubert 2001) and that wasting is more prevalent among African children when compared to Caucasian children.

Research regarding the prevalence of wasting was more prevalent in rural areas when compared to urban areas, ranging from moderate to severe wasting (Steenkamp, Lategan, & Raubenheimer 2016; Tomlinson, Hartley, Le Roux, & Rotheram-Borus 2016). In Monyeki, Monyeki, Brits, Kemper, & Makgae's (2008) longitudinal study (1996 to 2003) on children aged three to 10 years in the Ellisras District of South Africa, it was found that boys' prevalence of wasting ranged as follows: mild (23.6%), moderate (14.9%) and severe (43.6%). The boys presented higher wasting percentages and persistence when compared to the first measurement. According to Benefice, Monroy, Jimenez, and Lopez (2006), children who are wasted may have long-term consequences such as stunting.

Stunting is a global problem and affects millions of boys worldwide (UNICEF 2016). Stunting refers to a child's Z-scores of height-for-age ratio below minus two (-2) standard deviations (SD) from the median according to the World Health Organization (WHO) Child Growth Standards (WHO 2014). Studies (from developed and developing countries) have reported that the prevalence of stunting in children between the ages of five to 19 years ranges from 17.4% to 27.0%, with 22.2% of children being severely stunted (with boys being more stunted than girls) (De Onis, Blössner, & Borghi 2011; Senbanjo, Oshikoya, Odusanya, & Njokanma 2011). De Onis et al. (2011) also reported in 2010, that 167 million children from developing countries were stunted. These researchers further indicated that the prevalence of stunting among the African region has increased over the past decade (in developed and developing countries). Furthermore, the WHO (2015) reported that, globally, almost one in every four children (156 million) below five years of age (thus adding up to 23% of children) were stunted and that the highest prevalence of stunting was observed in the African Region (38%).

Studies from Africa, more specifically South Africa, reported that the prevalence of stunting also affects boys. In this regard, researchers have reported that boys younger than five years of age are more affected by stunting than school children and the prevalence of stunting ranges between 0% - 43.6% among boys (aged six to 13 years) in the Ellisras District (Motswagole, Kruger, Faber, & Monyeki 2012). A study by Shisana (2014) reported the prevalence of stunting among the different provinces of South Africa, indicating the following: the North West with 23.7%, Mpumalanga with 23.1%, and Northern Cape Province with 22.8% of children being stunted. Furthermore, these researchers indicated that boys from rural areas (23.2%) are more affected by stunting when compared to boys from urban areas (13.6%) (Shisana 2014). Results from the Western Cape, Northern Cape and Free State reported that 47% of children were moderately stunted and 32%

were severely stunted (Steenkamp et al. 2016). With regard to longitudinal studies in South Africa, the Ellisras District Transition and Health during Urbanisation of South Africans (THUSA BANA) study indicated that stunting among boys ranged from 8% to 47.6% in the North West province (Monyeki et al. 2008). Another study by Kruger *et al.* (2014) in the North West Province reported that 4.29% of the children were stunted, with 4.06% of them being boys. Adding to this, these researchers reported that African Grade 1 learners had a higher stunting prevalence when compared to Caucasian learners (6% vs. 0%). The Ellisras Longitudinal Growth and Health Study (ELS) in the Limpopo Province reported an overall prevalence of stunting being 6.1%, while 13.7% of the boys in this study were stunted (Motswagole et al. 2012). Stunting is dramatically affecting children internationally and locally, but stunting and wasting also affect children's academic performance.

There was a strong correlation found among stunted and wasted children and their academic performance. Studies done in Sweden, Australia, Finland and the United States of America indicated that wasted children had poor cognitive and academic development, higher dropout or failure rates, higher absenteeism from school, lower mathematic marks and learned at a slower rate when compared to their peers (Alaimo, Olson, & Frongillo 2001; Hughess & Bryan 2003). Several studies have found a significant association between wasting and lower academic performance among children between the ages of three to 14 years in Bangladesh and Sri-Lanka (Cook & Jeng 2009; Golam, Saimul, Enamul, Ashrufel, Asma, Kamruzzaman, & Saw 2014) as well as poor concentration (Wisniewski 2010). Wasting and stunting were reported to be positively associated with lower grades in Mathematics and Language subjects as well as cognitive and communication development (Hollar, Messiah, Lopez-Mitnik, Hollar, Almon, & Agatston 2010; Pearce et al. 2016; Sudfeld et al. 2015). Moreover, children (Peru and Jamaica) suffering from severe stunting tested up to 10 points lower on the Weshsler Intelligence Scale for Children-Revised test and these children especially struggled with spelling and reading (Berkman, Lescano, Gilman, Lopez, & Black 2002; Chang, Walker, Grantham-McGregor, & Powell 2010). Prendergast and Humphrey (2014) reported in their review article, that various studies confirmed that children affected by stunting do have lower cognitive development and these children tend not to enrol for school or enrol much later. This may be due to these children looking immature. Furthermore, these researchers indicated that stunted children have lower grades and have a lack of sufficient memory when compared to non-stunted children (Prendergast & Humphrey 2014). Miller, Murray, Thomson, and Arbour (2015) reported that stunting and severe stunting were

negatively associated with learning and affect not only these children's literacy skills, but also their numeracy development (Patil et al. 2016).

Stunting and wasting's effect on children worldwide was observed and the same tendency can be observed in South Africa. According to Casale, Desmond, and Richter (2014), children younger than five years' and primary school children's schooling and cognitive development are affected by stunting. Longitudinal studies done in the rural areas of Ellisoras in South Africa reported a positive association between wasting and English and Mathematics performance among Grade 4 to 8 learners (Themane, Monyeki, Nthangeni, Kemper, & Twisk, 2003; Matabane, Liebenberg, & Monyeki 2012). Moreover, these researchers also reported a negative association between academic intelligence performance and growth parameters among boys in Grade 4 to 8. Furthermore, stunted South African children have lower cognitive development and these children have lower academic achievements when compared to non-stunted children (Skosana 2016). From the literature, it seems that boys show lower academic achievements when they are stunted or wasted compared to their peers.

It is clear from the above literature that stunting and wasting are not just worldwide occurrences, but also a problem in South Africa, impacting school boys' academic performance. Longitudinal studies regarding stunting, wasting and the effect on academic performance (overall and individual subjects) in South Africa are limited. However, studies have not investigated gender differences concerning stunting, wasting and its effect on academic performance. Thus, it strengthens this study, as boys was taken into consideration. Therefore, the aim of this study was to determine the effect of stunting and wasting on academic performance over a period of seven years on primary school boys in the North West Province of South Africa.

