The effect of physical activity on the body composition and health related fitness of 9 to 13 year old boys

Susanna Maria du Preez

(BSc, BSc Hons)

12275794

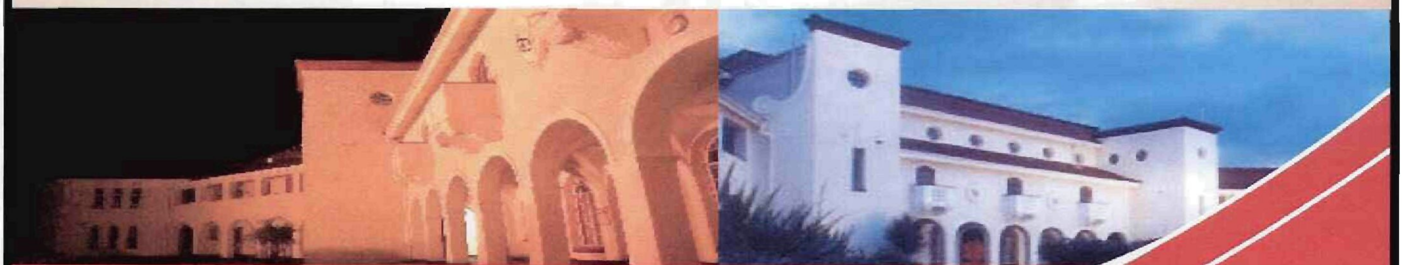
Potchefstroom

November 2008

Dissertation submitted in fulfillment of the requirements for the degree *Master of Science* at the Potchefstroom Campus of the North-West University

Supervisor: Prof. J. Hans de Ridder

Co-Supervisor: Dr. M. Andries Monyeki



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

Acknowledgements

"For the Lord gives wisdom; from His mouth comes knowledge and understanding."

Proverbs 2:6

This dissertation would not have been successfully completed without the support of various parties. I therefore express my gratitude to:

- **My dearest Lord and Father,** for giving me the opportunity, talent, support and willpower not to surrender in this study. For always loving and leading me and for giving me the mental strength to complete this dissertation. All the honour is due to you Lord.

- **Prof. Hans de Ridder, my supervisor.** Thank you for your unconstrained advice, wisdom and leadership, but above all, your passion for life, which inspired me to keep going when times were tough. It was a privilege to work with you.

- **Dr. Andries Monyeki, my co – supervisor.** Thank you for your interest in my study and for your advice, support and input throughout this research.

- **Marissa Stadler, my co-student on this project.** Thank you for leading the way and for your support during the physical activity intervention programme.

- **Dr. Suria Ellis,** for the guidance in the statistical analyses.

- **Prof. Lesley Greyvenstein,** for the language editing.

- **Prof. Casper Lessing,** for the reference editing of this dissertation.

- Lastly and most importantly, **my family**, my mother, **Santie de Bruyn**, step father, **Kobus van Eeden**, grandmother, **Susan de Bruyn** and my three beautiful sisters, **Welma, Kobie and Marita**, who are not only sisters but also my best friends in the world. Thank you for all your love, faith and patience.

- To **my loving friend, Walter Botha.** Thank you for always listening, loving, understanding, believing and supporting me. Thank you for all the beautiful memories we share, my studies would not be complete without your love.

- Finally I would like to **dedicate** this research and my M.Sc degree **to my mother, Santie de Bruyn**. Thank you for being the perfect role model to me. You are the most amazing woman I have ever met. Thank you for always understanding, for all your wisdom, friendship, valuable advice and for the inspiration to continue with my academic work and successfully complete any task I start. Everything I achieved in life is because you are always there for me.

The author,

Sanri du Preez

November 2008

Declaration

The co-authors of the articles which form part of this dissertation, Prof. J. Hans de Ridder (supervisor) and Dr. M. Andries Monyeki (co-supervisor) hereby give permission to the candidate, Miss S.M. du Preez, to include the two articles as part of a Masters dissertation. The contribution, both supervisory and supportive, of these co-authors was kept within limits, thereby enabling the candidate to submit this dissertation for examination purposes. This dissertation, therefore, serves as partial fulfilment of the requirements for the M.Sc. Degree within the School of Biokinetics, Recreation and Sport Science in the Faculty of Health Science at the North-West University, Potchefstroom Campus.

Prof. J. Hans de Ridder

Supervisor and Co-author

Dr. M. Andries Monyeki

Co-supervisor and Co-author

Abstract

The influence of physical activity on the body composition and health related fitness of 9 to 13 year old boys

Physical activity plays a vital role in all children's lives. Physical activity prevents various life threatening diseases, including cardiovascular diseases, obesity, hypertension, cancer and many more. Physical activity also includes a number of other benefits of which psychological, cognitive, mental and academic improved performance are only a few to be mentioned. Unfortunately the modern century leads to a high prevalence of juvenile sedentary lifestyle. Physical activity is not one of the focus areas in schools or in homes. Modern technology causes children to spend more time being sedentary than physically active. It is essential to do further research on the influence of physical activity on the body composition and health related physical fitness of children. This provides an opportunity to emphasize the importance of physical activity during school time and as a lifestyle at home. Children, parents and physical educators need to realize the essence of the total wellbeing of individuals and thus incorporate a physically active lifestyle in children's lives.

This dissertation is comprised of five chapters of which two chapters (3 and 4) can be read independently as they are written in the form of research articles.

A literature review was conducted in Chapter 2 to gain more insight on various topics related to physical activity, body composition and physical fitness. Aspects focused on in this review include the benefits of physical activity, physical fitness, the risks of physical inactivity and anthropometrical characteristics.

The first objective of this study was to determine the influence of a ten month physical activity intervention programme on the body composition of 9 – 13 year old boys. The second objective was to examine the influence of a ten month physical activity intervention programme on the health related fitness of 9 – 13 year old boys.

A cross-sectional experimental design was used. A total of 322, 9 -13 year old boys formed part of the study. The ten month physical activity intervention also included pre and post-tests. Two schools were selected to represent an experimental and a control group. School A, the experimental group (EG) was represented by 173 subjects and School B, the control group (CG) was represented by 149 subjects. The two schools are in the Gauteng Province, in South Africa and approximately seven kilometres from each other. The learners from the two schools also participated against each other during sporting events.

The participants of school A took part in half hour sessions of physical activity twice per week and the participants from school B did not take part in the physical activity intervention programme. The study was explained to all the parents and also confirmed with a letter that was signed to give each child the appropriate permission to take part in this study.

Anthropometric data were collected according to standard protocol proposed by International Society for the Advancement of Kinanthropometry (ISAK, 2001). The various measurements taken included body mass, stature, triceps skinfolds, subscapular skinfolds and calf skinfolds and humerus and femur breadths. These measurements were used to determine the body mass index and percentage body fat of the subjects.

The criteria of EUROFIT tests protocol were used, as these are designed primarily for school-aged children (6 – 18 years). The EUROFIT test is a sensitive, individual and reliable instrument for assessing its various principal dimensions, cardiovascular endurance, agility, strength, muscular endurance, flexibility and speed. EUROFIT takes the normal school/class environment into account. These different dimensions are tested for the outcomes of different results. A pre-test was done in the beginning of the intervention period and a follow-up post-test evaluation was done ten months subsequent to the onset of the programme.

The data were collected on the data sheets. To analyze the data the pre and post-tests were examined by the use of Statistica (Statsoft, Inc. 2008). Descriptive statistics were used to define information on all body composition and physical fitness variables. The pre and post-test comparisons were determined by use of a dependent t-test and age groups were compared by using independent t-tests (Thomas, Nelson & Silverman, 2005). Practical significance was also calculated (Thomas *et al.*, 2005). A small practically significant influence was determined by effect size d-value ≥ 0.2, a medium or substantial practically significant effect was determined by an effect size d-value ≥ 0.5 and whereas a large practically significant effect was determined by effect size d-value ≥ 0.8. A p-value smaller to 0.05 was accepted as statistically significant (Ellis & Steyn, 2003; Steyn, 2005; Thomas *et al.*, 2005). Comparisons between the EG and CG for the pre-test and post-test respectively were done by means of an independent t-test.

The findings for the first objective were based on the research question of whether a ten month Physical Activity Intervention Programme (PAI) will have an influence on the body composition of 9 - to 13 year old boys. Statistically and practically significant improvements were found for the increase in stature. In addition significant decreases in percentage body fat and BMI for EG were evident after the ten month physical activity intervention. The CG showed that inactivity leads to an increase in the body mass index and percentage body fat.

As for the second objective, the findings for the influence of the ten month physical activity intervention programme on health related physical fitness of 9 - 13 year old boys are reported, the results show that the EG improved statistically significant in all seven physical fitness components tested and improved practically significant in five of the seven physical fitness components tested. Improvements were evident in the 10 x 5m shuttle run, in the multi phase physical fitness test (Bleep-Test), the sit-up test, bent arm hang test, standing broad jump and in the grip strength test as opposed to the CG whose results did not change much from the pre-test to the post-test. From the findings in the present study it can be concluded that when engaging in physical activity over a ten month period, health related physical fitness improves.

Given the findings, the study further recommends the inclusion of physical activity programmes in schools and after school community physical activity programmes.

Key words: Juvenile obesity, physical fitness, physical activity, body composition, anthropometry, children, health, sedentary lifestyle, hypo-kinetic diseases.

Opsomming

Die effek van fisieke aktiwiteit op liggaamsamestelling en gesondheids verwante fiksheid by 9- tot 13-jarige seuns

Fisieke aktiwiteit speel 'n baie belangrike rol in alle kinders se lewens. Fisieke aktiwiteit voorkom verskeie lewensgevaarlike siektetoestande, wat onder andere kardio-vaskulêre siektes, obesiteit, hoë bloeddruk, kanker en vele meer insluit. Daar is ook heelwat ander voordele soos psigologiese, kognitiewe, geestelike en akademiese prestasie verbetering, om slegs 'n paar te noem. Ongelukkig veroorsaak die moderne tegnologie van vandag dat die voorkoms van 'n onaktiewe leefwyse drasties verhoog veral onder kinders. Moderne tegnologie veroorsaak dat kinders meer tyd spandeer om onaktief te wees as aktief. Dit is dus van kardinale belang om verdere navorsing te doen oor die effek van fisieke aktiwiteit op liggaamsamestelling en gesondheidsverwante fiksheid. Hierdie navorsing sal die geleentheid bied om klem te lê op die belangrikheid van die totale welstand van individue en om fisieke aktiwiteit in kinders se lewens te inkorporeer.

Hierdie verhandeling is saamgestel uit vyf hoofstukke waarvan twee hoofstukke (3 en 4) in die vorm van artikels aangebied word en dus apart gelees kan word.

In Hoofstuk 2 is 'n literatuuroorsig gedoen om meer insig en inligting aangaande die probleem te bekom. Die kern van hierdie hoofstuk was om die verband tussen fisieke aktiwiteit, liggaamsamestelling en fisieke fiksheid vas te stel. Fokuspunte in hierdie hoofstuk was die voordele wat fisieke aktiwiteit bied, fisieke fiksheid, die risikos van onaktiwiteit en antropometriese eienskappe van kinders.

Die eerste doelstelling van hierdie studie was om vas te stel wat die effek van 'n tien maande fisieke aktiwiteits intervensieprogram op die liggaamsamestelling van 9- tot 13-jarige seuns sal wees. Die tweede doelstelling was om te ondersoek wat die effek van 'n tien maande fisieke aktiwiteits intervensieprogram op die gesondheidsverwante fiksheid van 9- tot 13-jarige seuns is.

Vir hierdie studie word gebruik gemaak van 'n eenrigting oorkruis eksprimentele ontwerp. In totaal was daar 322, 9- tot 13- jarige seuns wat deelgeneem het aan hierdie studie. Die tien maande fisieke aktiwiteits intervensieprogram het ook voor en na toetse ingesluit. Twee skole is geselekteer om deel te neem aan hierdie studie waarvan skool A die eksperimentelegroep (EG) verteenwoordig het en skool B die kontrolegroep (KG). Die EG het uit 173 proefpersone bestaan en die KG het uit 149 proefpersone bestaan. Die twee skole is ongeveer sewe kilometer van mekaar af in die Gauteng Provinsie in Suid Afrika. Die skole neem ook tydens sportseisoene teen mekaar deel. Die proefpersone in die EG het tweemaal per week aan 'n half-uur voorgeskrewe fisieke aktiwiteitsessie deelgeneem. Die proefpersone in die KG het aan geen voorgeskrewe fisieke aktiwiteits program deelgeneem nie. Tydens 'n inligtingsessie was hierdie studie aan alle ouers verduidelik en 'n ingeligte toestemmings brief was geteken deur elke ouer om aan die kind toestemming te gee om aan hierdie studie deel te neem.

Antropometriese data was volgens die standaarde wat aangedui word deur die "International Society for the Advancement of Kinanthropometry" gedoen (ISAK, 2001). Die verskeie mates wat geneem was sluit die volgende in, liggaamsmassa, liggaamslengte, trisep-, subskapulêre- en kuit velvoue sowelas humerus- en femur deursnee. Uit hierdie mates is die liggaamsmassa-indeks (LMI) en die persentasie liggaamsvet van elke proefpersoon bepaal.

Die kriteria van die EUROFIT toets protokol is vir hierdie studie gebruik aangesien dit hoofsaaklik ontwerp is vir kinders tussen die ouderdomme 6- tot 18-jaar. Die EUROFIT toets protokol is sensitief, individueel en 'n betroubare instrument vir die waardebepaling van verskeie hoof dimensies naamlik kardio-vaskulêre uithouvermoë, ratsheid, spierkrag, spier uithouvermoë, soepelheid en spoed. Die EUROFIT neem die normale skool/klaskamer omgewing in ag. Die verkillende dimensies word getoets vir die uitkomste van die verskillende resultate. Aan die begin van die fisieke aktiwiteits intervensieprogram is daar 'n voortoets gedoen en 'n opvolg na-toets is gedoen tien maande na die aanvang van die program.

Die data is ingesamel op data opname profielkaarte. Statistica 2004 is gebruik om hierdie data te analiseer (Statsoft, Inc. 2008). Beskrywende statistiek is gebruik om die inligting aangaande liggaamsamestelling en fisieke fiksheids veranderlikes weer te gee. Afhanklike t-toetse is gebruik om die voor en na-toetse met mekaar te vergelyk en onafhanklike t-toetse is gebruik om die verskillende ouderdomsgroepe met mekaar te vergelyk. Praktiese betekenisvolheid is bepaal d.m.v. effekgrootte. 'n D-waarde van $\geq$ 0.2 word as 'n klein praktiese betekenisvolheid beskou, 'n d-waarde van $\geq$ 0.5 dui matige praktiese betekenisvolheid aan en 'n d-waarde van $\geq$ 0.8 word as 'n groot praktiese betekenisvolheid beskou. 'n P-waarde kleiner as 0.05 is aanvaar as statisties betekenisvol (Ellis & Steyn, 2003; Steyn, 2005, Thomas *et al.*, 2005). Vergelykings tussen die voor en na-toetse van die EG en die KG is deur middel van onafhanklike t-toetse gedoen.

Rakend die eerste doelstelling wat gebaseer was op die navorsingsvraag of 'n tien maande fisieke aktiwiteits-intervensieprogram 'n effek op die liggaamsamestelling van 9- tot 13-jarige seuns sal hê, is daar 'n statisties en prakties betekenisvolle verhoging in die lengte van die seuns. Betekenisvolle afnames in die liggaamsvet en LMI waardes vir die EG na die tien maande fisieke aktiwiteits intervensie is waargeneem. Die KG toon dat onaktiwiteit tot 'n verhoging in LMI sowel as persentasie liggaamsvet lei.

Wat die tweede doelstelling betref, word die bevindinge vir die effek van die tien maande fisieke aktiwiteits intervensieprogram op die gesondheidsverwante fisieke fiksheid van 9- tot 13- jarige seuns gerapporteer, die resultate wys daarop dat die EG in al sewe fiksheids komponente statisties betekenisvolle verbeteringe getoon en in vyf van die sewe fiksheids komponente prakties betekenisvolle verbeteringe getoon het. Verbetering is aangetoon in die 10 x 5m "Shuttle Run", in die multi-fase fisieke fiksheids-toets ("Bleep" Toets), die opsit-toets, die gebuigde armhang, staande verspring, en handgreepkrag. Die KG het nie veel verbeter of verander vanaf die voor- tot die na-toetse nie. Uit die bevindinge van die huidige studie kan die gevolgtrekking gemaak word dat gesondheidsverwante fiksheid sal verbeter wanneer daar oor 'n tydperk van tien maande aan fisieke aktiwiteit deelgeneem word.

Uit die resultate van hierdie studie word dit aanbeveel dat fisieke aktiwiteit in skole en in naskool aktiwiteits programme geïnkorporeer moet word.

Sleutel woorde: Kinderobesiteit, fisieke fiksheid, fisieke aktiwiteit, liggaamsamestelling, antropometrie, kinders, gesondheid, onaktiewe leefstyl, hipo-kinetiese siektes.

Table of Contents

List of Tables

List of Figures

List of Acronyms and Abbreviations

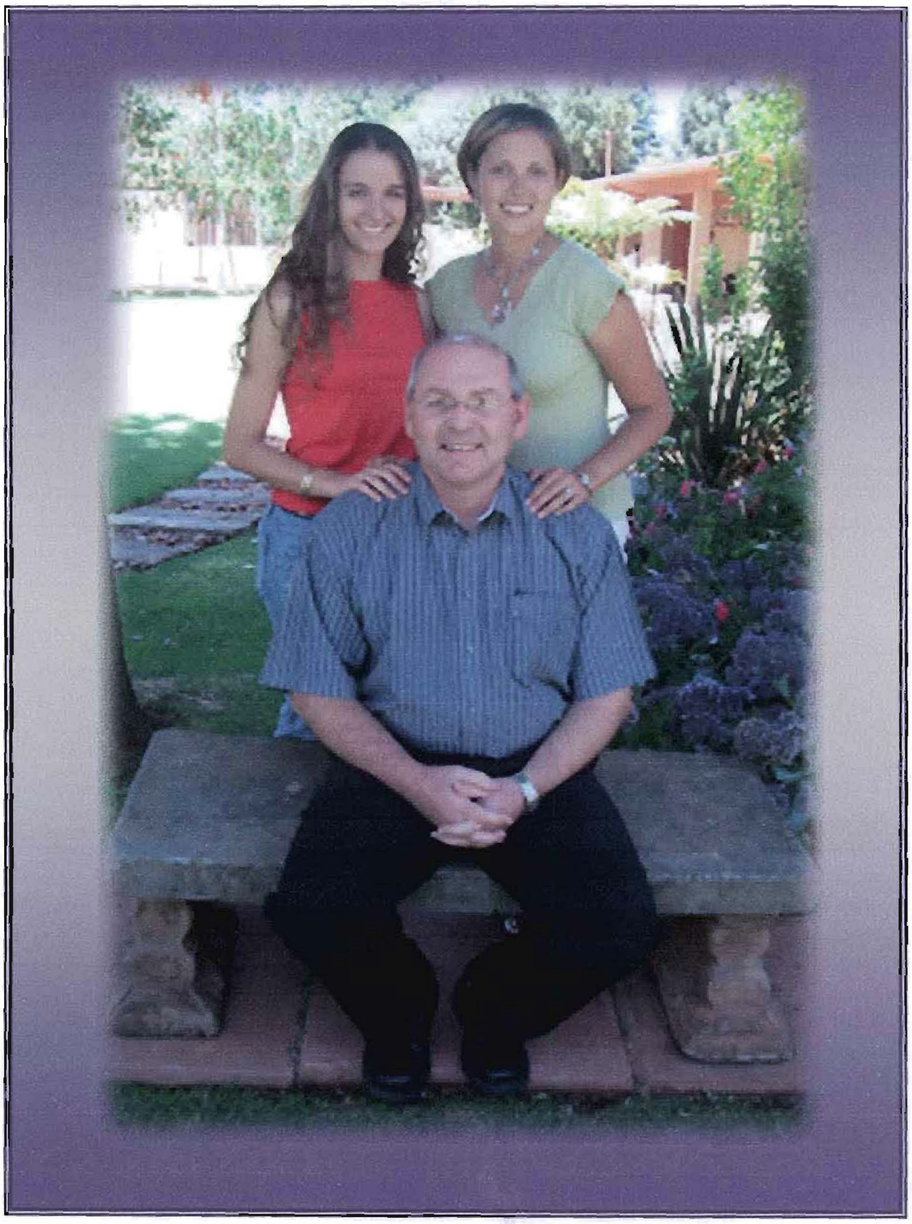
ACSM	American Council of Sports Medicine
BIA	Bioelectrical Impedance Analysis
BM	Body Mass
BMI	Body Mass Index
BP	Blood Pressure
CDC	Centers for Disease Control
CG	Control Group
cm	centimeter
CRF	Cardiorespiratory Fitness
DEXA	Dual X-Ray Absorptiometry
Ed	Edition
EG	Experimental Group
EPPI-Centre	The Evidence for Policy and Practice Information and Co-ordinating Centre.
EUROFIT	European Fitness Test
g/mm^2	gram per millimeter square
HC	Hip Circumference
HHR	High Health Risk
HR	heart rate
ISAK	International Society for the Advancement of Kinanthropometry
JAMA	Journal of American Medical Association
kg	kilogram
kg/m^2	kilogram per meter square
Km/h	Kilometer per hour
LDL	Low-Density Lipoprotein

LHR	Low Health Risk
M	Meter
Max	Maximum
mg/dL	Milligram per deciliter
Min	Minimum
MMC	Mid arm muscle circumference
mmHG	Millimeter Mercury
MMWR	Morbidity and mortality weekly report
n	Quantity
NCCDPHP	National center for chronic disease prevention and health promotion, United States of America
NDAS	National data analysis system, United States of America
NHANES	National Health and Nutritional Examination Survey
NHES	National Human Education Society
p	page
PA	Physical Activity
PAI	Physical Activity Intervention
PAIx	Physical Activity Index
PF	Physical Fitness
PWC	Physical workload capacity
RDA	Recommended Daily Allowances
S.A.	South Africa
SA NFCS	South African National Food Consumption Survey
SASMA	South African Sport Medicine Association
SASReCon	South African Sport and Recreation Conference
SD	Standard Deviation
Sec	Seconds
SHAPE study	Study on Heart Failure Awareness and Perception in Europe
T.V.	Television
T2DM	Type 2 Diabetes Mellitus
THUSA	Transition and Health during Urbanization of South Africans

THUSA BANA	Transition and Health during Urbanization of South Africans for children ("help the children")
U.S.	United States
USA	United States of America
VLPL	Very-Low Density Lipoprotein
VO_2Max	Maximal Oxygen Consumption
WC	Waist Circumference
WHO	World Health Organisation
WHR	Waist to hip ration
$\bar{X}$	Average

Chapter 1

PROBLEM AND AIMS OF THE STUDY



1 Problem and aims of the study

1.1 INTRODUCTION

Most severe complications and adulthood diseases are embedded in childhood and adolescence years (Dao *et al.*, 2004:290; Whitney & Rolfes, 2002:552). During this and other studies it was found that the effects of a multidisciplinary weight loss intervention on body composition in obese adolescents (Dao *et al.*, 2004:291). Healthy lifestyle strategies including physical activity and healthy eating patterns collaborate in reducing body fat percentage, total fat mass and BMI (Ara *et al.*, 2004:1587; Dao *et al.*, 2004:292; DeStefano *et al.*, 2000:63). Regular participation in physical activity will improve the child's physical fitness (Colchino *et al.*, 2000:977). It can therefore be said that recent studies on youth fitness showed that physical activity improves various fitness components in children. Examples of these various components are aerobic fitness (running time for 300m), aerobic capacity (VO_2Max), cardiovascular endurance (1-mile run), muscular strength (push ups), muscular endurance (sit-ups), flexibility, running speed (running time for 30m) and height jumped (squat jumps) (Ara *et al.*, 2004:1588-1590; Colchino *et al.*, 2000:977; DeStefano *et al.*, 2000:63).

The importance of physical activity has to be emphasized and refers to a healthy childhood, a healthy adulthood and the prevention of obesity and various diseases caused by inactivity (Janssen *et al.*, 2004:364; Steinbeck, 2001a:S28). Research showed that physical activity prevents obesity and the increased prevalence of overweight in the youth (Ara *et al.*, 2004:1585; DeStefano, 2000:63; Janssen *et al.*, 2004:363). Increased levels of physical activity account for a decrease in BMI levels, waist to hip ratio (WHR), body fat percentage and body weight (Ara *et al.,* 2004:1587; Colchino *et al.,* 2000:977; Dao *et al.*, 2004:296; Steinbeck, 2001b:120) and hence the prevention of coronary diseases in childhood such as coronary artery diseases and type 2 diabetes mellitus (T2DM).

Physical activity does not only account for the improvement of physical health, but is also associated with various other advantages such as improvement of academic performance, cognitive abilities, self-perception, learning and movement disabilities and the social aspect of health, behaviour and discipline (Dwyer *et al.,* 2001:236; Shephard, 1997:113). Children participating in regular physical activity showed a positive relation to self-perception and self-worth (Colchino *et al.*, 2000:977; Dwyer *et al.*, 2001:235).

Dwyer *et al.* (2001:230) studied the relationship of academic performance to physical activity and fitness in children. Results of this study showed that children who had higher scholastic ratings, performed better in the 50m-run, 1.6km run, completed more sit-ups, and leapt a greater distance in the standing long jump. Shephard (1997:113) reported various studies confirming that an increase in physical activity will enhance academic performance. These studies included the Trois Riviers experiment and the SHAPE study showing that regardless of the time eliminated from the academic curricular activities, more time for fitness intervention showed gains in behavioural and arithmetic score (Shephard, 1997:116-120). Two other studies reported by Shephard (1997:117-119) showed that weekly participation in physical activity significantly associated with high academic scores. Interestingly, body weight and BMI levels were negatively related to scholastic performance, and thus, if a child participates in physical activity, the BMI levels and body weight will be lower and children who are physically active will perform better academically (Dwyer *et al.,* 2001:233). The possible mechanisms for these better academic and cognitive performances in physically active children, according to Dwyer *et al.* (2001:235) and Shephard (1997:119-120), are that physical activity increases blood flow to the cortex of the brain, making the child's concentration abilities easier. Exercise also alternates relative proportions of various branch amino acids, which increase the transfer of the serotonin precursor tryptophan across the blood brain barrier, therefore having a calming effect on children and facilitating children to sit and concentrate on the academic work that has to be done (Shephard, 1997:119-120).

1.2 PROBLEM STATEMENT

Research studies indicate sedentary lifestyle as a major problem worldwide facing many children of today (Ara *et al.,* 2004:1585; Janssen *et al.,* 2004:360; Whitney & Rolfes, 2002:552). The trend of a sedentary lifestyle among youth progressively increases as children approach adolescent years (Steinbeck, 2001b:120). Steinbeck's report in 1997 in the school fitness and physical activity survey (NSW) found that 30% of 8 and 10 year old boys have low aerobic capacity (Steinbeck, 2001b:120). Dao *et al.* (2004:290) acknowledges that the prevalence of obesity has doubled every 15 years since 1970 and reached 16% in the year 2000. According to the Centre for Disease Control's (CDC) behavioural risk factor surveillance system, the prevalence of obesity and overweight in children and adolescence has increased by 27% in the last decade to reach 13 to 14% in 1999 (Durstine & Moore, 2003:149).

Sedentary lifestyle is a direct cause for juvenile obesity, and is most likely to be continued as adult life starts (Anon, 2004:5; Ara *et al.,* 2004:1585; Dao *et al.,* 2004:290; Whitney & Rolfes, 2002:552). On the other hand it is stated that a child who is active will continue to live actively during adult life (Shephard, 1997:123). Many reasons for the decline in physical activity and the sedentary lifestyle of children are discussed in various research studies. The factors responsible for this decline, among others, include the technological progress of the 20^{th} century and the low priority that physical education and activity has in schools in many countries. Parents' own physical activity levels and their level of motivation for children to participate in physical activity are further factors (Engelbrecht *et al.,* 2004:46). In addition, the dangerous environment children have to deal with currently is also a contributing factor to inactivity (Engelbrecht *et al.,* 2004:46; Whitney & Rolfes, 2002:552). Violence, especially in low socio-economic, densly populated areas is high and this further restricts children from being physically active (Engelbrecht *et al.,* 2004:47).

Furthermore, internet, computer and Play Station games as well as watching television are also found to be factors responsible for sedentary lifestyle in youth (Whitney & Rolfes, 2002:552). Coetzee and Underhay (2003:33) proclaimed that the number of hours that are put aside for watching television is distressing and leads to a sedentary lifestyle. Engelbrecht *et al.* (2004:46) reviewed studies and reported that 26% American children watch more than four hours of television and 67% watch more than two hours per day. Many researchers found a positive relationship between the number of hours children spend watching television and their body mass index (BMI) values, body weight and body fat percentage (Engelbrecht *et al., 2004:47;* Janssen *et al.,* 2004:363; Steinbeck, 2001b:124). Steinbeck (2001b:124) acknowledges that while watching television, children are more inactive than during various other "still" events, for example drawing or reading. Physical activity levels are therefore influenced by this abundant amount of time spent in front of the television (Dao *et al.*, 2004:290; Janssen *et al.,* 2004:361; Steinbeck, 2001b:124). Television also cultivates bad eating habits and children see television time as snack time. This prevalence can be due to all the advertisements of various foods and along with snacks come all sorts of fast foods and beverages (Janssen *et al.*, 2004:361; Steinbeck, 2001b:124; Whitney & Rolfes, 2002:552). It is recommended by the Canadian association for health, physical education, recreation and dance that children should increase their physical activity time by at least 30 minutes and decrease the time they spend being sedentary by watching television, playing computer games and surfing the internet by at least 30 minutes a day (Anon, 2005:2).

Although Dao *et al.* (2004:296) claim a low-caloric diet to be unnecessary to achieve weight loss, he admits that a balanced diet is essential during the childhood years. It is important that diets are complied according to the national recommended daily allowances (RDA's) for subjects with low physical activity of the same age and sex, especially low-caloric diets, as this will contribute to growth status (Dao *et al.*, 2004:291-296; Whitney & Rolfes, 2002:552). In contrast to Dao *et al.* (2004:291-296), other researchers show that eating habits and diet are important parts of a weight loss and a healthy eating programme (Steinbeck, 2001b:120; Whitney & Rolfes, 2002:552). Children who prefer high fat food tend to become more overweight than their peers (Whitney & Rolfes, 2002:552).

A sedentary lifestyle could lead to various life-threatening diseases (Colchino *et al.,* 2000:977) such as overweight, diabetes mellitus, cardiovascular diseases, hypertension, and obesity. These diseases can lead to premature illness and death (Ara *et al.,* 2004:1585; Colchino *et al.,* 2000:977; Janssen *et al.*, 2004:360; Whitney & Rolfes, 2002:571). Research shows that parental obesity or overweight is an early predictor for childhood and adolescent obesity (Whitney & Rolfes, 2002:552). Steinbeck (2001b:118) reviewed in the Bogalusa study that those children whose parents were overweight had early coronary artery disease and developed an adverse cardiovascular risk profile, whereas children whose parents had a normal weight in their childhood years were not as affected. Children who are obese display a blood lipid profile indicative of the first stage of coronary atherosclerosis development (Whitney & Rolfes, 2002:553). Coronary atherosclerosis implicates the accumulation of fibrous tissue and blood lipids along the walls of the coronary arteries. Blocked arteries can eventually account for a heart attack or a stroke when the blood flow to the heart or brain is restricted (Durstine & Moore, 2003:32). The above-mentioned blood lipid profiles account for high levels of total cholesterol, triglycerides, low-density lipoprotein (LDL) cholesterol and very-low density lipoprotein (VLPL) (Whitney & Rolfes, 2002:553). Apart from these risks related to obesity, obese children tend to develop pediatric hypertension (Whitney & Rolfes, 2002:553). Another risk factor threatening sedentary youth is T2DM that mostly occurs in overweight individuals. Recently research reported that the number of T2DM cases occurring in adolescence is increasing (DeStefano *et al.*, 2000:61; Steinbeck, 2001b:119; Whitney & Rolfes, 2002:552).