Studies and research regarding the effect of body composition on academic performance on South African boys are still limited. These findings will be beneficial for the Department of Basic Education, Government, schools, teachers, Kinderkinetici, and other healthcare professionals with regard to meaningful statistics about stunting and wasting, intervention and physical activity or nutritional programmes regarding children in South Africa. These findings will also provide a profile regarding boys' physical development, health and scholastic skills. Furthermore, the findings will help to determine whether these issues are related to SES and race when focusing on primary school boys.

Research methods and design

This study forms part of a longitudinal research design, the North-West Child-Health-Integrated-Learning and Development (NW-CHILD) study and stretched over a period of seven years (2010-2016). A baseline measurement and two follow-up measurements were included. The baseline data was collected in 2010, the first follow-up measurement was done in 2013 and the second follow-up in 2016, in the different areas of the North West Province of South Africa. Only data from the boys from all three measurements was utilised for the purposes of this study.

In 2010 (the initial measurement), Grade 1 boys (n=419) participated in the North West Province of South Africa. This group consisted of African, Caucasian, Indian and Mixed race boys. The boys were randomly selected from the list of population density and school status, where Quintile 1 represented schools from low SES areas and Quintile 5 represented schools from high SES areas. For the purpose of this study, Quintile 1 to 3 (n=92) were combined as low SES and Quintile 4 to 5 (n=89) as high SES. During the first follow-up measurements in 2013, 282 boys were still available. The last follow-up measurements were conducted in 2016, with most of the learners in Grade 7. This group consisted of 181 boys (63 Caucasian, 118 African and Mixed race boys). This group was divided into SES groups.

The anthropometric measurements include body mass (kg), height (cm), waist circumference (cm) and three skinfolds (sub-scapular, triceps and medial calf) (mm). Trained postgraduate students in Human Movement Sciences, specializing in Kinderkinetics, measured all the anthropometrical variables. Anthropometric measurements were taken by an Anthropometrist to ensure quality and inter-tester reliability, in accordance with the protocol of the International Society for the Advancement of Kinanthropometry (Stewart, Marfell-Jones, Olds, & de Ridder 2011). Height was measured with a portable stadiometer to the nearest 0.1 cm and body mass was measured to the nearest 0.1 kg with an electronic scale (BF 511, Omron) (Stewart et al. 2011). Each participant's body mass index (BMI) $[(\text{kg}/\text{height (m)}^2)]$ was calculated from the individual height and body mass measurements. The cut-off for indicating stunting and wasting is Z-scores below -2 of the median. Three skinfolds were taken, namely the sub-scapular (two centimetres from the sub-scapular landmark, running obliquely and laterally downwards), the triceps (is a parallel skinfold, taken along the long axis of the upper arm at the triceps skinfold site and medial calf (is a vertical measurement on the medial calf skinfold site) (Stewart et al. 2011). These skinfolds were measured with a pair of Harpenden skinfold callipers and each measured twice to calculate an average measurement that was used for analysis (Stewart et al. 2011).

In Grade 1 (2010), during the June examinations, The Mastery of Basic Learning Areas Questionnaire was used to determine the academic performance of the different learning areas. A four-point scale was used, with (1) indicating not achieved, (2) partially achieved, (3) achieved and (4) outstanding achievement. Lastly, a cluster point was calculated from three variables: reading, writing and Mathematics.

In Grade 4 (2010), the June examination results were collected from all participating schools and the same procedure was followed in 2016, when the learners were mainly in Grade 7. The learning areas according to the Department of Basic Education's Curriculum and Assessment Policy Statements (CAPS) are: Mathematics, Home Language, Second Additional Language, Life Orientation (LO), Natural Science (NS), Social Science and Technology.

Academic performances regarding Annual National Assessments (ANA) of September 2010 and 2013 were collected from all the learners who participated in this study. The ANA results of 2016 were also collected after the learners had completed the ANA examination in September 2016. The Language and Mathematics results of the learners were made available by the Department of Basic Education. All six learning areas as mentioned above were assessed with the ANA grading scales (See Table 1). The rating code and percentages were used regarding the ANA assessments.

Table 1: Grading scales for ANA assessments (Department of Education 2015).

Rating code	Description of competence	Percentage
7	Outstanding achievement	80-100
6	Meritorious achievement	70-79
5	Substantial achievement	60-69
4	Adequate achievement	50-59
3	Moderate Achievement	40-49
2	Elementary achievement	30-39
1	Not achieved	0-29

STATISTICA StatSoft (2017) was used to analyse the data. Firstly, descriptive data was analysed and averages and standard deviations were calculated. Two-way tables were used to determine any relationship and change that might have occurred over time regarding stunting, wasting and SES. Furthermore, ANOVAs were used for each year, two-way frequency tables were used to compare the classifications of the SES groups, stunting and wasting over a period of seven years. Lastly, the Pearson Chi-square was used to indicate the significance of the relationships (stunting, wasting and academic performance) and the level of statistical significance was set at $p \leq 0.05$. The strength of the relationship was indicated by phi-coefficient, with $w \approx 0.1$ indicating a small effect, $w \approx 0.3$ a medium effect and $w \geq 0.5$ a large effect. The WHO (2007) reference data was used as a standard to determine the z-scores for height-for-age (HAZ), referred to as stunting and weight-for-age (WAZ), known as wasting. Z-score values of less than -2 from the standard deviation (SD) for HAZ were used to determine the prevalence of stunting. The Z-scores for wasting were determined using BMI-for-age (De Onis et al. 2006).

Results

The group consisted of 181 boys (63 Caucasian and 118 African and Mixed race). Table 2 represents the descriptive statistics for 2010, 2013 and 2016, with regard to age, stature, weight and BMI.

Table 2: Descriptive statistics for primary school boys over the period of seven years (2010-2016).

Variable	N	Mean	Minimum	Maximum	SD
2010					
Age	181	6.9	6.0	7.8	0.4
Stature	181	120.8	102.1	141.7	6.5
Weight	181	23.1	16.4	45.9	5.0
BMI	181	15.7	12.6	26.8	2.2
2013					
Age	181	9.9	9.0	10.7	0.4
Stature	181	136.1	117.0	161.0	6.9
Weight	181	32.6	19.6	65.6	8.8
BMI	181	17.5	12.9	30.8	3.4
2016					
Age	181	12.9	11.9	13.7	0.4
Stature	181	152.6	131.9	178.8	9.2
Weight	181	45.3	23.1	100.8	13.5
BMI	181	19.3	14.0	36.5	4.2

N= number of participants; SD standard deviation

Two-way tables were used to determine the number of learners in each SES and their stunting or wasting status. Table 3 reports that wasting (3.86%) overall had a higher percentage when compared to stunting (3.32%) in 2010. The same tendency was found in 2013, however, in 2016, stunting and wasting presented equal percentages (6.63%). Further indicated by Table 3, is that more boys were stunted (5.16%) in 2010, when compared to wasting (4.12%) among the low SES group. The opposite was found among the high SES group with wasting (3.57%) being higher when compared to stunting (1.19%). The same findings were obtained in 2013 (high and low SES) and 2016 (only low SES) with regard to the last finding of higher wasting percentages when compared to stunting. Furthermore, it is clear that boys from the low SES groups had higher percentages of stunting and wasting when compared to the percentages of boys from high SES groups (Table 3). Lastly, only one statistical significant relationship was reported over a period of seven years in 2016 between wasting and high SES ($p=0.007$).