Children adapt habits and lifestyle behaviours from a very early age and are much more flexible than adults to change these bad behaviours into good, healthy ones. Thus to prevent all the above-mentioned diseases it is critical to take action as early as possible and make it a habit to be and stay physically active from childhood years (Shephard, 1997:123). Action to be taken to encourage children to participate in a healthy lifestyle, should include parental education and motivation. To be an active example for a healthy lifestyle, they should encourage physical play time (Shephard, 1997:123). More ways to improve physical activity should also include implementing physical activity in the daily lives of children. Furthermore, make sure parents feel safe to let their children walk or cycle to school (Anon, 2002:701) and that parks and playgrounds are safe for children in terms of apparatus as well as crime (Cradock *et al.,* 2005:357; Kirtland *et al.,* 2003:329). School boards should be strongly encouraged to implement a daily physical activity and health education programme during school time; this is advised to be introduced in the youngest grades of the school. (Burten *et al.*, 2003:3*;* Orleans *et al.,* 2003:77; Shephard, 1997:123). It is important for parents to motivate children and to provide the optimum support their children need. Parents are the role-models of many children. It is thus important for parents to be a good example for children in terms of physical activity levels (Fogelholm *et al.*, 1999:1266; Trost *et al.*, 2003:277). It is the responsibility of the parents to make sure that children keep themselves busy with healthy activities instead of watching too much T.V. or taking part in too much computer activities (Burten *et al.,* 2003:3). When these implementations take place, it will be a turning point for physical activity levels and for the youth and future adults' quality of life.

Given the above-mentioned background, the present study aims to add more scientific knowledge on the effects of minimizing and reducing sedentary lifestyle, and efforts on how to increase physical activity, on physical fitness and enhance healthy living and body composition. This would most likely lower the prevalence of obesity and overweight which are the cause of various other diseases.

The first question to be answered by this study is whether a ten month physical activity intervention programme (PAI) will have a positive effect on the body composition of 9 – 13 year old boys. The second question to be answered is whether a ten month physical activity intervention programme (PAI) will show statistically and practically significant improvement of the health related physical fitness levels of 9 – 13 year old boys. The answers to these questions will better describe the value of a physical activity intervention programme on school boys. This intervention programme can provide physical educators, parents and children with answers to improve physical fitness and health amongst school boys between the ages 9 – 13 years.

1.3 OBJECTIVES

The objectives of this study are:

1.3.1 To determine whether a ten month physical activity intervention programme (PAI) will have statistically, as well as practically significant improvement on the body composition of 9 – 13 year old boys.

1.3.2 To determine whether a ten month physical activity intervention (PAI) will have statistically, as well as practically significant improvement on the health related physical fitness of 9 – 13 year old boys.

1.4 HYPOTHESIS

This study is based on the following hypotheses:

1.4.1 The implementation of a ten month physical activity intervention programme (PAI) has statistically, as well as practically significant improvement on the body composition of 9 – 13 year old boys.

1.4.2 The implementation of a ten month physical activity intervention programme (PAI) has statistically, as well as practically significant improvement on the health related physical fitness of 9 – 13 year old boys.

1.5 STRUCTURE OF DISSERTATION

The results of this dissertation are presented in the form of separate research articles which can be read independently as chapters (Figure 1). Each article is submitted for publication in an accredited scientific journal with interests in the topic.

Following this introductory ***Chapter 1***, which present the problem statement, aims, hypothesis and the structure of the dissertation, is a review of related literature.

Chapter 2 is based on a literature review of the most important literature on this topic that will form the basis for the research articles. Statistics on the prevalence of obesity worldwide as well as the causes of a sedentary lifestyle among children are discussed in this chapter. An overview of chronic diseases as a result of obesity is also given and the value of physical activity at home and in schools is emphasized.

The following two chapters are discussed in the various articles:

Chapter 3 is a research article, presented for publication in the "African Journal for Physical, Health Education, Recreation and Dance", describing the influence of a ten month physical activity intervention programme on the body composition of 9 – 13 year old boys. Some author guidelines are not followed exactly as prescribed by the "African Journal for Physical, Health Education, Recreation and Dance", this is only for technical reasons of this dissertation and will be corrected for purpose of the journal.

Chapter 4 is a research article, presented for publication in the "African Journal for Physical, Health Education, Recreation and Dance", discussing the influence of a ten month physical intervention programme on the health related physical fitness of 9 – 13 year old boys. Some author guidelines are not followed exactly as prescribed by the "African Journal for Physical, Health Education, Recreation and Dance", this is only for technical reasons of this dissertation and will be corrected for purpose of the journal.

Chapter 5 will conclude the dissertation with a general conclusion, consequences and recommendations.

References of Chapters 1, 2 and 5 are presented according to the North-West University (Potchefstroom Campus) guidelines. ***References of Chapters 3 and 4*** are presented according to the specific journal's guidelines to which the articles are submitted and are listed at the end of each chapter. ***Guidelines of each journal, informed consent forms and the data collection sheet*** are included in the Appendixes.

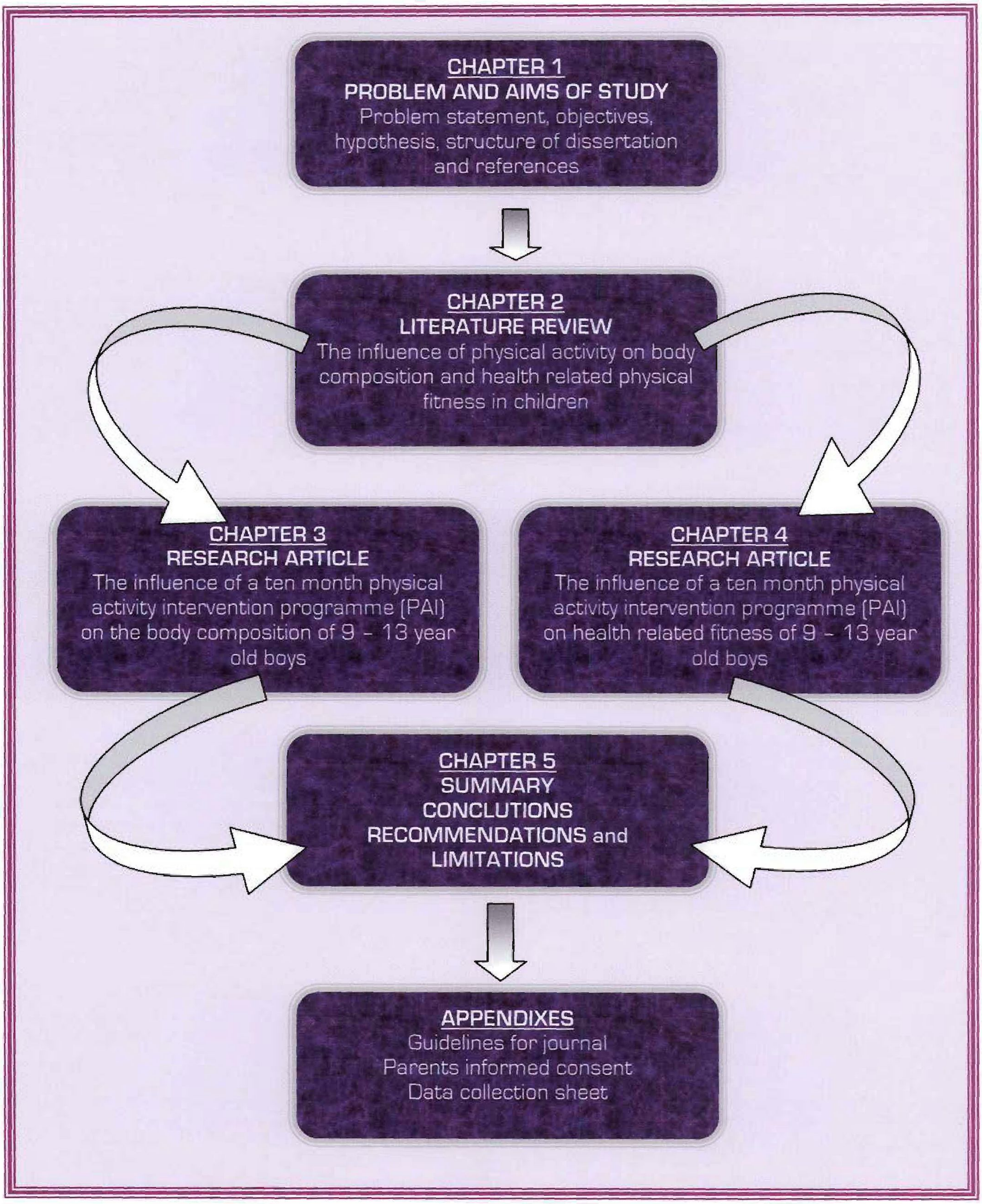


Figure 1.1: Structure of Dissertation

1.6 REFERENCES

ANON. 2002. Barriers to children walking and biking to school, United States, 1999. *MMWR Centers for disease control and prevention,* 51(32):701-704.

ANON. 2004. Inactivity cited in overweight youths. *Journal of physical education, recreation and dance,* 75(9):5.

ANON. 2005. Quality school health: addressing obesity and physical inactivity in Canadian children. *Canadian Association for health, physical education, recreation and dance.* Canada. p. 1-3.

ARA, I., VINCENTE-RODRIGUEZ, G., JIMENEZ-ROMIRES, J., DORADO, C., SERRANO-SANCHEZ, J.A. & CALBET, J.A.L. 2004. Regular participation in sports is associated with enhanced physical fitness and lower fat mass in prepubertal boys. *International journal of obesity,* 28:1585-1593.

BURTEN, G., HARDEN, A., REES, R., KAVANAGH, J., OLIVER, S. & OAKLEY, A. 2003. Children and physical activity: a systematic review of barriers and facilitators - Executive summary. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

COETZEE, M. & UNDERHAY, C. 2003. Gesondheidsrisikogedrag by adolessente van verskillende ouderdomme. *South African journal for research in sport, physical education and recreation,* 25(2):27-36.

COLCHINO, K., ZYBERT, P. & BASCH, C.E. 2000. Effects of after-school physical activity on fitness, fatness, and cognitive self-perception: a pilot study among urban, minority adolescent girls. *American journal of public health,* 9(6):977-978.

CRADOCK, A.L., KAWACHI, I., COLDITZ, G.A., HANNON, C., MELLY, S.J., WIECHA, J.L. & GORTMAKER, S.L. 2005. Playground safety and access in Boston neighborhoods. *American journal of preventive medicine,* 28(4):357-363.

DAO, H.H., FRELUT, M.L., OBERLIN, F., PERES, G., BOUTGEOIS, P. & NAVARRO, J. 2004. Effects of a multidisciplinary weight loss intervention on body composition in obese individuals. *International journal of obesity,* 28:290-299.

DeSTEFANO, R.A., CAPRIO, S., FAHEY, J.T., TAMBORLANE, W.V. & GOLDBERG, B. 2000. Changes in body composition after a 12-week aerobic exercise programme in obese boys. *Pediatric diabetes,* 1:61-65.

DURSTINE, J.L. & MOORE, G.E. 2003. ACSM'S exercise management for persons with chronic diseases and disabilities. 2nd ed. Champaign, Ill.: Human Kinetics. 374p.

DWYER, T., SALLIS, J.F., BIZZARD, L., LAZARUS, R. & DEAN, K. 2001. Relation of academic performance to physical activity and fitness in children. *Pediatric exercise science,* 13:225-237.

ENGELBRECHT, C., PIENAAR, A.E. & COETZEE, B. 2004. Racial background and possible relationships between physical activity and physical fitness of girls: The Thusa Bana Study. *South African journal for research in sport, physical education and recreation,* 26(1):41-53.

FOGELHOLM, M., NUUTINEN, O., PASANEN, M., MyöHäNEN, E. & SääTELä, T. 1999. Parent-child relationship of physical activity patterns and obesity. *International journal of obesity,* 23:1262-1268.

JANSSEN, I., KATZMARZYK, P.T., BOYCE, W.F., KING, M.A. & PICKETT, W. 2004. Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *Journal of adolescent health,* 35:360-367.

KIRTLAND, K.A., PORTER, D.E., ADDY, C.L., NEET, M.J., WILLIAMS, E.J., SHARPE, P.A., NEFF, L.J., KIMSEY, C.D. & AINSWORTH, B.E. 2003. Environmental measures of physical activity supports: perception versus reality. *American journal of preventive medicine,* 24(4):323-331.

ORLEANS, C.T., KRAFT, M.K., MARX, J.F. & McGINNIS, J.M. 2003. Why are some neighborhoods active and others not? Charting a new course for research on the policy and environmental determinants of physical activity. *Annals of behavioral medicine,* 25(2):77-79.

SHEPHARD, R.J. 1997. Curricular physical activity and academic performance. *Pediatric exercise science,* 9:113-126.

STEINBECK, K. 2001a. Obesity in children - the importance of physical activity. *Australian journal of nutrition and dietetic,* 58 Supplement 1:S28-S32.

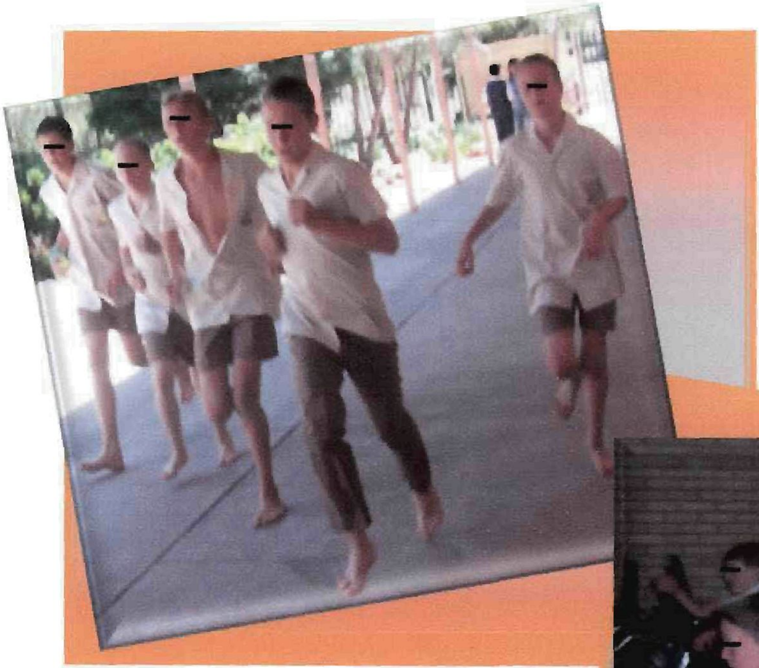
STEINBECK, K.S. 2001b. The importance of physical activity in the prevention of overweight and obesity in childhood: a review and an opinion. *International association for study of obesity reviews,* 2:117-130.

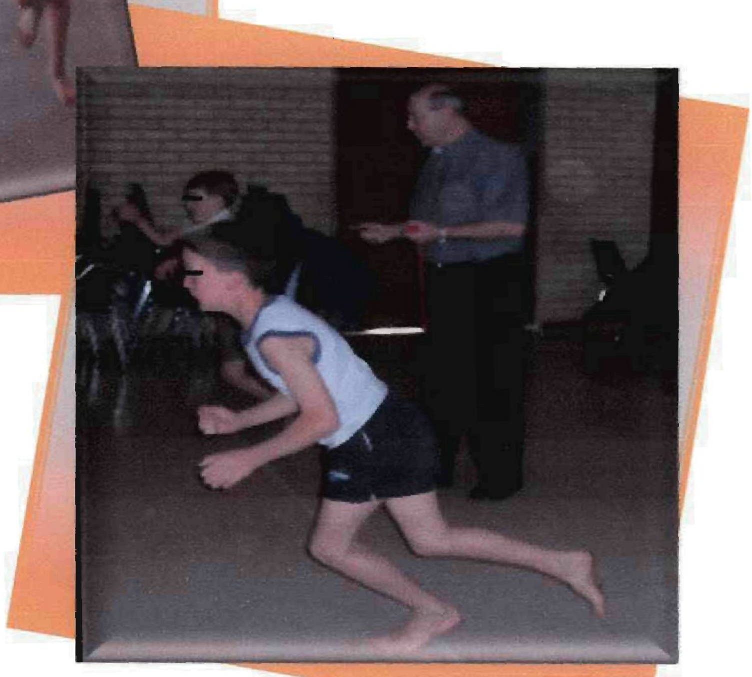
TROST, S.T., SALLIS, J.F., PATE, R.R., FREEDSON, P.S., TAYLOR, W.C. & DOWDA, M. 2003. Evaluating a model of parental influence on youth physical activity. *American journal of preventive medicine,* 25(4):277-282.