Table 3: The relationship between socio-economic status, stunting and wasting over seven years

2010	Normal	Stunting	Wasting	Overall	2013	Normal	Stunting	Wasting	Overall
Low	88	5	4	97	Low	82	5	6	93
SES	90.72%	5.16%	4.12%	53.59%	SES	88.17%	5.38%	6.45%	51.38%
High	80	1	3	84	High	83	2	3	88
SES	95.24%	1.19%	3.57%	46.41%	SES	94.32%	2.27%	3.41%	46.62%
Overall	168	6	7	181	Overall	165	7	9	181
	92.82%	3.32%	3.86%	100%		91.16%	3.87%	4.97%	100%

2016	Normal	Stunting	Wasting	Overall
Low	77	9	11	97
SES	79.38%	9.28%	11.34%	53.59%
High	80	3	1	84
SES	95.24%	3.57%	1.19%*	46.41%
Overall	157	12	12	181
	86.74%	6.63%	6.63%	100%

$p \leq 0.05$ *; SES=socio-economic status

ANOVAs were used for each year to compare SES, stunting and wasting over a period of seven years (See Table 4 and 5). From Table 4, it is clear that SES affects academic performance. In 2010, numeracy ($p=0.001$), Language ($p=0.004$) and the average academic mark ($p=0.001$) were statistical significant ($p \leq 0.05$) when compared to SES. The same tendency was observed in 2013 between Language, Mathematics, average academic mark, Language (department) and average academic mark (department). Furthermore, Language, Mathematics and average academic mark (for department as well) all reported a statistical significance in 2016. Effect sizes were further determined between SES (high and low), normal weight and stunting. In 2010, a medium effect was reported among the average academic mark and normal weight boys ($d=0.59$). A large effect was also reported between Language ($d=0.80$), the average academic mark ($d=0.84$) and stunting. Furthermore, a small effect was reported between numeracy ($d=0.23$), Language ($d=0.21$) and the average academic mark ($d=0.23$) and low SES. In 2013, only Mathematics ($d=0.84$) reported a large effect among high SES. Lastly, in 2016, Language reported a medium effect ($d=0.53$) and Mathematics (department) a large effect ($d=0.85$) among normal weight boys. Furthermore, a small effect was found between Language (department), the average academic mark and low SES ($d=0.21$ and $d=0.28$ respectively). The same was reported between the high SES for the average academic mark ($d=0.23$).

Table 4: ANOVA's between normal weight, stunting and academic subjects per year.

Subjects		Normal Weight		Stunting		MSE	p-values			Effect size of SES		Effect size (normal weight and stunting)	
		Low SES	High SES	Low SES	High SES		Stunting	SES	Stunting & SES	Normal weight	Stunting	Low SES	High SES
2010	Numeracy	70.97	84.72	66.67	81.25	348.5	0.34	≤0.001*	0.92	0.74	0.78	0.23•	0.19
	Language	66.33	75.86	62.08	78.13	397.8	0.82	0.004*	0.45	0.48	0.80■	0.21•	0.11
	Average	67.88	78.82	63.61	79.17	340.8	0.63	≤0.001*	0.57	0.59▲	0.84■	0.23•	0.02
2013	Language	44.16	65.73	43.57	65.85	217.8	0.94	≤0.001*	0.91	1.46	1.51	0.04	0.01
	Mathematics	41.11	60.21	38.00	45.40	311.5	0.23	≤0.001*	0.72	1.08	0.42	0.18	0.84■
	Average	51.49	67.73	49.94	65.66	164.1	0.49	≤0.001*	0.92	1.27	1.23	0.12	0.16
	Language(ANA)	43.61	69.39	36.74	62.00	264.0	0.04*	≤0.001*	0.94	1.59	1.55	0.42	0.45
	Average (ANA)	41.44	64.80	36.65	58.20	230.8	0.08	≤0.001*	0.78	1.54	1.42	0.32	0.43
2016	Language	55.72	62.33	50.82	59.50	155.5	0.08	≤0.001*	0.63	0.53▲	0.70	0.39	0.23
	Mathematics	44.50	57.12	43.42	54.75	263.2	0.54	≤0.001*	0.82	0.78	0.70	0.07	0.15
	Average	50.41	62.28	48.07	59.69	123.1	0.21	≤0.001*	0.95	1.07	1.05	0.21•	0.23•
	Language (Dep.)	49.78	57.37	46.08	59.67	179.9	0.76	≤0.001*	0.20	0.57	1.01	0.28•	0.17
	Mathematics (Dep.)	40.02	56.22	41.50	53.33	359.6	0.83	≤0.001*	0.51	0.85■	0.62	0.08	0.15
	Average (Dep.)	41.91	56.90	41.33	58.99	118.7	0.69	≤0.001*	0.48	1.38	1.62	0.05	0.19

ANA – Annual national assessment; Dep. – Departmental marks; Average – Average academic mark; $p \leq 0.05^*$; SES- socio-economic status; MSE-Mean Square Error; • small effect; ▲ medium effect; ■ large effect