WHITNEY, E.N. & ROLFES, S.R. 2002. Understanding nutrition. 9th ed. Belmont, Calif.: Wadsworth. 697p.

Chapter 2

THE INFLUENCE OF PHYSICAL ACTIVITY ON BODY COMPOSITION AND HEALTH RELATED PHYSICAL FITNESS IN CHILDREN





2 The influence of physical activity on body composition and health related physical fitness in children

In this chapter literature regarding the influence of physical activity on body composition and health related fitness will be discussed. Various concepts such as physical activity, the benefits of regular physical activity, physical inactivity, risk factors, body composition, the prevalence of juvenile obesity, causes of juvenile sedentary lifestyles, and recommendations to improve children's active lifestyles will be the focus in the literature review.

2.1 INTRODUCTION

Physical activity has drastically declined among children and this has led to various unfavourable situations, with the most prevalent and high-risk condition, the commonly appearing disease known as obesity (Baranowski *et al.,* 2000:S1; Steinbeck, 2001:117). This health-threatening epidemic of obesity clearly needs serious attention, not only in adults but also in the youth (Baranowski *et al.,* 2000:S1). Juvenile obesity is increasing daily in most countries of the world (Ara *et al.*, 2004: 1585). According to Baranowski *et al.* (2000:S1), the magnitude of this problem is often underestimated and will in future explode into serious life threatening child and later on adulthood diseases if the necessary interventions are not applied. Many cross-sectional epidemiological studies and interventions confirm the critical condition and mention many accompanying risk factors that are the result of inactivity which leads to obesity (Ara *et al.*, 2004:1585; Ball *et al.*, 2003:396-400; Fox, 2004:30; Janssen *et al.*, 2004:360; NDAS, 2004; Steinbeck, 2001:118-119; Van der Merwe, 2002:44; Verster, 2001:16). Such risk factors are coronary heart diseases, hypertension, hyperlipidemia, T2DM, psychological disorders, metabolic risks, premature deaths and orthopaedic disorders.

Body composition can be estimated by measurement of anthropometric parameters of the body. These measurements give a clear description of one's physical appearance (Ackland & Blanksby, 2001:116-117). Measures to determine body composition include among others, body mass, stature, percentage body fat, waist-to-hip ratio (WHR), body mass index (BMI), breadths and girths (Ackland & Blanksby, 2001:116-117). Regular physical activity promotes metabolic adaptations that result in significant positive improvements of BMI levels, percentage body fat levels and WHR (Pienaar & Van der Walt, 1988:46; Verster, 2001:18; Vincent *et al.*, 2003:1367). A positive improvement in body composition (thus lower fat percentage and lower BMI levels) and regular physical activity improves a human being's health status and leads to a longer life expectancy (Fox, 2004:31; Vincent *et al.*, 2003:1367).

Scientists conducted several studies on physical activity and obesity, and proved that early recognition and solution for this epidemic is vital (Ara *et al.*, 2004:1585; Ball *et al.*, 2003:396-400; Dao *et al.*, 2004:290). Further research on the topic is critical to assure that the most efficient intervention is applied to address the juvenile obesity epidemic.

2.2 PHYSICAL ACTIVITY

2.2.1 Introduction

Literature describes physical activity as a comprehensive concept, including movement, fitness, exercise and training. Physical activity is defined as "bodily movement produced by skeletal muscles that result in energy expenditure" by Meyers *et al.* (1996:852) and Summerfield (1998:2). The WHO (1998:119) defines physical activity as any body movement produced by skeletal muscle action which leads to a meaningful increase in the resting energy utilization.

There are three categories of physical activity (Meyers *et al.*, 1996:852; Summerfield 1998:2; WHO, 1998:119):

- Profession orientated activity: Activities done during a person's working hours.
- Daily activity: Activities done during every day, for instance housekeeping
- Free time physical activity: Activity done during a person's personal free time, consisting of two components:
    - Exercise: Structured physical activity with the purpose to increase or maintain physical fitness
    - Sport: This form of physical activity includes a competition component the physical activities.

2.2.2 Benefits of regular physical activity

Literature shows that regular physical activity has significant health benefits. These benefits include among others the following:

2.2.2.1 Physical health improvement and prevention of certain diseases

A lifestyle behaviour of physical activity has been shown to influence the largest number of chronic disease risk factors beneficially including coronary heart diseases, obesity, hyperlipidemia, hypertension and T2DM (Meyers *et al.*, 1996:852; Summerfield, 1998:2; Treiber *et al.*, 1989:285). It also increases bone density and bone mass, especially in children as they are still growing and developing new bone cells each day (Meyers *et al.*, 1996:852; Sothern *et al.*, 1999:272; Summerfield, 1998:2). Sothern *et al.* (1999:272) suggested that young girls should participate in resistance or strength exercise along with other physically activities to prevent osteoporosis in later life. It is important to be physically active during childhood years as this prevents a child to grow up to be an obese/overweight adult (Dao *et al.,* 2004:290; Evans & Gates-Wienake, 2004:4; Meyers *et al.*, 1996:852; Verster, 2001:15). Regular physical activity in childhood years may continue into adulthood (Jeffery *et al.*, 2003:688; Steinbeck 2001:118; Summerfield, 1998:3). Physical activity ensures sufficient energy expenditure to balance out the energy intake, which is necessary to prevent an increase in body mass and thus preventing overweight/obesity (Manios *et al.*, 1999:29; Meyers *et al.*, 1996; Jeffery *et al.*, 2003:688; Summerfield, 1998:2). Physical appearance will also be improved by regular physical activity as physical activity shows a negative relation to BMI values, body mass values and percentage body fat (Khanna *et al.*, 1998:136-137).

2.2.2.2 Psychological improvement

Physical activity reduces anxiety levels and improves self image and moods of children (Summerfield, 1998:2). Colchino *et al.* (2000:977) state that physical activity has a significant improvement on psychological and emotional health. Folsom-Meek (1991:380) conducted a study using 97 participants with a mean age of 9.4 years and measured the relationship among attributes, physical fitness, and self-concept development. Body mass correlated significantly with self-concept and proved that physical activity is a necessity to prevent an increase in body mass. Exercise increases the transfer of the serotonin precursor tryptophan across the blood brain barrier; this has a calming effect on children and leads to a decrease in anxiety levels (Shephard, 1997:119-120). In a review done by Sothern *et al.* (1999:271-272) it is stated that physical activity improves body image, self-satisfaction and self-esteem.

2.2.2.3 ***Cognitive, mental and academic improvement***

Another important benefit provided by physical activity is the cognitive and mental improvement, thus improvement in academic performance and concentration levels (Summerfield, 1998:5). Dwyer *et al.* (2001:226) reviewed 9000 school children between the ages of 7 and 15 years (500 in each age/sex stratum) (The Australian School Health and Fitness Survey). Results of this study showed that children who had higher scholastic ratings performed better in the 50m-run, completed more sit-ups, and leapt a greater distance in the standing long jump. The 1.6km run was also associated with better scholastic performance (Dwyer *et al.,* 2001:232). Measures of cardiorespiratory endurance, muscular force and power, and physical activity were all related to scholastic ability. They concluded that fitness and physical activity are related to academic performance (Dwyer *et al.*, 2001:235). Shephard (1997:113) reported various studies confirming that an increase in physical activity will enhance academic performance. These studies included the Trois Riviers experiment and the SHAPE study showing that regardless of the time eliminated from the academic curricular activities, to make more time for the fitness intervention, a large gain in behavioural and arithmetic score still came to the forefront (Shephard, 1997:116,120). The possible mechanisms for these better academic and cognitive performances in physically active children, according to Dwyer *et al.* (2001:235) and Shephard (1997:119,120) are that physical activity increases blood flow to the cortex of the brain, making the child's concentration abilities easier. As mentioned before, exercise also alternates relative proportions of various branch amino acids, which increases the transfer of the serotonin precursor tryptophan across the blood brain barrier. This has a calming effect on children and facilitates children to sit and concentrate on the academic work that has to be done (Dwyer *et al.,* 2001:235).

2.3 PHYSICAL FITNESS

Colchino *et al.* (2000:977) investigated 11 to 14 year old children (n = 20) for 12 weeks engaging in extracurricular physical activity. They found a significant improvement in cardiovascular endurance, muscular strength, muscular endurance and flexibility. Manios *et al.* (1999:24-29) investigated physical activity in 569 children aged 6 years and found that boys had a higher fitness level than girls. They concluded that boys choose to participate in moderate to vigorous activities whereas girls choose less vigorous activities (Manios *et al.*, 1999:29). Sothern *et al.* (1999:272) stated that a strong and balanced muscular system would promote a healthy posture and reduce the occurrence of back injuries. Many other researchers found beneficial development and enhanced physical fitness due to regular participation in physical activity. Improved physical fitness components include: increased VO_2max (provided the training is vigorous and prolonged) thus improvement in aerobic fitness (Khanna *et al.*, 1998:137-140; Klausen *et al.*, 1989; Meyers *et al.*, 1996:853; Treiber *et al.*, 1989:285), increased strength (Klausen *et al.*, 1989; Sothern *et al.*, 1999:272), increased flexibility (Colchino *et al.*, 2000:977; Folsom-Meek, 1991:380) and increased muscle endurance (Folsom-Meek, 1991:380; Treiber *et al.*, 1989:286; Sothern *et al.*, 1999:272). Reported data by researchers is summarized in Table 2.1.

Table 2.1: Summary of published data on the relationship between physical activity and health related fitness

Author group and year of publication	Participants	Age	Method	Study outcome
Ackland & Blanksby, 2001	n = 172 (swimmers) n = 172 (tennis players)	8 – 11 years 8 – 14 years	▪ Percentage body fat ▪ BMI	▪ ↓ fat percentage (swimmers) ▪ ↓ fat percentage (tennis players)
Colchino *et al.*, 2000	n = 30	11 – 14 years	▪ Fitness test ▪ Skinfolds ▪ Self-perceived profile or children	▪ ↑ heath related fitness ▪ ↑ self perception ▪ ↓ BMI
Folsom-Meek, 1991	n = 97	7 – 12 years	▪ BMI ▪ Health related fitness test (aerobic fitness, abdominal strength, flexibility, body composition) ▪ Martinek-Zaichkowsky self concept scale for children	▪ ↑ heath related fitness ▪ Body composition inversely correlated with self-image
Khanna *et al.*, 1998	n = 777 (Trained and untrained athletes)	10 – 16 years	▪ Body mass ▪ Height ▪ Body fat ▪ Aerobic capacity ▪ Anaerobic capacity	▪ ↑ Body mass – trained ▪ ↑ Height - Trained athletes ▪ ↑ VO_2Max
Klausen *et al.*, 1989	n = 85	10 – 15 year	▪ VO2max ▪ Isometric strength ▪ Functional strength	▪ ↑ VO_2Max boys ▪ ↓ Speed: ↑ age: girls ▪ ↑ Functional strength ▪ ↔ Isometric strength
Manios *et al.*, 1999	n = 569	6 years	▪ Gender differences in P.A. ▪ 20m Shuttle run ▪ BMI ▪ MMC ▪ Haemoglobin	▪ Gender preferences in P.A. choices
Meyers *et al.*, 1996 (the Bogalusa Heart study)	n = 995	9 – 15 years	▪ 24h P.A. recall ▪ Self administered P.A. checklist ▪ Sedentary activity checklist	▪ Children with reported physical education during school: ↑ PF ▪ ↑ age : ↓ PA
Treiber *et al.*, 1989	n = 29	10 years	▪ PWC170 ▪ Habitual exercise	▪ ↑ endurance ▪ ↑ efficiency of cardiovascular system

NOTE: n= number of participants; ↑: increase ↓: decrease; PA: Physical activity; PF: Physical Fitness; MMC: Mid Arm muscle circumference; PWC170: Physical workload capacity; VO_2Max: Aerobic Capacity; BMI: Body Mass Index

2.3.1 The EUROFIT Test Battery

For the purpose of the study, a discussion of the motor fitness and physical fitness tests will follow: The EUROFIT (Eurofit, 1988) health related test battery for children, components are shown in Table 2.2.

Table 2.2: EUROFIT Protocol Components (Eurofit, 1988:25)

	TESTS	COMPONENTS
	PHYSICAL FITNESS TEST (CARDIORESPIRATORY ENDURANCE)	
a	Endurance Shuttle run (Levels and stages) / Multi Phase Fitness Test ("Bleep Test")	• Cardiovascular endurance
	MOTOR TESTS	
b	Shuttle run 10 x 5 meters (Seconds)	• Agility • Speed
c	Handgrip strength (Kilograms)	• Strength (Static strength)
d	Standing Broad jump (cm)	• Strength (Explosive strength)
e	Bent arm hang (Seconds)	• Strength (Functional strength) • Muscular endurance (Arm and shoulder)
f	Sit ups (count per 30 seconds)	• Strength (Trunk) • Muscular endurance (Trunk muscular)
g	Sit and reach (cm)	• Flexibility

Monyeki *et al.* (2005) used the Eurofit protocol to compare physical fitness and body composition in malnourished children in South Africa. In this study it was found that boys outperformed girls in physical fitness. In another study done by Cordon *et al.* (2004:150), boys reflected meaningfully better results than girls when making use of the Eurofit protocol.

Figure 2.1 below shows the eight components which contribute to physical fitness according to the Eurofit 1988 physical fitness protocol. As can be seen, certain elements are common to both performance-related and health-related fitness. Further, the health-related components have the added value of being essential elements in performance-related fitness.

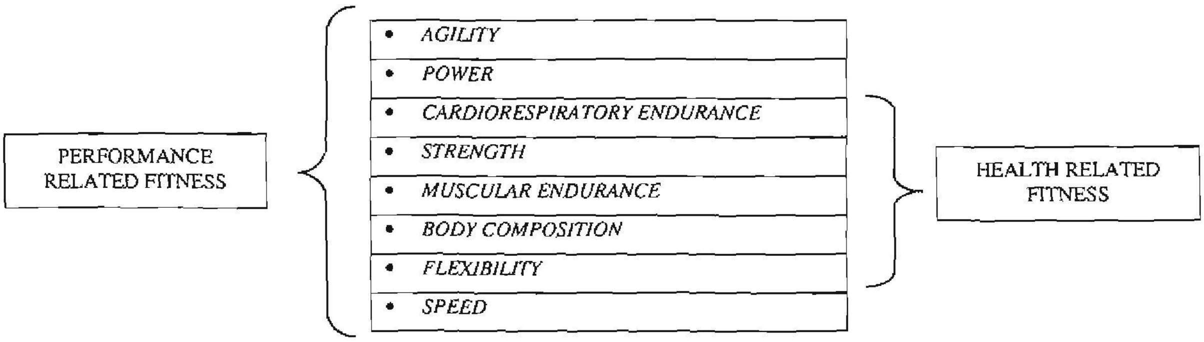
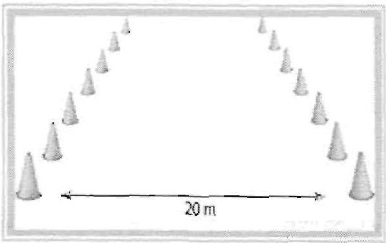


Figure 2.1: Components of the EUROFIT test battery (Eurofit, 1988)

2.3.1.1 Physical Fitness (Cardiorespiratory Endurance)

I. Endurance Shuttle Run (Cardiovascular Endurance)



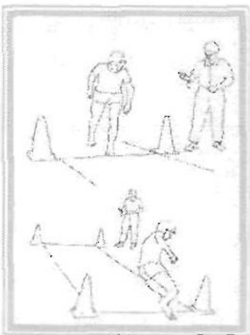
The purpose of the aerobic fitness test is to test the cardiovascular endurance (Eurofit, 1988:25). The multiphase fitness test is being used in this study. Aerobic fitness is an important component, especially for endurance based sports like long distance swimming, cycling and running. According to Nassis *et al.* (2005:137-141), the sum of the skinfolds, BMI and percentage body fat is lower in overweight and obese children with high cardiovascular fitness than children in the same category with low cardiovascular fitness. Cardiovascular fitness can possibly lower risk for obesity.