Table 5 reports the effect of wasting and SES on academic performance. This table reports that Language, Mathematics and average academic mark were statistically significant ($p \leq 0.05$) when compared to SES in 2010. The ANA marks only represent the marks obtained by the ANA tests, whereas the department marks represent the term mark (including all tests and projects) per subject. The same was reported in 2013 and 2016, with regard to Language, Mathematics, average academic mark, Language (ANA), Language (department), Mathematics (department) and the average academic mark (department). Further, in 2013, statistical significance was found with regard to SES and wasting ($p=0.03$) between Mathematics (department) and the average academic mark (department). The same tendency was reported in 2016, where a statistical significance ($p=0.05$) was reported with regard to the effect of SES and wasting on the Mathematics marks (department). Effect sizes were determined for the relationships between wasting, normal weight and SES. A small effect was found between high SES, numeracy ($d=0.20$), Language ($d=0.27$) and the average academic mark ($d=0.26$) in 2010. The same effect was observed regarding low SES and the average academic mark ($d=0.23$). Also reported in 2010, was a medium effect with regard to normal weight boys ($d=0.52$) and a large effect regarding wasting and SES ($d=0.82$). In 2013, Language ($d=0.29$) and the average academic mark ($d=0.28$) reported a small effect for the high SES. The same effect was observed for the relationship between the average academic mark and low SES ($d=0.24$). A large effect was reported for Language (ANA) and Mathematics (ANA) among normal weight boys ($d=0.87$ and $d=0.88$ respectively). Also, a medium effect was found among mathematics (ANA) and low SES ($d=0.50$). Language and Language (department) both reported a medium effect among normal weight boys and low SES respectively ($d=0.56$ and $d=0.50$) in 2016. Lastly, a small effect was observed among Mathematics ($d=0.22$) and the average academic mark ($d=0.27$) with regard to high SES.

Table 5: Meaningful differences between normal weight, wasting and academic subjects per year.

Subjects		Normal		Wasting		MSE	p-values			Effect size of SES		Effect size of normal and wasting	
		Low SES	High SES	Low SES	High SES		Wasting	SES	Wasting & SES	Normal	Wasting	Low SES	High SES
2010	Numeracy	71.54	82.92	63.46	86.67	343.1	0.53	$\leq 0.001^*$	0.09	0.61	1.25	0.44	0.20•
	Language	65.19	73.77	62.98	79.17	393.7	0.67	$\leq 0.001^*$	0.30	0.43	0.82■	0.11	0.27•
	Average	67.31	76.81	63.14	81.67	336.7	0.92	$\leq 0.001^*$	0.19	0.52▲	1.01	0.23•	0.26•
2013	Language	45.02	65.78	40.60	70.14	222.5	0.99	$\leq 0.001^*$	0.15	1.39	1.98	0.30	0.29•
	Mathematics	58.37	65.18	52.12	67.00	256.0	0.50	$\leq 0.001^*$	0.22	0.43	0.93	0.39	0.11
	Average	52.15	67.34	48.59	70.39	166.2	0.92	$\leq 0.001^*$	0.21	1.18	1.69	0.28•	0.24•
	Language (ANA)	54.07	68.79	34.00	71.45	284.0	0.25	$\leq 0.001^*$	0.06	0.87■	2.22	1.19	0.16
	Mathematics (ANA)	42.72	58.43	33.83	65.64	316.9	0.82	$\leq 0.001^*$	0.03*	0.88■	1.79	0.50▲	0.41
	Average (ANA)	42.73	63.61	33.52	68.55	238.1	0.51	$\leq 0.001^*$	0.03*	1.35	2.27	0.60	0.32
2016	Language	55.15	62.20	48.98	63.91	158.8	0.37	$\leq 0.001^*$	0.12	0.56▲	1.18	0.49	0.14
	Mathematics	46.44	56.93	40.32	60.45	255.6	0.68	$\leq 0.001^*$	0.13	0.66	1.26	0.38	0.22•
	Average	50.76	61.78	46.43	64.78	123.9	0.76	$\leq 0.001^*$	0.10	0.99	1.65	0.39	0.27•
	Language (Dep.)	50.04	58.09	43.32	60.41	181.4	0.41	$\leq 0.001^*$	0.09	0.60	1.27	0.50▲	0.17
	Mathematics (Dep.)	45.23	56.72	33.16	58.94	342.0	0.18	$\leq 0.001^*$	0.05*	0.62	1.39	0.65	0.12
	Average (Dep.)	43.20	57.72	38.68	58.13	116.3	0.34	$\leq 0.001^*$	0.25	1.35	1.80	0.42	0.04

ANA – Annual national assessment; Dep. – Departmental marks; Average – Average academic mark; $p \leq 0.05^*$; SES- socio-economic status; MSE-Mean Square Error; • small effect;

▲ medium effect; ■ large effect

Discussion

The aim of this study was to determine the effect of stunting and wasting on the academic performance of primary school boys over a period of seven years in the North West Province of South Africa. This study found that the overall stunting and wasting percentage has increased from 2010 (3.32% vs. 3.86%) to 2016 (6.63% vs. 6.63%). Furthermore, among the low SES, stunting and wasting percentages increased with each assessment. The same tendency was reported among the stunted boys in the high SES, however, a decrease in wasting was reported from 2010 (3.57%) to 2016 (1.19%). The study reported lower percentages when compared to studies done globally. This might be due to larger sample sizes in the other studies, which were also not longitudinal of nature. In a cross-sectional study conducted in South Nigeria, it was reported that 13% of their group was wasted and that the prevalence of wasting was higher in children, aged five to nine years (19%), than adolescents, aged 10 to 18 years (8.3%) (Ene-Obong et al. 2012). In South Africa, a study conducted by Shisana (2014), reported that the stunting prevalence among boys was the highest at age zero to three years (26.9%) when compared to the seven- to nine-year-old boys (10%). Symington, Gericke, Nel, and Labadarios (2016) found that overall 17% of the children (three to nine years of age) in their study were stunted and that the lowest prevalence of stunting was found in the Gauteng Province (16.5%) when compared to the Mpumalanga Province (18.2%). Younger age groups were used as these are the ages during which stunting and wasting generally appears (Symington et al. 2016).

Poor academic performance has a positive correlation with stunting and wasting among boys. The current study found that, in 2010, the stunting and wasting in boys had a significant association with Language, Mathematics and their average academic score. Additionally, in 2013, Language, Mathematics and average academic scores (which included the departmental average academic scores as well) were mostly influenced by stunting and wasting among boys. The same tendency was reported in 2016 among stunted and wasted boys. Furthermore, only one statistically significant relationship was reported over a period of seven years in 2016 between wasting and high SES with regard to Mathematics (department). The findings are consistent with research that stated, Language and Mathematics are the main subjects that are affected by stunting and wasting. This may be due to low school attendance, negative cognitive development and a lack of reading and/or writing (Kleinman et al. 2002). Jyoti, Frongillo, and Jones (2005) have found that food insecurity will lead to a decline in academic performance regarding reading and Mathematics. Certain studies (Miller et al. 2015; Prendergast & Humphrey 2014) regarding stunting found that

stunted and severely stunted children had lower cognitive abilities and they enrolled late or not at all in school, had poor memory and lower academic performance. These children also had problems with learning and it affected both the children's literacy skills and numeracy development. Rashmi et al. (2015) found strong relationships between children's nutritional status and academic performance. These researchers further reported that children who were wasted had lower grades in their First Language and Mathematics. South African studies (Matabane et al. 2012; Themane et al. 2003) found the same tendency where wasting had a positive association with poor academic performance, especially with regard to English and Mathematics.