Description of test: A test of cardiorespiratory fitness begins at walking pace and ends running fast, whereby the subjects move from one line to another 20 metres distant, reversing direction, and in accordance with a pace dictated by a sound signal, which become progressively faster (few subjects will be able to keep going to the end.). The stage at which the subject drops out is the indicator of his/her cardiorespiratory endurance (Eurofit, 1988:25).

2.3.1.2 Motor Fitness Tests

The motor dimension of physical fitness concerns the development of psychomotor capacities required for the control of movement and of muscular skills in order to carry out some motor tasks (Pienaar, 2001:113; Pissanos *et al.*, 1983:71). The term "motor fitness" is commonly used to identify this complex component. It cannot be measured with a single test: it needs a combination of tests, each measuring different factors. Three of its basic components - strength, muscular endurance and speed - themselves comprise of more than one factor at least, and two different tests are thus required to evaluate each of these factors (Eurofit, 1988; Pissanos *et al.*, 1983:72). According to Reilly and Stratton (1995:207), ages 9 to 12 years old are the most important ages as this is the time where growth and neurologic development increases the most.

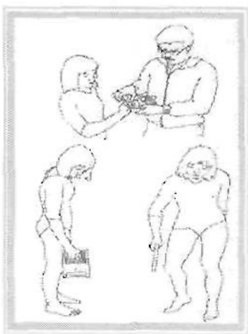
II. Shuttle Run 10 x 5 m Test (Agility and Speed)



According to Davis *et al.* (1997:118), agility is the physical ability of a person's body to change direction of the body position quickly. Gallahue and Ozmun (1995:313) describe agility as the body's ability to move quickly and accurate. The test has been performed on South African as well as Australian children, where South African children showed unfavorable results with an increase in age and the Australian children showed improved results with an increase in age (Du Randt, 2000:5; Moyeki *et al.*, 2003:E93-E102).

Description of test: Time of running and turning (shuttle) test at maximum speed.

III. Hand Grip Strength Test (Static Strength)

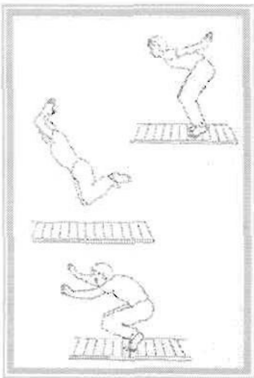


Static strength refers to the strength applied to an external resistance with no change in muscular length. The handgrip test is a typical example where the static or isometric strength of the hand and front arm are determined (Eurofit, 1988:50; Malina & Bouchard, 1991:188-190). Front arm and hand muscle strength show a linear increase in boys with ages 13-14 years, where an increase in strength development can be seen (Malina and

Bouchard, 1991:189). Amstrong and McManus (1996:26) found that handgrip strength increases linearly with age until the start of puberty.

Description of test: Dynamometer to be taken in subjects preferred hand. The dynamometer has to be squeezed forcefully for at least 2 seconds, while holding the dynamometer away the body.

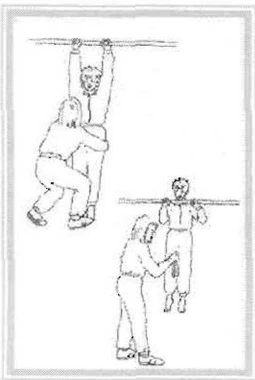
IV. Standing Broad Jump Test (Explosive Strength)



Explosive strength is the muscular ability to generate maximal strength in the shortest time period. Jumping ability is generally used as an indicator of explosive strength (Malina & Bouchard, 1991:188). Gallahue (1996:65) defines explosive strength as the ability to give a maximal attempt to generate strength in the shortest time and describes explosive strength as the product of strength and speed. Standing broad jump is used to determain explosive strength (Eurofit, 1988:48). According to Malina and Bouchard (1991:192), an increase in the achievement of explosive strength values increases linearly until the age of 13 years in boys. According to Monyeki *et al.* (2005:54-60), there is a relationship between the BMI and standing broad jump.

Description of test: Jumping for distance measured in centimeters from a standing start with both feet together in take-off.

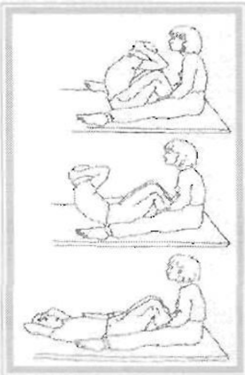
V. Bent Arm Hang Test [Functional (Arm and Shoulder) Strength]



Bent arm hang is designed to determine isometric muscle contraction in the upper body (Adams *et al.*, 1994:54; Malina & Bouchard, 1991:190). Monyeki *et al.* (2005:54-60) found that high BMI levels and the sum of skinfolds correlate with low results in the bent arm hang test. Van Rooyen (1993:60) shows that individuals who participate in sporting activities are generally stronger than those who do not participate in sport. Van Rooyen (1993:60) also indicates that an increase in muscle strength leads to an increase in muscle endurance.

Description of test: Time measured in seconds, maintaining a bent arm position while hanging from a bar.

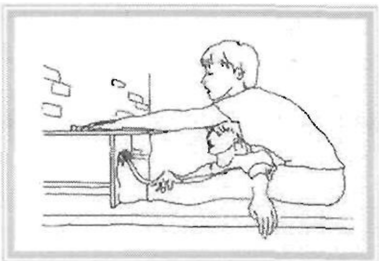
VI. Sit-up Test (Abdominal (Trunk) Strength and Muscular Endurance)



According to Brittenham and Brittenham (1997:2), abdominal strength is important for any type of sport. These researchers indicate that abdominal strength will contribute to an individual's stability, strength replacement, movement effectiveness and body posture. It is also stated that individuals in a variety of sport types need strong abdominal muscles to achieve better results effectively with a low risk to injury (Elphinston & Pook, 1998:7). The sit up test is designed to determine the abdominal muscle strength and endurance (Eurofit, 1988:52; Malina & Bouchard, 1991:189).

Description of test: Maximum number of sit-ups achievable in 30 seconds.

VII. Sit and Reach Test (Flexibility)



Flexibility is a joint's ability to move freely through the full range of motion (ROM) allowed by its structure (Davis *et al.*, 1997:118). This may involve movement in one plane only (hinge joints such as the knee), or movement in all directions (ball and socket joints such as the hip and shoulder). In order to achieve and maintain a joint's ROM, it is necessary to stretch the muscles that move those joints (Gallahue, 1996:63; Malina & Bouchard, 1991:188). Static flexibility is the ability to assume an extended position and then hold it still where as dynamic flexibility refers to the ability to use the muscles to move the joint through its ROM. Flexibility normally weakens with an increase in age, especially during the puberty years where the bone length increases where the muscle inserts (Davis *et al.*, 1997:160). For the purpose of this study static flexibility is determined by use of the sit and reach test and mainly determines the flexibility of the lower back, hip and hamstring muscles (Malina & Bouchard, 1991:196). According to Monyeki *et al.* (2005:54-60), there is a positive relationship between the BMI levels and sit and reach test and the sum of the skinfolds also correlates significantly with the sit and reach test.

Description of test: Reaching forward as far as possible from a seated position.

2.4 PHYSICAL INACTIVITY

The etiology of overweight and obesity is multi-factorial, and the main contributing factors to juvenile obesity include physical inactivity, diet and genetics (Fox, 2004:35; Steinbeck, 2001:126). Thus the ultimate possible treatment and preventative method for obesity is correcting the energy balance disturbance via decreasing sedentary time, increasing physical activity and developing healthy childhood eating patterns (Fox, 2004:33; Steinbeck, 2001:126; Van der Merwe, 2002:45; Verster, 2001:17).

2.4.1 Introduction

The WHO (1998:120) describes physical inactivity or sedentary lifestyle as a condition where minimal body movement takes place and energy utilisation is almost equal to the resting metabolic tempo, for example: inactive activities such as television viewing, reading, eating or computer games.

Sedentary lifestyle is a direct cause for juvenile obesity and this state is most likely to be continued as adult life starts (Anon, 2004:5; Ara *et al.,* 2004:1585; Dao *et al.,* 2004:290; Whitney & Rolfes, 2002:552). If children follow a physically active pattern in their childhood years, an active lifestyle will be continued as adulthood starts (Shephard, 1997:123). The one factor most likely to be responsible for the greater percentage of a sedentary lifestyle is the technological progress of the 20th century. Anderson *et al.* (1998:938), Engelbrecht *et al.* (2004:46) and Evans and Gates-Wienake (2004:3) reviewed a study and reported that 26% of American children watch more than four hours television and 67% watch more than two hours per day. These children have a higher prevalence of overweight than those watching one or fewer hours of television per day. Evans and Gates-Wienake (2004:3) reported that the NHANES III study indicates a positive relationship between television viewing and 8 to 16 year old children who are overweight. Utter *et al.*

(2003:2) reported a positive relation between watching television and BMI after performing a study on 4746 middle and high-school children with a mean age of 14.9 years. Many other studies also reported positive associations between overweight, sedentary lifestyle and watching television (Ara *et al.*, 2004:1585; Evans & Gates-Wienake, 2004:3; Janssen *et al.*, 2004:363; Meyers *et al.*, 1996: 852) A recommendation to reduce time spent in front of the television is seen to be an effective treatment and preventing method for overweight and obesity among the youth (Anderson *et al.*, 1998:938).

2.4.2 Causes of obesity and/or sedentary lifestyle

2.4.2.1 Diet

Dietary intake and poor eating habits were also seen to be significantly associated with watching television and other sedentary activities such as doing homework, playing computer games or reading (Janssen *et al.*, 2004:361; Steinbeck, 2001:124; Utter *et al.*, 2003:2; Whitney & Rolfes, 2002:552). The consumption of junk food and snacks such as chips/crackers/popcorn/pretzels roughly tripled since the mid–1970's to the mid 1990's among children. The intake of soft drinks showed the same trend, and doubled from 105 grams to 200 grams per day for girls and from 112 grams to 217 grams per day for boys (Strum, 2005b:5).

2.4.2.2 Genetics

Fox (2004:35) quoted the British Nutrition Foundation (1999) and said that hereditability of fatness ranges between 20–50%. Thus children with obese parents have a 20-50% higher chance of predisposed obesity. Obese children also tend to be more inactive than their peers, increasing the chances of additional elevation in obesity (Steinbeck, 2001:122-123). Genetically predisposed obesity plays a vital role in risk for developing chronic diseases (Treuth *et al.*, 2004:198).

2.4.2.3 Decrease in school based activity and physical education

School based physical activities have declined in the past years and more attention is now given to academic performance (Janssen *et al.,* 2004:361; Orleans *et al.,* 2003:77; Steinbeck, 2001:126). Many school boards see physical activity and physical education as wasting academic time (Morrow *et al.*, 1999:3; Shephard, 1997:114). This, however, is in contrast to scientific research, which provides convincing evidence that physical activity enhances many aspects of physical as well as mental health, and will thus improve academic performance (Dayley & Ryan, 2000:531; Dwyer *et al.*, 2001:225; Shephard, 1997:113).

2.4.2.4 Unsafe environments

Unsafe environments, such as unsafe parks for children to play in due to poor maintenance to playground equipment and unsafe climbing heights on some of the playground equipment, cause an increase in injury prevalence (Cradock *et al.*, 2005:357). Another environmental factor preventing childhood physical activity is the unsafe traffic and poor road safety. This phenomenon leads to a decrease of pedestrian children and bike riding (Bruton *et al.,* 2003:4-6; CDC, 2002:701; Fox, 2004:33; Orleans *et al.,* 2003:78). The Centre for Disease Control and Prevention (CDC) in the United States of America (USA) analysed data from the National Health Styles' Survey and reported that the one barrier preventing children from walking and biking to school is the dangerous motor vehicle traffic (CDC, 2002:703). The high prevalence of crime rate in the 20^{th} century is another threatening situation, forcing parents to accompany children to parks and other recreational local environments. This causes a reduced playtime for children as parents have many other obligations such as work (Bruton *et al.,* 2003:4; CDC, 2002:703; Kirtland *et al.,* 2003:329; Orleans *et al.,* 2003:78).

2.4.2.5 Parental motivation

Physical activity is a lifestyle behaviour; lifestyle behaviours are adopted since infancy and thus learnt from parents. Scientific evidence is clear that parental participation in physical activity has a definitive influence on children's participation in physical activity (Steinbeck, 2001:122). Parents motivating and supporting children to be actively involved in physical activity events, plays an important role in a child's enthusiasm to lead a physically active life (Bruton *et al.,* 2003:4; Green *et al.,* 2003:446; Manios *et al.,* 1999:29; Rochford & Kaminsky, 2004:3; Steinbeck, 2001:122). Steinbeck (2001:118) reviewed studies and summarised that the Bogalusa study found that children whose parents were overweight had an offspring with early coronary artery disease and developed an adverse cardiovascular risk profile, whereas children whose parents had a normal weight in their childhood years, were not that affected. Children of active parents tend to be more physically active than their peers; children of active mothers are twice as likely to be active as children of inactive mothers (Steinbeck, 2001:122). This phenomenon increased more than threefold for active fathers and showed a six-fold increase in activity levels where both parents are active (Steinbeck, 2001:122).

2.4.2.6 Technology

Fast developing technology, such as the computer, play-station games and the internet, also contributes to the rate of an increase in childhood inactivity. These factors are taking up more time than previously and are drastically increasing among children and adolescents (Bruton *et al.,* 2003:3-5; Engel *et al.,* 2003:1207; Manios *et al.*, 1999:27; Steinbeck 2001:124; Strum, 2005a:2, 4-6; Utter *et al.* 2003:2).

2.4.3. Health related risk factors

2.4.3.1 Stigmatisation of obese children

Many children do not feel good enough to participate in physical activity when having an overweight appearance. Peers often make negative comments to these children, causing them to discontinue any participation in team events or other activities requiring movement of the body. This can lead to the development of psychological dysfunctions and is linked to the obesity-inactivity-obesity cycle (Evans & Gates-Wienake, 2004:3).

2.4.3.2 Coronary heart diseases

Inactive and overweight children have much higher risk of illness and premature death from coronary heart diseases (Ara *et al.*, 2004:1585). Ball *et al.* (2003:396) conducted a study on 83 children aged 6 – 12 year to investigate whether body composition variables, physical activity, physical inactivity and/or cardiorespiratory fitness explained the presence of risk factors for coronary heart disease and T2DM in obese children. The boys and girls were divided into two groups, namely the low health risk group (LHR) and the high health risk group (HHR). Groups were classified by the presence of dislipidemia, insulin resistance, and elevated blood pressure. If participants did not pose any of these risk factors, they were classified as LHR. Boys and girls possessing $\geq$1 risk factor were in the HHR (Ball *et al.*, 2003:394). Accordingly, 36% were classified in the LHR and 64% were classified in the HHR (Ball *et al.*, 2003:396). Obese children and adolescents are more commonly diagnosed with coronary heart diseases and T2DM every day (Evans & Gates-Wienake, 2004; Janssen *et al.*, 2004:363-364; Schmitz *et al.*, 2002:1310). The Centre of Disease Control and Prevention of the USA reported that approximately 60% of 5 - 10 year old children who were overweight had at least one risk factor for coronary heart diseases, (such as hypertension, hyperlipidemia, elevated insulin levels) and 20% had two or more risk factors (Evans & Gates-Wienake, 2004:4; NCCDPHP, 2005b). Another health threatening disease in youth is the abnormal metabolic state typically seen in overweight middle-aged and older individuals. Recent research indicates that adolescents can have the metabolic syndrome based on conventional metabolic syndrome criteria used in adults. This criterion is based on having more than 3 of the following: central adiposity (>88cm (woman) and >120cm (men) waist circumference), high fasting blood glucose (>110mg/dL), high-density lipoproteins (HDL<50mg/dL (woman) and <40mg/dL (men)), high blood pressure (>130/85mmHg) and approximately 29% overweight (defined as BMI>95th percentile) (Evans & Gates-Wienake, 2004:4). Another study of 965 children with an average age of 13.0 $\pm$ 2.6 years on metabolic syndrome among children and adolescents was done by Rodríguez-Moran *et al.* (2004:2516). In this study, 70% obese children were diagnosed with established metabolic syndrome (Rodríguez-Moran *et al.*, 2004:2516).