Conclusion

The study reported that stunting among primary school boys gradually increased from 2010 (3.32%) to 2016 (6.63%) and the same tendency was reported regarding the wasting among boys (3.36% to 6.63 %). It is clear that the prevalence of stunting and wasting remained a major concern (including as a health risk) over a period of seven years. Stunted and wasted children are at risk of various health issues, including low immune systems which will lead to more absent days from school and a lack of essential nutrients for development (physically and cognitively). Furthermore, the study reported that stunting and wasting among primary school boys lead to lower academic achievements when compared to normal weight children with SES being the most influential factor. From the literature, it is clear that stunting and wasting have a great effect on academic performance, especially among subjects such as Mathematics and Language. Valuable findings were reported however, strengths and shortcomings were encountered. The study can be seen as a ground-breaking study in South Africa, due to its longitudinal (over the period of seven years) nature, following the boys throughout primary school. The study sample was randomly selected, which could lead to generalisation, however, the small sample size could have complicated this. The longitudinal effect of the study provided the researchers with valuable data with regard to stunting and wasting and academic performance. More studies are recommended in the other provinces of South Africa as this study only concentrated on the North West Province. Lastly, more longitudinal studies in the South African setting should be done, to strengthen the findings.

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CHAPTER 5

SUMMARY, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

5.1 Summary

There were two objectives for this study. The first objective was to determine the effect of overweight and obesity on the academic performance of primary school boys over a period of seven years, taking in consideration their race and socio-economic status. Secondly, to determine the effect of stunting and wasting on the academic performance of primary school boys over a period of seven years, in the North West Province of South Africa, also taking in consideration socio-economic status (SES).

In Chapter 1, the problem statement, objectives and hypothesis were discussed in more detail.

In order to achieve the objectives and hypothesis of this study, a literature review was done in Chapter 2. An introduction was given, followed by all relevant terminology: body composition, body mass index, overweight, obesity, stunting, wasting, depression, cardiovascular diseases, hypertension, asthma and diabetes mellitus. Furthermore, the South African population, population size, demographics and SES were discussed. This chapter also contains a description of various concepts related to this study, which includes overweight, obesity, stunting and wasting. These conditions were discussed in detail with regard to the classifications, international and South African prevalence among boys, different racial and SES groups. Furthermore, the effect of overweight, obesity, stunting and wasting on psychosocial and health development was discussed. The psychosocial development addressed the following sub-divisions: self-esteem, depression and peer group relationships followed by the health-related aspects that included: cardiovascular disease, hypertension, asthma, diabetes mellitus, growth impairment and motor development. Lastly, the academic system and the effect of overweight, obesity, stunting and wasting on academic performance were discussed. The literature review reported that high prevalence of

overweight, obesity, stunting and wasting is both an international and South African occurrence. However, controversial findings with regard to overweight, obesity, stunting and wasting prevalence among boys from different SES groups are reported. The literature review has stated that boys from low SES groups are more likely to be diagnosed with stunting or wasting, whereas boys from high SES groups are more likely to be overweight or obese. Taking race into account, it has been found that Caucasian boys are more likely to be overweight and/or obese when compared to Indian and African boys. The literature review has also indicated that overweight, obesity, stunting and wasting have a number of effects on children's development, whether it is psychosocial- or health development. Overweight, obesity, stunting or wasting are more likely to develop psychosocial problems such as depression, poor peer group relationships and low self-esteem. The same tendency was found among health-related aspects. Furthermore, these children tend to be more likely to develop hypertension, diabetes mellitus, asthma and present growth impairments such as muscular development problems, joint problems, arthritis, tendonitis and postural imbalance and overall growth (stature), whether in a direct or indirect manner.

With regard to academic achievement among boys, the literature review has indicated that overweight, obesity, stunting and wasting have an important effect. The findings have reported that overweight and obese boys tend to struggle with regard to academic subjects such as Mathematics, reading, Language and Science. Other aspects that are affected by these conditions include school attendance, lower cognitive abilities and -development. SES conditions also play a role with regard to academic achievements. Boys from low SES conditions tend to have lower academic achievements when compared to boys in high SES conditions. Children from low SES conditions also generally scored less on their tests/assessments compared to other children from high SES conditions. The same tendency (of poor academic achievements) was observed among the stunted and wasted boys. Lastly, the literature review has reported that stunting and wasting have a negative effect on school achievements. These children tend to drop out of school more often than their peers, they struggle to concentrate, they have poor memory and they are more likely to struggle with subjects such as reading, writing and Mathematics.

Chapter 3 was prepared in an article format with the title “Longitudinal effects of overweight and obesity on academic performance of primary school boys: the NW-CHILD study.” and will be submitted to the *South African journal of childhood education* for possible publication. This article presents the results of the effect of overweight and obesity on academic performance among

primary school boys in the North West Province. One hundred and eighty-one boys (over all three assessments) from Quintile 1 to Quintile 5 schools (Quintile 1 represents low SES and 5, high SES) were tested, with a mean age of 6.9 years (SD=0.40) in 2010, 9.9 years (SD=0.40) in 2013 and 12.9 year (SD=0.40) in 2016. Data analysis were completed with STATISTICA (StatSoft, 2017). Descriptive statistics (mean, standard deviations (SD), minimum and maximum values) for each variable were determined. Repeated measure ANOVA's were used for over time effect to determine the difference between the different SES groups and the boys' body composition (BMI) as well as their academic performance (2010-2016). Two-way tables were used to calculate any relationship or change that might have occurred over time with regard to overweight, obesity, SES and race and further to compare the classifications of the different quintiles. Pearson Chi-square was used to indicate the significance of associations between BMI and academic performance and the level of statistical significance was set at $p \leq 0.05$. The relationship strength was indicated by phi-coefficient, with $w \approx 0.1$ a small effect, $w \approx 0.3$ a medium effect and $w \geq 0.5$ a large effect. Lastly, Spearman rank order correlations between BMI and academic performance were determined. The strength of these correlations was set at $r \approx 0.1$ indicating a small effect, $r \approx 0.3$ indicating a medium effect and $r \approx 0.5$ a large effect (Cohen, 1988). The results reported that the boys' Body Mass Index (BMI) increased with each assessment (2010, 2013 and 2016). Nearly all school subjects reported a positive correlation with small to medium effects ($r \geq 0.1$ and $r \geq 0.3$) with regard to BMI and academic performance, however, a negative correlation was found regarding Afrikaans in 2013 ($r = 0.06$) and BMI. English and Language, as tested with the ANA test, reported a medium effect ($r \geq 0.3$), whereas the other subjects only reported small effects ($r \geq 0.1$). Furthermore, no statistical significance ($p \geq 0.05$) was observed among the BMI values and academic subjects, however, SES and academic subjects reported statistically significant associations ($p \leq 0.05$), especially among Mathematics and Language (English and First Additional Language).