2.4.3.3 Adulthood obesity

Diseases most commonly seen and feared for obese children are diseases of adulthood, as childhood obesity is most likely to result in adulthood obesity (Dao *et al.,* 2004:290; Evans & Gates-Wienake, 2004:4; Steinbeck, 2001:118; Verster, 2001:15). Van der Merwe (2002:44) states that children between the ages of 3 and 5 years with one overweight parent would probably have a prevalence of adulthood obesity as high as 62%. Adulthood obesity is a widespread disease, right over the world and is becoming a major distressing problem (Van der Merwe, 2002:43). Adulthood weight status is classified according to their BMI. A BMI of >25 kg/m², classify one as overweight and ≥30 as obese (Van der Merwe, 2002:43). Engel *et al.* (2003:11) and Van der Merwe (2002:43) estimated that 7% of the global population is obese, that is roughly 250 million people and that 1.5 billion people are overweight. In most of the European countries, the prevalence of obesity and overweight in children and adolescence increased with 27% to reach a prevalence of 14% in the last decade (Durstine & Moore, 2003:149). In South Africa 31.6% men and 56.8% woman between the ages 15 and 64 years are overweight or obese (Van der Merwe, 2002:43). Van der Merwe (2002:43) reports that two thirds of adults aged 20 – 74 years in the USA are overweight and 31% are obese. Adulthood obesity can lead to many other life threatening diseases and eventually death (Van der Merwe, 2002:43).

2.4.3. Other related diseases

There are many diseases threatening the health of obese or inactive children. These diseases are among others hypertension, hyperlipidemia, psychological disorders, orthopedic disorders, premature death/mortality (Ara *et al.*, 2004:1585; Dao *et al.*, 2004:290; Janssen *et al.*, 2004:363-364). Some of these diseases are illustrated in Figure 2.2 and a summary of the reported chronic diseases related to juvenile obesity follows in Table 2.3. Van der Merwe (2002:44) reported these diseases according to the proportion of the disease prevalence attributable to obesity.

The following figure indicates these proportions:

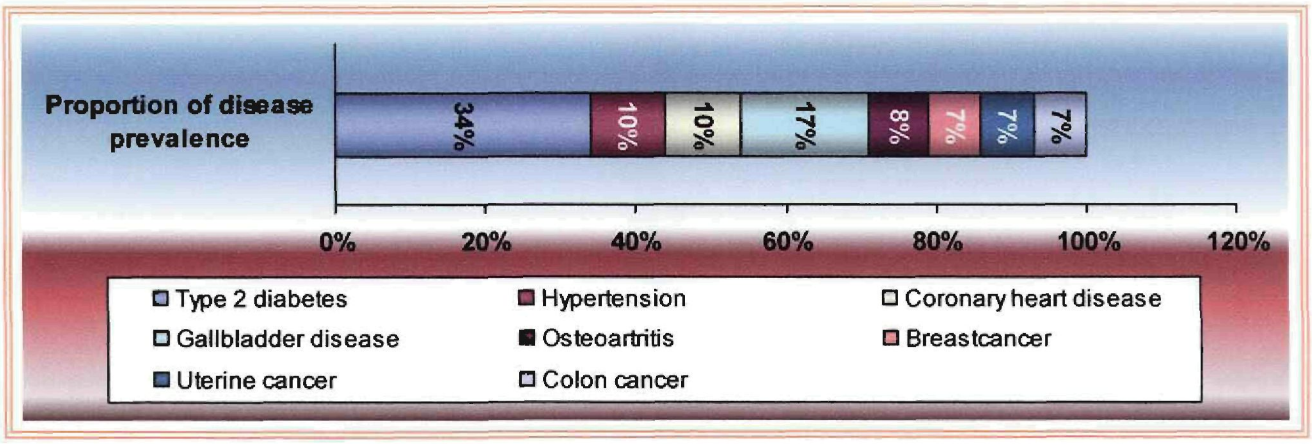


Figure 2.2: Proportion of disease prevalence attributable to obesity (Van der Merwe, 2002:44)

Table 2.3: Summary of reported chronic diseases related to juvenile obesity

Author group and year	Chronic disease	Participants	Age	Components tested	Results
▪ Ball *et al.*, 2003 (Bogalusa Heart Study)	❑ Coronary heart disease ❑ Hypertension ❑ Hyperlipidemia	n = 83	6 – 12 years (Obese)	❑ >75th percentile from reference population of children (n=700): • Dyslipidemia • Insulin resistance • Elevated blood pressure ❑ Physical activity Cardiorespiratory fitness	Risk profile ❑ 36% children LHR ❑ 64% HHR
▪ Dao *et al.*, 2004	❑ Coronary diseases	n = 55	9 – 17 years (Obese) (Adolescents) Duration: 6 – 12 months	❑ Body composition ❑ Diet assessment ❑ PAI ❑ Tanner Stage	❑ ♀: ↑ BMI (with age and Tanner ↑) ❑ ↓: WC, HC, BM (Adequate growth can be achieved) ❑ Diet restriction not necessary, healthy diet is more important for growth
▪ Janssen *et al.*, 2004 (WHO Health behavior in School-Aged children Survey)	❑ Obesity	n = 5890	11 – 16 years (Adolescents)	❑ Self report: • Height • Body mass • Dietary habits • Leisure time activities ❑ BMI	❑ 15% Canadian youth – overweight (pre-obese) ❑ 4.6% were obese (in 2002) ❑ P.A ↓ & T.V time ↑: overweight children
▪ Jeffery *et al.*, 2003	❑ Obesity	n = 202	• 25 – 50 years (overweight)	❑ ↑ physical activity of 2500 kcal /wk	❑ Promote long-term weight loss

Author group and year	Chronic disease	Participants	Age	Components tested	Results
▪ Ribeiro *et al.*, 2003	❑ Hypertension ❑ Coronary heart disease	n = 1439	8 – 16 years	❑ BP ❑ Weekly active checklist ❑ PAIx ❑ BMI	❑ BP ∞ BMI ❑ ≠ BMI:PAI
▪ Treiber *et al.*, 1989:285	❑ Hypertension	n = 29	10 years	❑ PWC170 + Electrocardiograph ❑ Habitual P.A.	❑ P.A. ↑ efficiency of cardiovascular system ❑ P.A. ↓ BP
▪ Treuth *et al.*, 2004	❑ Parental obesity – Influences (mentally & physically)	n = 91	8 – 10years	❑ Fitness: Treadmill ❑ Physical activity: Heat rate monitor, questionnaire ❑ Sedentary activity: Questionnaire	❑ Fitness: ↔ ❑ Fitness in girls with 2 lean parents ↑: than girls with 2 obese parents ❑ Daily activity: ↔ ❑ T.V. time: ↔

NOTE: ♂: Male; ♀: Female; ↑: increase; ↓: decrease; ↔: No significant change; ∞: Directly related; ≠: No significant association; BM: Body mass; BMI: Body Mass Index; BP: Blood Pressure; HC: Hip circumference; HHR: High Health Risk; LHR: Low Health Risk; n: number of participants; P.A.: Physical activity; PAI: Physical activity intervention; PAIx: Physical activity index; PWC170 + : Physical Workload Capacity; T.V.: Television WC Waist circumference; WHR: waist-to-hip ratio;

By means of all of the above-mentioned research, it is evident that prevention and treatment of obesity as early as possible in a child's life is crucial.

2.4.4 Prevalence of juvenile obesity

The prevalence of obesity is a worldwide epidemic and literature shows an increase in the statistical values reported by scientists. Engel *et al.* (2003:1207) and Van der Merwe (2002:43) reported that 7% of the world's population (250 million people) is obese and 1.5 billion people overweight. According to the Centre for Disease Control (CDC) behavioural risk factor surveillance system, the prevalence of obesity and overweight in children and adolescence in European countries, has increased by 27% in the last decade to reach a prevalence of 13 to 14% in 1999 (Durstine & Moore, 2003:149). A summary of various reported statistics on the prevalence of overweight and obesity among children is provided in Table 2.4.

Table 2.4: Summary of reported data on the global prevalence of juvenile overweight and obesity

Author group and year	Statistical indication of overweight and obesity among children	Participants and ages	Region	Increase
Armstrong, 2006	3.2 % (overweight) 14% (obese) 4.9% (overweight) 17.9% (obese)	▪ 6 – 13 year boys ▪ n = 5611 ▪ 6 – 13 year girls ▪ n = 4584	South Africa	Similar in other development countries about 10 years ago
Dao *et al.*, 2004	15%	▪ 9 – 17 years ▪ n = 55	France	Doubled every 15 years since 1970
Evans & Gates-Wienake, 2004 (Reporting NHANES 1999-2000)	15 %	▪ 6 – 19 years	United States of America	▪ 110%: 6 – 11 years ▪ 150%: 12 – 17 years (boys) ▪ 70 %: 12 – 17 years (girls)
Fox, 2004 (Reported data)	38 % 33 %	▪ Boys ▪ Girls ▪ 7 – 11 years	Mediterranean island of Malta	
Fox, 2004 (Reported data)	36%	▪ Girls ▪ 7 – 11 years	Italy	
Janssen *et al.*, 2004	23% 18%	▪ Boys ▪ Girls ▪ 7 – 13 years ▪ n = 5890	Canada	9% - 23% 11% - 18% Since 1981 - 1996
NDAS, 2005 (Reviewed data)	>10% 15%	▪ pre-school ≤ 6 years ▪ 6 – 19 years	United states	
Summerfield, 1998 (Reviewed data)	11% 14%	▪ 6 – 11 years ▪ 12 -17 years	United States of America	Doubled the prevalence of 30 years ago
Tremblay& Willms, 2000	28% 23.6%	▪ Boys ▪ Girls ▪ 7 – 13 years	Canada	15% - 28% 15% - 23.6% (1981 – 2000)
YRBS, 2002	17 % (Overweight) 4% (Obese)	▪ 13 – 19 years	South Africa	

2.5 ANTHROPOMETRICAL CHARACTERISTICS

2.5.1 Body composition

Body composition takes into account all the substances which compose the body. The body is roughly composed of water, protein, minerals and fat (Kravitz & Heyward, 2004:1). Substances of the body can be divided into two sections, giving the fat-containing components and the fat-free components. The fat-containing components can then be divided into two categories namely, essential fat and non-essential fat (fat produced by the body itself) (Kravitz & Heyward, 2004:1). The essential fat is necessary for normal function of the body and has to be ingested via a healthy balanced diet. Excessive fat is stored in the adipose tissue of the body as well as internally around the organs and subcutaneously, directly beneath the skin (Kravitz & Heyward, 2004:1). The other component of the body is the fat-free components (many accounting for lean body mass). These components include muscles, bones, ligaments, tendons and internal organs (Kravitz & Heyward, 2004:2).

2.5.2 Body composition components measures

There is many different laboratory as well as field methods to assess body composition, for example: BMI, skinfolds, the Bod Pod, BIA, underwater weighing, DEXA etc. (Kravitz & Heyward, 2004:2; Tershkovec *et al.*, 2002:867).

2.5.2.1 Body mass

Body mass is measured in kilograms (kg). The subject, wearing minimal clothing, stands in the centre, on the scale. Weight is recorded to the nearest tenth of a kilogram. A normal child will tend to have a constant increase in body mass from the early age of 2 years where after the growth spurt (puberty years) will start during the adolescent years, starting approximately at the age of 13 years old (Armstrong & McManus, 1996:22). Boys tend to show a larger increase in body mass than girls during these puberty years (Armstrong & McManus, 1996:23). Body mass will increase rapidly during the growth spurt years which may influence the interpretation of BMI. Growth spurt needs to be kept in mind when BMI is used to classify obesity during puberty (WHO, 1995:54).

2.5.2.2 Stature

Stature is measured in centimeters (cm). The stature is measured with the individual standing straight against an upright surface, touching it with heels, buttocks and back. The head is oriented with the upper border of the ear opening and the lower border of the eye socket on a horizontal line, heels together and on the board. The subject takes and holds a deep breath and is then measured to the nearest millimeter (EUROFIT, 1988). A normal child will tend to have a consistent increase in stature from birth until the growth spurt starts during adolescent years approximately at the age of 13 years (Armstrong & McManus, 1996:20). Boys tend to show a larger increase in stature than girls during these puberty years (Armstrong & McManus, 1996:22). Stature will increase rapidly during the growth spurt years which may influence the interpretation of BMI. Growth spurt needs to be kept in mind when BMI is used to classify obesity during puberty (WHO, 1995:56).

2.5.3 Body Mass Index (BMI)

BMI is an anthropometric index of body mass and stature that is defined as body mass in kilograms divided by stature in meters squared (kg/m^2) (NCCDPHP, 2005a). BMI is the commonly accepted index for classifying adiposity in adults and although it is recommended for use with children and adolescents, the growth factor in children must be taken into account when using the BMI (NCCDPHP, 2005b; Van der Merwe, 2002:44; Verster, 2001:15;). BMI in children is also age and gender specific because adiposity varies in these two situations. BMI-for-age is frequently used to classify the weight status (underweight/normal/overweight/obese) of children but is not the exclusive standard by which to judge a child at risk of overweight or obesity. To measure this index, a calibrated portable electronic scale for determining body mass and a portable stadiometer for measuring stature can be used (Evans & Gates-Wienake, 2004:3; Heyward, 1998:295; NCCDPHP, 2005a). BMI has the limitation of requiring the height of a person and as children still grow linearly, this occurrence demands an additional measurement method to determine the risk status of a child (Evans & Gates-Wienake, 2004:1, 3; NCCDPHP, 2005a). Thus BMI should be used to identify and not to diagnose the prevalence of overweight and risk of overweight or obesity in children and adolescents. Additionally skinfold measurement should be done to determine the estimate percentage body fat calculated using equations.

The formula to determine BMI:

$$BMI = \frac{\text{Body mass (kg)}}{\text{Stature}^2 (m^2)}$$

$$= kg/m^2$$

BMI = Body Mass Index, kg = kilogram, m=meter

Classification of obesity in children via BMI

The criteria used for the weight classification and cut-offs of BMI–for–age for children ages 2 to 20 years (Table 2.5. and Figures 2.2 and 2.3), is as follows:

Table 2.5: Weight clasification by BMI values (Dietz, 2005; Fox, 2004:28; NCCDPHP, 2005b)

≥95th percentile	**Overweight**
85th to < 95th percentile	**Risk of overweight**
< 5th percentile	**Underweight**

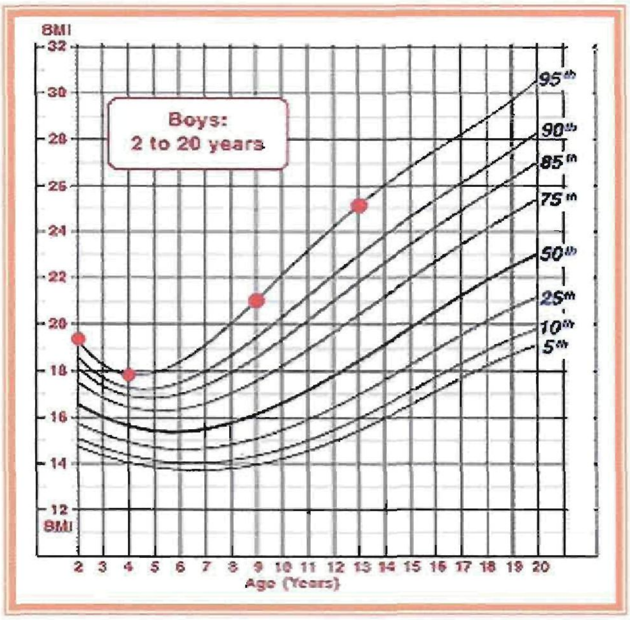


Figure 2.3: BMI – for – age:

Boys 2 – 20 years (NCCDPHP, 2005b)

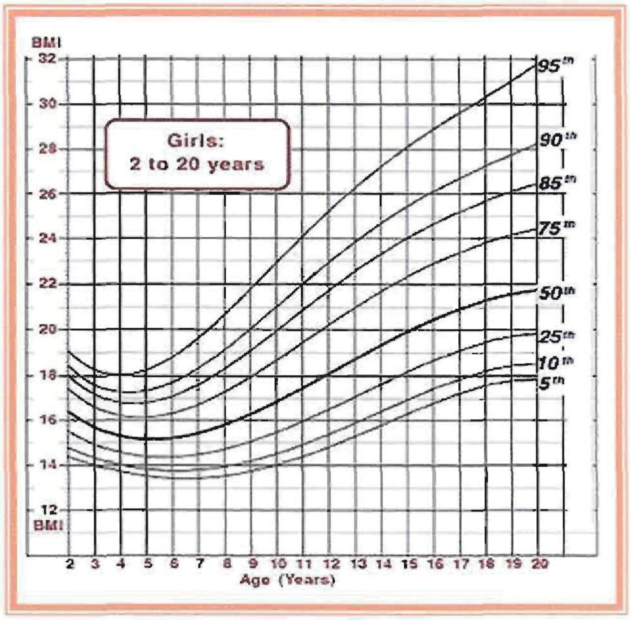


Figure 2.4: BMI – for – age:

Girls 2 – 20 years (NCCDPHP, 2005b)

Currently there are population-specific reference data of which the NHES II, NHES III and NHANES III is the most generally used reference data in the literature (Flegal & Troiano, 2000:812). Cole *et al.* (2000:1240) developed a BMI classification model which includes a combination of various other countries' reference population and subsequently established cut-off points for children and adolescents regarding overweight and obesity. Cole *et al.* (2000:1242) converted children's BMI values to internationally accepted cut-off points for adults of 25 kg/m² for overweight and 30 kg/m² for obese. These values are gender and age specific (Cole *et al.*, 2000:1242).