Chapter 4 was also prepared in an article format with the title "Longitudinal effects of stunting and wasting on academic performance of primary school boys: the NW-CHILD study." and will also be submitted to the *South African journal of childhood education* for possible publication. This article presents the results of the effect of stunting and wasting on academic performance among primary school boys in the North West Province. A total of 181 boys from Quintile 1 to Quintile 5 (1 referring to low SES and 5, high SES) schools took part in this study, with a mean age of 6.9 years (SD=0.40) in 2010, 9.9 years (SD=0.40) in 2013 and 12.9 year (SD=0.40) in 2016. Data analysis was conducted with STATISTICA (StatSoft, 2017). Firstly, descriptive statistics (mean,

minimum, maximum and standard deviations (SD)) for each variable were established. Repeated ANOVA's were used for over time data to determine the difference between the different SES and the boys' BMI as well as their academic performance from 2010 to 2016. Two-way tables were used to calculate any relationship or change that might have occurred over time with regard to stunting, wasting and SES and also to compare the classifications of the different quintiles. Pearson Chi-square was used to indicate the significance of associations between BMI and academic performance as well as the level of statistical significance (set at $p \leq 0.05$). The relationship strength was represented by phi-coefficient, with $w \approx 0.1$ indicating a small effect, $w \approx 0.3$ a medium effect and $w \geq 0.5$ a large effect. Lastly, Spearman rank order correlations between BMI and academic performance were determined. The strength of these correlations was set at $r \approx 0.1$ indicating a small effect, $r \approx 0.3$ a medium effect and $r \approx 0.5$ a large effect (Cohen, 1988). The results revealed that the prevalence of stunting (3.32% to 6.63%) and wasting (3.86% to 6.63%) increased each year from 2010 to 2016. Academic performance, which included Language, Mathematics and average academic scores was affected statistically by stunting and wasting ($p \leq 0.05$). Over a period of seven years (overall), it was found that stunting and wasting had an effect on academic performance, especially with regard to Language, Mathematics and average academic score.

5.2 Conclusions

This study's conclusions are derived from the results of this study.

5.2.1 Conclusion 1

Hypothesis 1 states, that overweight and obesity will statistically affect academic achievement in a negative way. Primary school boys (overweight and obese) will have lower academic achievements, thus the academic achievements will be lower than the results of 2013 and 2016 when compared to the first year. Low SES will also negatively affect academic achievement among overweight and obese boys. The findings of this study reported that overweight and obesity did not affect the boys' academic performance negatively, but instead reported a strong positive correlation ($r \geq 0.1$ and $r \geq 0.3$) between overweight/obesity and academic performance and the different school subjects. Based on these findings, the first part of the hypothesis as mentioned above, is **rejected**. The second part regarding the relationship between SES and academic subjects (Mathematics and Language) reported statistical significances ($p \leq 0.05$), thus this part of the hypothesis can be **accepted**.

From this article, it is clear that overweight and obesity did not affect the boys' academic performance negatively and these boys performed better when compared to normal weight boys. With regard to SES conditions, it was found that the boys from high SES condition groups had higher overweight and obesity prevalence, when compared to normal weight boys. Furthermore, the analysis regarding the relationship between the boys' SES and academic performance indicated that Home Language, English and BMI reported a medium ($r \geq 0.3$) practical effect with all the other subjects only indicating a small ($r \geq 0.1$) practical significance.

5.2.2 Conclusion 2

Hypothesis 2 stated that stunting and wasting will statistically affect academic achievements in a negative way. Primary school boys (stunted and wasted) will have lower academic achievements, thus the academic achievements will be lower in 2013 and 2016 when compared to the first year. Furthermore, low SES will negatively affect academic achievement among stunted and wasted primary school boys. Stunting will have the greatest effect on academic performance like Mathematics, reading and writing skills. The finding of this study reported that the boys' academic performance, which included Language, Mathematics and average academic scores, were negatively affected by stunting and wasting, with statistical significant differences ($p \leq 0.05$). Over a period of seven years, it was reported that stunting and wasting had a negative effect on academic performance, especially with regard to Language and Mathematic subjects. Based on these results, the hypothesis as set above, is **partially accepted**. The second part of the hypothesis states that low SES will negatively affect academic performance - this part can be **accepted**.

From this article it is concluded that SES played a greater importance when compared to race. It was found that boys from low SES conditions did however not perform as well as boys from high SES conditions. Adding, the boys at risk of developing stunting and wasting reported a statistical significance with academic achievements in Language and Mathematics. The same tendency was reported by the boys that are stunted and wasted, as well as comparing these results over the period of six years.

5.3 Recommendations and Limitations

The findings in this study reported no negative association between overweight and/or obese boys and academic achievements, however, a positive association was found. It was also found that overweight and obese boys had a greater statistical significance with regard to SES conditions and

academic performance when compared to race. The findings further found that stunting and wasting statistically affected academic performance (including Language and Mathematics) negatively and that stunting and wasting affected academic performances over a period of seven years. It is, therefore recommended that intervention programs are planned and implemented to help guide and support the community, teachers, schools and government with regard to stunted and wasted children to help to improve their academic achievements and nutritional status.

In this study, all efforts were made to enhance the generalisability of the results. Some limitations should be brought to light to help optimise future studies in this perspective. The following limitations were noted:

- 5.3.1. The finding of this study was based on data from only one of the nine provinces in South Africa. This study was based on a randomised study design and has relative good generalisability, however, it is recommended that future studies should be conducted in the other eight provinces of South Africa.
- 5.3.2. It was found that limited longitudinal studies have been done in South Africa with regard to overweight, obesity, stunting and wasting. It is recommended that more studies on these aspects are done among boys and girls in all provinces of South Africa.
- 5.3.3. Limited to no data was available with regard to overweight, obesity and academic achievements among boys in South Africa. It is recommended that more research be done in this regard to form a reference guideline.
- 5.3.4. This study only focused on respective school types set by the SES. Future studies should possibly look at SES in more depth, by using demographic questionnaires to help gather more information.
- 5.3.5. The effect that low SES conditions have on boys' academic performance can further be investigated and intervention programs can be developed to help improve stunted and wasted boys' academic performance.