Table 2.6: Average body mass index (BMI) values for children and adolescents between the ages 9 and 13 years (Flegal & Troiano, 2000:812)

Age (years)	NHES II & III (1963 – 1970)		NHANES III (1988 – 1994)	
	Male	Female	Male	Female
9	16.9	17.0	18.0	18.2
10	17.1	17.6	18.4	18.4
11	17.9	18.2	19.4	19.4
12	18.4	19.2	20.1	20.2
13	19.4	19.9	20.5	21.8

NHES II & III = National Health Examination Survey, VSA 1963 – 1970

NHANES III = National Health and Nutrition Examination Survey, VSA 1988 - 1994

Table 2.7: International cut-off points for body mass index (BMI) for overweight and obese children between the ages of 8.5 and 14 years (Cole *et al.*, 2000:1242)

Age (years)	OVERWEIGHT* (BMI 25 kg/m² - Adults)*		OBESE* (BMI 30 kg/m² - Adults)*	
	Male	**Female**	**Male**	**Female**
8.5	18.8	18.7	22.2	22.2
9	19.1	19.1	22.8	22.8
9.5	19.5	19.5	23.4	23.5
10	19.8	19.9	24.0	24.1
10.5	20.2	20.3	24.6	24.8
11	20.6	20.7	25.1	25.4
11.5	20.9	21.2	25.6	26.1

Age (years)	OVERWEIGHT* (BMI 25 kg/m² - Adults)*		OBESE* (BMI 30 kg/m² - Adults)*	
	Male	Female	Male	Female
12	21.2	21.7	26.0	26.7
12.5	21.6	22.1	26.4	27.2
13	21.9	22.6	26.8	27.8
13.5	22.3	23.0	27.2	28.2
14	22.6	23.3	27.6	28.6

* Proposed by Cole *et al.* (2000)

BMI-for-age can identify the clinical risks for various diseases. Children being overweight are at high risk of developing chronic diseases including cardiovascular diseases, hypertension, hyperlipidemia, T2DM, psychological disorders, metabolic risks and premature deaths (Ara *et al.*, 2004:1585; Ball *et al.*, 2003:396-400; Fox, 2004:30; Janssen *et al.*, 2004:360; NCCDPHP, 2005b; NDAS, 2004; Steinbeck, 2001:118-119; Van der Merwe, 2002:44; Verster, 2001:16). Overweight children, furthermore have the risk of becoming overweight adults, which will also lead to the above-mentioned diseases and eventually a shorter and lower quantity of life (Dao *et al.*, 2004:290; NDAS, 2004; Van der Merwe, 2002:43-44).

A lower level of BMI was detected in the study of Janssen *et al.* (2004:360), where a negative relation between physical activity and the BMI levels of children 11-16 years old was found (Janssen *et al.*, 2004:363). Folsom-Meek (1991:379) studied 97 grade 1 to 6 children and reported an inverse correlation between aerobic endurance scores and BMI levels.

2.5.2.4 Percentage body fat and skinfold measurement

Percentage body fat can classify children in categories of underweight, normal, overweight or obese. There are many methods to determine percentage body fat, for example underwater weighing and bio-electric impedance. These methods are, however, expensive and not always cost-effective and not suitable for a big population study (Heyward, 1998:295).
Additionally to BMI measurement, skinfold measurement should be done to determine the estimate percentage body fat and thus classify an individual as overweight or obese. Apparatus to be used for this measurement includes a skinfold calliper with a constant

compression of 10 g/mm² for the measuring of skinfolds (NCCDPHP, 2005b). It should be noted that BMI is not a measure of fatness, but a measure of heaviness and, therefore, it is wise to measure skinfolds additionally for an indicator of fatness.

To determine percentage body fat, the following formulas of Boileau *et al.* (1985:17-27) can be used where three skinfold measurements are required, namely: triceps, subscapular and medial calf.

Determination of fat percentage as suggested by Boileau *et al.* (1985:17-27):

Boys 6 – 11 years: % Body fat = (sum of triceps- and subscapular skinfolds) – 0.012 (sum of triceps and subscapular skinfolds) ^{2} - 3.4

Boys 12 – 14 years: % Body fat = (sum of triceps- and subscapular skinfolds) – 0.012 (sum of triceps and subscapular skinfolds) ^{2} - 4.4

Table 2.8 Percentage body fat classification for children according to Lohman (1992:150)

Classification Level	Percentage body fat (girls)	Percentage body fat (boys)
Low percentage body fat UNDERWEIGHT	< 12 %	< 12 %
Normal percentage body fat NORMAL	12.1 – 24.9 %	12.1 – 19.9 %
High percentage body fat OVERWEIGHT	> 25 %	> 20 %
High percentage body fat OBESE	> 30 %	> 25 %

2.6. RECOMMENDATIONS

2.6.1 It is important for all children and adolescents to be physically active during the day (Meyers *et al.*, 1996:852). Morrow *et al.* (1999:3) recommends that a child has a need for at least 60 minutes of physical activity during the day. This activity should require moderate to vigorous level of exertion. Physical activities can include play, sport, transport and work (Meyers *et al.*, 1996:852).

2.6.2 Physical activity should be incorporated into a daily programme at school. This physical activity can be in the form of physical education, organised sport or recreation (Morrow *et al.,* 1999:3; Summerfield, 1998:5).

2.6.3 Family members should motivate children to be physical active (Bruton *et al.*, 2003:4-5, Steinbeck, 2001:126; Trost *et al.*, 2003:277).

2.6.4 Parents and teachers should set a good example for children and thus be physically active themselves (Green *et al.*, 2003:446, Manios *et al.*, 1999:28-29).

2.6.5 Effective dietary changes should be made, for example to reduce the poor habit of eating crackers/biscuits/junk food/soft drinks and replace these foods with vitamin rich healthy food types (Strum, 2005b:5; Whitney & Rolfes, 2002:552).

2.7 CONCLUSION

The mentioned causes for the ever increasing sedentary lifestyle of children and adolescents are only a few reported by researchers. This prevalence highlights the increasing risk of chronic diseases accompanying inactivity. From the reviewed literature it was found that physical activity enhances many main contributing factors of a child's life on the one hand, on the other hand overweight and obesity are found to be a problem in children. Many of the following factors are vital for adulthood health. Improvement of physical health, including disease prevention and enhancement of physical fitness, improvement of mental health, self concept and academic performance are only a few of the mentioned benefits provided by regular physical activity. It is thus of great importance that an upward trend in the physical activity patterns of children will develop in the near future.

2.8 REFERENCES

ACKLAND, T.R. & BLANKSBY, B.A. 2001. Gender and activity comparison of body composition among Australian children. Body composition in children and adolescents. *Medicine sports science,* 44:115-131.

ADAMS, G.R., GULLOTTA, T.P. & MARKSTROM-ADAMS, C. 1994. Adolescent life experiences. 3rd ed. Pacific Grove, Calif.: Brooks/Cole. 364 p.

AMSTRONG, N. & MCMANUS, A. 1996. Growth, maturation and physical education. (*In* , N., *ed.* New direction in physical education. London: Change and Innovation. p. 19-51.)

ANDERSON, R.E., CRESPO, C.J., BARTLETT, S.J., CHESKIN, L.J. & PRATT, M. 1998. Relationship of physical activity and television watching with body mass and level of fatness among children. *Journal of American medical association (JAMA),* 279(12):938-942.

ANON. 2004. Inactivity cited in overweight youths. *Journal of physical education, recreation and dance,* 75(9):5.

ARA, I., VINCENTE-RODRIGUEZ, G., JIMENEZ-ROMIRES, J., DORADO, C., SERRANO-SANCHEZ, J.A. & CALBET, J.A.L. 2004. Regular participation in sports is associated with enhanced physical fitness and lower fat mass in prepubertal boys. *International journal of obesity,* 28:1585-1593.

ARMSTRONG, M.E.G., LAMBERT, M.I., SHARWOOD, K.A. & LAMBERT, E.V. 2006. Obesity and overweight in South African primary school children – the Health of the Nation Study. *South African medical journal,* 96:439-444

BALL, G.D.C., MARSHALL, J.D. & McCARGAR, L.J. 2003. Fatness and fitness in obese children at low and high health risk. *Pediatric exercise science,* 15:392-405.

BARANOWSKI, T., MENLIN, J., RESNICOW, K., FRANK, E., CULEN, K.W. & BARANOWSKI, J. 2000. Physical activity and nutrition in children and youth: an overview of obesity prevention. *Preventive medicine,* 31:S1-S10.

BOILEAU, R.A., LOHMAN, T.G. & SLAUGHTER, M.H. 1985. Exercise and body composition of children and youth. *Scandinavian journal of sport science,* 7(1):17-27.

BRITTENHAM, D. & BRITTENHAM, G. 1997. Stronger abs and back. Champaign, Ill.: Human Kinetics. 234 p.

BRUTON, G., HARDEN, A., REES, R., KAVANAGH, J.M, OLIVER, S. & OAKLEY, A. 2003. Children and physical activity: a systematic review of barriers and facilitators. http://www.eppi.ioe.ac.uk Access date: 25 July 2005.

CDC *see* UNITED STATES. Department of Health and Human Services, Centers for Disease Control and Prevention

COLCHINO, K., ZYBET, P. & BASCH, C.E. 2000. Effects of after school physical activity on fitness, fatness and cognitive self-perception: a pilot study among urban, minor adolescent girls. *American journal of public health,* 9(6):977-978.

COLE, T.J., BELLIZZI, M.C., FLEGAL, K.M. & DIETZ, W.H. 2000. Establishing a standard definition for child overweight and obesity worldwide: international survey. *British medical journal,* 320:1240-1243, May.

CORDON, G., DE BOURDEAUDHUIJ, I., DE CLERCQ, D., PHILIPPAERTS, R., VERSTRAETE, S. & GELDHOF, E. 2004. Physical fitness, physical activity, and self-reported back and neck pain in elementary school children. *Pediatric exercise science,* 16:147-157.

CRADOCK, A.L., KAWACHI, I., COLDITZ, G.A., HANN, C., MELLY, S.J., WIECHA, J.L. & GORTMAKER, S.L. 2005. Playground safety and access in Boston neighborhoods. *American journal preventive medicine*, 28(4):357-363.

DAO, H.H., FRELUT, M.L., OBERLIN, F., PERES, G., BOUTGEOIS, P. & NAVARRO, J. 2004. Effects of a multidisciplinary weight loss intervention on body composition in obese individuals. *International journal of obesity*, 28:290-299.

DAVIS, B., BULL, R., ROSCOE, J. & ROSCOE, D. 1997. Physical education and the study of sport. 3rd ed. London: Mosby. 602 p.

DAYLEY, A.J. & RYAN, J. 2000. Academic performance and participation in physical activity by secondary school adolescents. *Perceptual and motor skills*, 91:531-534.

DIETZ, W. 2005. Director: Recommendations for using BMI to assess overweight. The centers for disease control and prevention. http://www.cdc.gov/nccphp/dnpa/bmi/appendix/.htm. Access date: 15 June 2005.

DU RANDT, R. 2000. A comparison between South African and Australian performance on Australian Talent Search Program. Port Elizabeth: Nelson Mandela Metropolitan University, 10 p. (Unpublished)

DURSTINE, J.L. & MOORE, G.E. 2003. ACSM'S exercise management for persons with chronic diseases and disabilities. 2nd ed. Champaign, Ill.: Human Kinetics. 374 p.

DWYER, T., SALLIS, J.F., BIZZARD, L., LAZARUS, R. & DEAN, K. 2001. Relation of academic performance to physical activity and fitness in children. *Pediatric exercise science*, 13:225-237.

ELPHINSTON, J. & POOK, P. 1998. The core workout. 2nd ed. Australia: Core Workout. 136 p.

ENGEL, S.G., CROSBY, R.D. & KOLOTKIN, R.L. 2003. Impact of weight loss and regain on quality of life: mirror image for differential effect. *Obesity research*, 11(10):1207-1213.

ENGELBRECHT, C., PIENAAR, A.E. & COETZEE, B. 2004. Racial background and possible relationships between physical activity and physical fitness of girls: The Thusa Bana Study. *South African journal for research in sport, physical education and recreation*, 26(1):41-53.

EUROFIT. 1988. European test of physical fitness. Rome: Council of European Committee for Development of Sport. 72 p.

EVANS, E.M. & GATES-WIENAKE, P. 2004. Juvenile obesity: a call for fitness professionals. *ACSM's certified news*, 14(1):1-5.

FLEGAL, K.M. & TROIANO, R.P. 2000. Changes in the distribution of body mass index of adults and children in the US population. *International journal of obesity*, 24:807-818.

FOLSOM-MEEK, S.L. 1991. Relation among attributes physical fitness and self-concept development of elementary school children. *Perceptual and motor skills*, 73:379-383.

FOX, K.R. 2004. Tackling obesity in children through physical activity: a perspective from the United Kingdom. *Quest,* 56:28-40.

GALLAHUE, D.L. & OZMUN, J.C. 1995. Understanding motor development. Infants, children, adolescents, adults. 3rd ed. Madison, Wis.: Brown & Benchmark. 510 p.

GALLAHUE, D.L. 1996. Developmental physical education for today's children. 3rd ed. Madison, Wis.: Brown and Benchmark. 610 p.

GREEN, J., WATERS, E., HAIKERWAL, A., O'NEILL, E., RAMAN, S., BOOTH, H.L. & GIBBONS, K. 2003. Social cultural and environmental influences on child activity and eating in Australian migrant communities. *Child: Care, health and development*, 29(6):441-448.

HEYWARD V.H. 1998. Practical body composition assessment for children, adults and older adults. *International journal of sport nutrition,* 8:285-307.

JANSSEN, I., KATZMARZYK, P.T., BOYCE, W.F., KING, M.A. & PICKETT, M.A. 2004. Overweight and obesity in Canadian adolescents and activity pattern. *Journal of adolescent health,* 35:360-367.

JEFFERY, R.W., WING, R.R., SHERWOOD, N.E. & TATE, D.F. 2003. Physical activity and weight loss: does a prescribing higher physical activity goal improve outcomes? *American journal of clinical nutrition,* 78:684-689.

KHANNA, G.L., MAJUMDAR, P., SAHA, M. & MANDAL, M. 1998. Cardiorespiratory fitness and body composition in Indian children of 10 - 16 years: physical fitness and nutrition during growth. *Medical sport science*, 43:132-144.

KIRTLAND, K.A., PROTER, D.E., ADDY, C., NEET, M.J., WILIAMS, J.E., SHARPE, P.A., NEFF, L.J., KOMSEY, C.D. & AISWORTH, B.E. 2003. Environmental measures of physical activity supports: perception versus reality. *American journal of preventive medicine*, 24(4): 323-331.

KLAUSEN, K., SCHIBYE, B. & RASMUSSEN, T.B. 1989. A longitudinal study of changes in physical performance of 10 - 15 year old boys and girls. (*In* Oseid, S. & Carlsen, K., *eds.* Children and exercise XIII. Champaign, Ill.: Human Kinetics. p. 113-122.)