- 5.3.6. The stunted and wasted boys were very few, thus, it was necessary to combine the two groups. It will be optimal to be able to separate the groups and report their results separately.
- 5.3.7. With regard to stunting and wasting, only a few boys remained this way during the duration of this study which included their primary school years. This impacted the results with regard to the longitudinal effects that these conditions have on children and their academic performance.

APPENDIX A

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ETHICS APPROVAL CERTIFICATE OF PROJECT

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

Project title: A Longitudinal analysis of health risk factors, growth and development among 7-13-year-old children.															
Project Leader: Prof AE Pienaar															
Ethics number:	N	W	U	-	0	0	0	7	0	-	0	9	-	A	1
	Institution			Project Number					Year		Status				
Status: S – Submission; R – Re-Submission; P – Provisional Authorisation; A – Authorisation															
Approval date: 2015-10-12				Expiry date: 2017-12-15				Risk:				Children Category 3			

Special conditions of the approval (if any): None

General conditions:

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

- The project leader (principle investigator) must report in the prescribed format to the NWU-IRERC:
 - annually (or as otherwise requested) on the progress of the project,
 - without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-IRERC. Would there be deviated from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-IRERC and new approval received before or on the expiry date.
- In the interest of ethical responsibility the NWU-IRERC retains the right to:
 - request access to any information or data at any time during the course or after completion of the project;
 - withdraw or postpone approval if:
 - any unethical principles or practices of the project are revealed or suspected,
 - it becomes apparent that any relevant information was withheld from the NWU-IRERC or that information has been false or misrepresented,
 - the required annual report and reporting of adverse events was not done timely and accurately,
 - new institutional rules, national legislation or international conventions deem it necessary.

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

Yours sincerely

Linda du Plessis

Digitally signed by Linda du Plessis DN:
cn=Linda du Plessis, o=NWU, ou=Vaal Triangle Campus,
email=linda.duplessis@nwu.ac.za, c=ZA
Date: 2015.10.16 10:03:26 +0200

Prof Linda du Plessis

Chair NWU Institutional Research Ethics Regulatory Committee (IRERC)

APPENDIX B

Communication letter



25 May 2015

Dear Mr/Mrs

RESEARCH PROJECT – NW-CHILD study- A 6-year follow up study of growth, health, perceptual-motor and visual–motor abilities and physical proficiency of primary school learners in the North West Province of South Africa.

Thank you for the opportunity to contact you again with regard to our on-going research project of which your school were part of in 2010 when the learners were in Grade 1. We did the follow-up measurements in 2013 when they were in Grade 4, and we will do our final measurements in 2016 when the learners are in Grade 7, the final year of their primary school years. As this is an on-going research project which involves 20 schools in the North West province where the same children have to be measured again we have to start early with the planning and the management of the final part of the project that will commence in 2016.

At this stage we need to obtain your approval that your school will take part in the final measurements that will take place in 2016.

If you approve, we need to decide on the dates in 2016 that we will visit your school to do all the measurements which will be completed on one morning at your school. These dates need to be finalised as we have to book accommodation for our research team in advance in the area of your school. We also have to finalise our travel arrangements which depends on these dates.

We will also have to obtain the class list of your learners who will be currently in Grade 6 (and some in Grade 5 because of retention), in order to recruit or find the learners that were part of our

study in 2013. Our experience showed that many of the learners in our study group left the research schools during the period between 2010 and our follow-up measurements in 2013, and this will most probably have happened again since our measurements in 2013.

I also want to remind you that, because of the longitudinal nature of the study that we will again ask permission from you to obtain the June 2016 progress reports of the learners as well as their Annual National Assessment (ANA) tests that they will receive in September 2016. The North West Department of Education granted us permission to obtain this information.

If you can provide us with the contact details of an administrative or staff member at your school that we can use as a contact at your school, when you are not available if we need to inquire about anything with regard to the project, we will be glad.

I include a list of all the learners that are currently participants in our study in your school of which we will need information.

If you want to contact us or e-mail any information to us, the following email address can be used: anita.pienaar@nwu.ac.za. However, information can also be **faxed to 018 299 1825**. My contact details as well as those of Dr Dané Coetzee and the HREC office is also included in this letter for your convenience. Additionally, I will also provide you with an envelope of which the postage is already paid, and you can then send it back by post.

Yours sincerely

Prof Anita Pienaar

Primary investigator: Kinderkinetics, School of Biokinetics Recreation and Sport Science (018) 299 1796 (w). anita.pienaar@nwu.ac.za

Dr. Dané Coetzee

Researcher: School of Biokinetics, Recreation and Sport Science (018 299 1792) (w)/ Dane.Coetzee@nwu.ac.za

You are also welcome to contact the Human Research Ethics Committee of the Faculty of Health Sciences via Ms Carolien van Zyl at 018 299 2094, Carolien.vanZyl@nwu.ac.za if you need to obtain any other relevant information.

Declaration by headmaster

By signing below, I the headmaster of confirms that I was informed by the researchers about the ongoing research study entitled, “The NW CHILD study” and that I agree that my school can take part in it.

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

.....
Signature of headmaster

.....
Signature of witness

Declaration by person obtaining consent

I (*name*) declare that:

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

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

.....
Signature of person obtaining consent

.....
Signature of witness

Declaration by investigator

I (name) declare that:

- I explained the information in this document to the head master of the school where the research will be conducted.
- I encouraged the headmaster to ask questions and took adequate time to answer them.
- I am satisfied that the headmaster adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

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

.....

.....

Signature of investigator

Signature of witness

APPENDIX C



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



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

School for Biokinetics, Recreation and Sport Science)

(018) 299 1796 (w)

Please send this form back to school the NEXT DAY.



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

_____ ✂ _____ ✂ _____ ✂ _____

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



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

Projekleier

Skool vir Biokinetika, Rekreasie en Sportwetenskap

(018) 299 1796 (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

APPENDIX D

Author Guidelines: South African Journal of Childhood Education

Original Research Article full structure

Title: The article's full title should contain a maximum of 95 characters (including spaces).

Abstract: The abstract, written in English, should be no longer than 250 words and must be written in the past tense. The abstract should give a succinct account of the objectives, methods, results and significance of the matter. The structured abstract for an Original Research article should consist of six paragraphs labelled Background, Aim, Setting, Methods, Results and Conclusion.

- **Background:** Summarise the social value (importance, relevance) and scientific value (knowledge gap) that your study addresses.
- **Aim:** State the overall aim of the study.
- **Setting:** State the setting for the study.
- **Methods:** Clearly express the basic design of the study, and name or briefly describe the methods used without going into excessive detail.
- **Results:** State the main findings.
- **Conclusion:** State your conclusion and any key implications or recommendations.

Do not cite references and do not use abbreviations excessively in the abstract.

Introduction: The introduction must contain your argument for the social and scientific value of the study, as well as the aim and objectives:

- **Social value:** The first part of the introduction should make a clear and logical argument for the importance or relevance of the study. Your argument should be supported by use of evidence from the literature.
- **Scientific value:** The second part of the introduction should make a clear and logical argument for the originality of the study. This should include a summary of what is already known about the research question or specific topic, and should clarify the knowledge gap that this study will address. Your argument should be supported by use of evidence from the literature.
- **Conceptual framework:** In some research articles it will also be important to describe the underlying theoretical basis for the research and how these theories are linked together in a

conceptual framework. The theoretical evidence used to construct the conceptual framework should be referenced from the literature.

- Aim and objectives: The introduction should conclude with a clear summary of the aim and objectives of this study.

Research methods and design: This must address the following:

- Study design: An outline of the type of study design.
- Setting: A description of the setting for the study; for example, the type of community from which the participants came or the nature of the health system and services in which the study is conducted.
- Study population and sampling strategy: Describe the study population and any inclusion or exclusion criteria. Describe the intended sample size and your sample size calculation or justification. Describe the sampling strategy used. Describe in practical terms how this was implemented.
- Intervention (if appropriate): If there were intervention and comparison groups, describe the intervention in detail and what happened to the comparison groups.
- Data collection: Define the data collection tools that were used and their validity. Describe in practical terms how data were collected and any key issues involved, e.g. language barriers.
- Data analysis: Describe how data were captured, checked and cleaned. Describe the analysis process, for example, the statistical tests used or steps followed in qualitative data analysis.
- Ethical considerations: Approval must have been obtained for all studies from the author's institution or other relevant ethics committee and the institution's name and permit numbers should be stated here.

Results: Present the results of your study in a logical sequence that addresses the aim and objectives of your study. Use tables and figures as required to present your findings. Use quotations as required to establish your interpretation of qualitative data. All units should conform to the **SI convention** and be abbreviated accordingly. Metric units and their international symbols are used throughout, as is the decimal point (not the decimal comma).

Discussion: The discussion section should address the following four elements:

- Key findings: Summarise the key findings without reiterating details of the results.
- Discussion of key findings: Explain how the key findings relate to previous research or to existing knowledge, practice or policy.

- **Strengths and limitations:** Describe the strengths and limitations of your methods and what the reader should take into account when interpreting your results.
- **Implications or recommendations:** State the implications of your study or recommendations for future research (questions that remain unanswered), policy or practice. Make sure that the recommendations flow directly from your findings.

Conclusion: Provide a brief conclusion that summarises the results and their meaning or significance in relation to each objective of the study.

Acknowledgements: Those who contributed to the work but do not meet our authorship criteria should be listed in the Acknowledgments with a description of the contribution. Authors are responsible for ensuring that anyone named in the Acknowledgments agrees to be named.

Also provide the following, each under their own heading:

- **Competing interests:** This section should list specific competing interests associated with any of the authors. If authors declare that no competing interests exist, the article will include a statement to this effect: *The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.* Read our **policy on competing interests**.
- **Author contributions:** All authors must meet the criteria for authorship as outlined in the **authorship** policy and **author contribution** statement policies.
- **Funding:** Provide information on funding if relevant
- **Disclaimer:** A statement that the views expressed in the submitted article are his or her own and not an official position of the institution or funder.

References: Harvard Reference Style Guide. Authors should provide direct references to original research sources whenever possible. References should not be used by authors, editors, or peer reviewers to promote self-interests. Refer to the journal referencing style downloadable on our *Formatting Requirements* page.

APPENDIX E

PROOF OF LANGUAGE EDITING

DECLARATION

I, C Vorster (ID: 710924 0034 084), Language editor and Translator and member of the South African Translators' Institute (SATI member number 1003172), herewith declare that I did the language editing of a dissertation written by Ms D van Staden (student number: 22805923) from the North-West University.

Title of the dissertation: A longitudinal study on the effect of overweight, obesity, stunting and wasting on academic performance of primary school boys: the NW-CHILD study



C Vorster

13 March 2019

Date

cvlanguage.editing@gmail.com

APPENDIX F

PROOF OF SUBMISSION

SAJCE Submission 754 - Confirmation and acknowledgement of receipt

Ref. No.: 754

Manuscript title: Longitudinal effects of stunting and wasting on academic performance of primary school boys: NW-CHILD study.

Journal: South African Journal of Childhood Education

Dear Deidre van Staden

Your submission has been received by the journal and will now be processed in accordance with published timelines.

Processing time guidelines are available under the journal's 'About' section, however, please note that each submission is assessed on its individual merit and in certain circumstances processing times may differ.

You can check the status of your submission in three ways:

- Journal Website: login to your account at

<https://sajce.co.za/index.php/sajce/author/submission/754>.

- Publisher Enquiry Service: telephone numbers are +27(0)219752602 and/or 0861000381.

- Publisher FAQ and Email Service: visit the Publisher FAQ and Email service at <https://publishingsupport.aosis.co.za/index.php>

You will receive additional emails from the journal as your submission passes through the phases of the editorial process.

Kind regards,

AOSIS Publishing

South African Journal of Childhood Education

South African Journal of Childhood Education

<http://www.sajce.co.za>

If you require immediate assistance, please contact the AOSIS Publishing:

Phone: +27 (0)86 1000 381 or +27 21 975 2602

Fax: +27 (0)86 5004 974

Support email: publishing@aosis.co.za

Business hours are weekdays between 8:00am-16:30pm

Confidentiality: The information contained in and attached to this email is

confidential and for use of the intended recipient. This email adheres to the email disclaimer described on www.aosis.co.za.

APPENDIX G

15 Maart 2019

Wie dit mag aangaan

Ek verklaar hiermee dat ek die PI (Principle Investigator) is van die NW-CHILD studie getiteld:

Old Title: *The effect of environmental influences and health risk factors on the Health, Sport and Academic progress of children living in the North-West Province of South Africa: A 6-year follow-up study.*

New title: *A Longitudinal analysis of health risk factors, growth and development among 7-13-year-old children.*

Hierdie projek het die volgende etieknommer (NWU- NW 00070-09-A1).

Ek verklaar hiermee dat ek toestemming verleen het dat Mej. Deidré van Staden (22805923) haar Meestersgraadverhandeling binne hierdie navorsingsprojek kon uitvoer met die titel:

A longitudinal study on the effect of overweight, obesity, stunting and wasting on academic performance of primary school boys: the NW-CHILD study

Vriendelike groete

Prof AE Pieaar