KRAVITZ, L. & HEYWARD, V.H. 2004. Getting a grip on body composition. *Understanding body composition*, 1:1-6.

LOHMAN, T.G. 1992. The prevalence of obesity in children in the United States. (*In* Heyward, V.H. & Stolarzyk, L.M., *eds.* Advances in body composition assessment. Champaign: Human Kinetics Publishers. p. 150.)

MALINA, R.M. & BOUCHARD, C. 1991. Growth, maturation and physical activity. Champaign Ill.: Human Kinetics. 501 p.

MANIOS, Y., KAFATOS, A. & CODRINGTON, C. 1999. Gender differences in physical activity and physical fitness in young children in Crete. *Journal of sports medicine and physical fitness*, 39:24-30.

MEYERS, L., STRIKMILLER, P.K., WEBBER, .S. & BERENSON, G.S. 1996. Physical and sedentary activity in school children grades 5 - 8: The Bogalusa Heart Study. *Medical and science in sport and exercise*, 28(7):852-859.

MONYEKI, M.A., KEMPER, H.C., TWISK, J.W., MONYEKI, K.D., TORIOLA, A.L. & STEYN, N.P. 2003. Anthropometric indicators of nutritional status and physical fitness of Ellisras rural primary school children, South Africa. *Medicina sportiva,* 7:E93-E102.

MONYEKI, M.A., KOPPES, L.L., KEMPER, H.C., MONYEKI, K.D., TORIOLA, A.L., PIENAAR, A.E. & TWISK, J.W.R. 2005. Relationship between physical activity and physical fitness of Ellisras rural primary school children of South Africa. *Journal of physical education and recreation (Hong Kong),* 11(2):54-60.

MORROW, J.R. Jr., JACKSON, A.W. & PAYNE, V.G. 1999. Physical activity promotion and school physical education. *President's council on physical fitness and sports research digest,* Series 3(7):1-9.

NASSIS, G.P., PSARRA, G. & SIDOSSIS, L.S. 2005. Central and adiposity are lower in overweight and obese children with high cardiorespiratory fitness. *European journal of clinical nutrition,* 59(1):137-141, Jan.

NCCDPHP *see* UNITED STATES OF AMERICA. National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP)

NDAS *see* UNITED STATES OF AMERICA National Data Analysis System (NDAS).

ORLEANS, C.T., KRAFT, K., MARX, J.F. & McGINNIS, J.M. 2003. Why are some neighbors active and others not? Charting a new course for research on the policy and environmental determinants of physical activity. *Annals of behavioral medicine*, 25(2):77-79.

PIENAAR, A.E. 2001. Perseptueel motoriese leer: teorie en praktyk. Potchefstroom: PU vir CHO. (Handleiding vir motoriese leer.) 199 p.

PIENAAR, A.E. & VAN DER WALT, T.S.P. 1988. Die invloed van deelname aan 'n gimnastiek program op sekere antropometriese veranderlikes by ses tot nege jarige meisies. *South African journal for research in sport, physical education and recreation,* 11(2):39-47.

PISSANOS, B.W., MOOR, J.B. & REEVE, G. 1983. Age, sex, and body composition as predictors of children's performance in basic motor abilities, health related fitness motor abilities and health related fitness items. *Perceptual and motor skills*, 56:71-77.

REDDY, S.P., PANDAY, S., SWART, D., JINABHAI, C.C., AMOSUN, S.K., JAMES, S., MONYEKI, K.D., STEVENS, G., MOREJELE, N., KAMBARAN, N.S., OMARDIEN, R.G. & VAN DEN BORNE, H.W. 2003. Umthenthe Uhlaba Usamila – The South African Youth Risk Behaviour Survey 2002. Cape Town: South African Medical Research Council.

REILLY, T. & STRATTON, G. 1995. Children and adolescent in sport: psychological considerations. *Sport exercise and injury*, 1(4):207-213, Oct.

RIBEIRO, J., GUERRA, S., PINTO, A., OLIVEIRA, J., DUARTE, J. & MOTA, J. 2003. Overweight and obesity in children and adolescents: relationship with blood pressure, and physical activity. *Annuals of human biology,* 30(2): 203-213.

ROCHFORD, M. & KAMINSKY, E. 2004. Fighting back against childhood obesity through the Cape May County Children's Health Summit: preventing chronic disease.

Public health research, practice and policy, 1(4). http://www.cdc.gov/pcd/issues/2004/oct/040067.htm Access date: 18 June 2005.

RODRíGUEZ-MORÁN, M., SALAZAR-VÁZQUEZ, B., VIOLANTE, R. & GUERRERO-ROMERO, F. 2004. Metabolic syndrome among children and adolescents aged 10-18 years. *Diabetes care*, 27(10):2516-2517.

SCHMITZ, K.H., JACOBS Jr. D.R., HONG, C-P., STEINBERGER, J., MORAN, A. & SINAIKO. 2002. Association of physical activity with insulin sensitivity in children. *International journal of obesity*, 26:1310-1316.

SHEPHARD, R.J. 1997. Curricular physical activity and academic performance. *Pediatric exercise science*, 9:113-126.

SOTHERN, M.S., LOFTIN, M., SUSKIND R.M., UDALL, J.N. & BLECKER, U. 1999. The health benefits of physical activity in children and adolescents: implications for chronic disease prevention. *European journal for pediatrics*, 158:271-274.

STEINBECK, K.S. 2001. The importance of physical activity in the prevention of overweight and obesity in childhood: a review and an opinion. *International association for study of obesity reviews*, 2:117-130.

STRUM, R. 2005a. Childhood obesity - what we can learn from existing data on societal trends, part 1. *Preventing health research, practice and policy*, 2(1). http://www.cdc.gov/pcd/issues/2005/jan/04_0038.htm. Access date: 13 August 2005.

STRUM, R. 2005b. Childhood obesity - what we can learn from existing data on societal trends, part 2. *Preventing health research, practice and policy,* 2(2). http://www.cdc.gov/pcd/issues/2005/jan/04_0039.htm. Access date: 13 August 2005.

SUMMERFIELD, L.M. 1998. Promoting physical activity and exercise among children. *Eric digests:*1-17.

TERSHAKOVEC, A.M., KUPPLER, K.M., ZEMEL, B. & STALINGS, V.A. 2002. Age, sex, ethnicity, body composition and resting energy expenditure of obese African American and white children and adolescents. *American journal of clinical nutrition,* 75:867-871.

TREIBER, F.A., STRONG, W.B., RENSMAN, F.W. & GRUBER, M. 1989. Relationship between habitual physical activity and cardiovascular responses to exercise in young children. (*In* Oseid, S. & Carlsen, K., *eds.* Children and exercise XIII. Champaign, Ill.: Human Kinetics. p. 285-293.)

TREMBLAY, M.W. & WILLMS, J.D. 2000. Secular trends in the body mass index of Canadian children. *Canadian medical association journal,* 163(11):1429-1433.

TREUTH, M.S., BUTTE, N.F., ADOLPH, A.L. & PUYAU, M.R. 2004. A longitudinal study of fitness and activity in girls predisposed to obesity. *Medicine and science in sport and exercise,* 36(2):198-204.

TROST, S.T., SALLIS, J.F., PATE, R.R., FREEDSON, P.S., TAYLOR, W.C. & DOWDA, M. 2003. Evaluating a model of parental influence on youth physical activity. *American journal of preventive medicine,* 25(4):277-282.

UNITED STATES OF AMERICA. National Data Analysis System (NDAS). 2004. National data analyze system homepage. http://www.ndas.cla.org Access date: 18 June 2005.

UNITED STATES OF AMERICA. National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). 2005a. The Centers for Disease Control and Prevention. http://www.cdc.gov/nccphp/dnpa/bmi/bmi-for-age.htm. Access date: 15 June 2005.)

UNITED STATES OF AMERICA. National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). 2005b. The Centers for Disease Control and Prevention. http://www.cdc.gov/nccphp/dnpa/bmi.htm. Access date: 15 June 2005.

UNITED STATES. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC). 2002. Barriers to children walking and biking to school - United States. 1999. *Morbidity and mortality weekly report (MMWR),* 51(32):702-704.

UTTER, J., NEUMARK-SZTAINER, D., JEFFERY, R. & STORY, M. 2003. Sedentary behaviors and body mass index of adolescents. *Nutrition research newsletter,* 22(11):P2, 11p.

VAN DER MERWE, M.T. 2002. The epidemiology and pathogenesis of obesity - where do we stand in 2002? *Geneeskunde, The medicine journal,* 44:43-46.

VAN ROOYEN, F. 1993. Effects of an enriched physical activity programme on selected anthropometrical, physiological and performance characteristics of an underprivileged ethnic group. Grahamstown: Rhodes University. (Dissertation - MSc.) 96 p.

VERSTER, J. 2001. Causes, risks and dietary treatment of obesity. *Geneeskunde, The medical journal*, 43:15-18.

VINCENT, S.D., PANGRAZI, R.P., RAUSTORP, A., TOMSON, L.M. & CUDDIHY, T.F. 2003. Activity levels and body mass index of children in the United States, Sweden and Australia. *Medical and science in sport and exercise*, 35(5):1367-1373.

WHITNEY, E.N. & ROLFES, S.R. 2002. Understanding nutrition. 9th ed. Belmont, Calif.: Wadsworth. 697 p.

WHO *see* WORLD HEALTH ORGANIZATION (WHO)

WORLD HEALTH ORGANIZATION (WHO). 1995. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. (World Health Organization, Technical report serial, 854.) Geneva: WHO. 452 p.

WORLD HEALTH ORGANIZATION (WHO). 1998. Obesity: preventing and managing the global epidemic. (Report of a WHO Consultation of Obesity.) Geneva: WHO. 276 p.

YRBS *see* REDDY, S.P., PANDAY, S., SWART, D., JINABHAI, C.C., AMOSUN, S.K., JAMES, S., MONYEKI, K.D., STEVENS, G., MOREJELE, N., KAMBARAN, N.S., OMARDIEN, R.G. & VAN DEN BORNE, H.W. The South African Youth Risk Behaviour Survey 2002 (YRBS)

Chapter 3

THE INFLUENCE OF A PHYSICAL ACTIVITY INTERVENTION PROGRAMME (PAI) ON THE BODY COMPOSITION OF 9 – 13 YEAR OLD BOYS

Miss. S.M. du Preez, Prof. J.H. de Ridder, & Dr. M.A. Monyeki

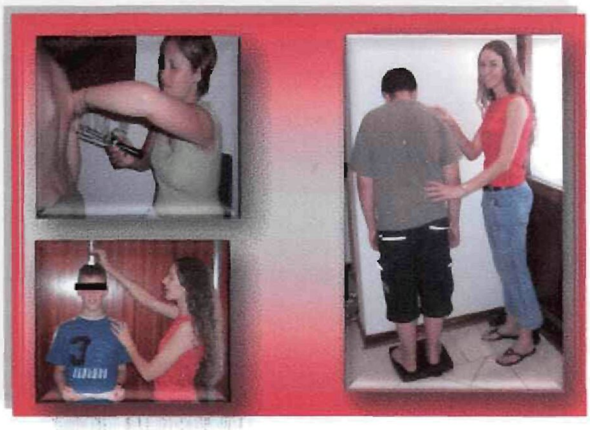
Presented for publication in the "African Journal for Physical, Health Education, Recreation and Dance"

Miss. SUSANNA MARIA DU PREEZ (Hons BSc) School for Biokinetics, Recreation and Sport Science, North-West University (Potchefstroom Campus), Potchefstroom, Republic of South Africa. Email: sanridup@netactive.co.za

Prof. J. HANS DE RIDDER, (PhD) School for Biokinetics, Recreation and Sport Science, North-West University (Potchefstroom Campus), Private Bag X 6001, Potchefstroom, 2550, Republic of South Africa. Email: Hans.DeRidder@nwu.ac.za ***(Correspondence address)***

Dr. M. ANDRIES MONYEKI, (PhD) School for Biokinetics, Recreation and Sport Science, North-West University (Potchefstroom Campus), Potchefstroom, Republic of South Africa. Email: Andries.Monyeki@nwu.ac.za

PHYSICAL ACTIVITY INTERVENTION AND BODY COMPOSITION



ABSTRACT

Excessive body fat is one of the main contributing factors in many related health threatening diseases such as diabetes, obesity, hypertension and coronary arterioscleroses. The objective of this study was to determine whether a ten month physical activity intervention programme (PAI) will have an influence on the body composition of 9 – 13 year old boys. A total of 322 (173 = experimental group (EG) and 149 = control group (CG)) subjects were measured and the EG participated in a ten month intervention of physical activity. The subjects were from two schools in the Gauteng Province, South Africa (School A, the EG and School B, the CG). Anthropometric measures of body mass (kg), stature (cm) and three skinfolds (triceps, subscapular and calf) were done according to standard protocol proposed by the International Society for the Advancement of Kinanthropometry (ISAK, 2001). Body mass-index (kg/m^2) was calculated from weight and stature, and percentage body fat was calculated from the skinfolds measurements by an equation developed by Boileau (1985). To analyze the data the pre and post-tests were employed, and analyses were performed using Statistica 2004 (Statsoft, Inc. 2008). Descriptive statistics, pre-test and post-test comparisons was done by dependent t-tests, and age groups were compared by using independent t-tests. Statistical significance was set at $p < 0.05$ and a small practically significant level were set at $d \geq 0.2$, a substantial or medium practically significant effect were set at $d \geq 0.5$ and a large practically significant level were set at $d \geq 0.8$. The results of the present study show improvement in body composition in the EG compared to the CG. Such improvements were observed in slight decreases in BMI and percentage body fat for the EG compared to increases in the CG. Given these findings, the study therefore recommends the inclusion of physical activity programmes in schools, and after school community physical activity programmes.

Key words: Juvenile obesity, physical fitness, physical activity, body composition, anthropometry, children, health, sedentary lifestyle, hypo-kinetic diseases.

3.1 INTRODUCTION

When measuring press interest as public concern, fatness and obesity among children have become major issues. Obesity as a topic featured 17 000 times in major English language media in the world in 2001, in 2003 - 46 000 times and in 2004, this occurrence was twice as frequent as it was in the previous year (Voûte & Valentin, 2005). Childhood obesity is thus becoming a worldwide public health concern (Burke, Beilin, Simmer, Oddy, Blake, Doherty, Kendall, Newnham, Landau & Stanley, 2005). Parents, teachers and the rest of the pediatric population are becoming more aware of this life threatening issue (Summerfield, 1998; Morrow, Jackson & Payne, 1999; Steinbeck, 2001; Bruton, Harden, Rees, Kavanagh, Oliver & Oakley, 2003; Trost, Sallis, Pate, Freedson, Taylor & Dowda, 2003). One important factor in any child's life is parental motivation and support to be actively involved in physical activity events. This motivation plays an important role in a child's enthusiasm to lead a healthy, physically active life (Manios, Kafatos & Codrington, 1999; Steinbeck, 2001; Bruton *et al.*, 2003; Green, Waters, Haikerwal, O'Neill, Raman, Booth & Gibbons, 2003). Physical activity should also be incorporated into a daily programme in schools. This physical activity can be in the form of physical education, organised sport or recreation (Summerfield, 1998; Morrow *et al.*, 1999).

Physical inactivity can lead to various unfavourable conditions and may become a long-term problem for an overweight child (Ara, Vincente-Rodriguez, Jimenez-Romires, Dorado, Serrano-Sanchez & Calbet, 2004; Dao, Frelut, Oberlin, Peres, Boutgeois & Navarro, 2004). Juvenile obesity is most likely to be transferred into a child's adulthood as this is the kind of lifestyle the child is used to and will continue to follow an inactive lifestyle at the onset of adulthood (Shephard, 1997). Excessive body fat is also one of the main contributing factors in many related health threatening hypo-kinetic diseases, such as diabetes mellitus, obesity, hypertension, respiratory diseases, psychological disorders, coronary arterioscleroses and mortality (Ford, Mokdad, Ajani, 2004; Janssen, Katzmarzyk, Boyce, King & Pickett, 2004; Burke *et al.*, 2005; Fritz, Stovell, Sydney & Merrill, 2005; Gance-Cleveland, Harris & Ward-Begnoche, 2005; Voûte & Valentin, 2005).

Sedentary lifestyle is a direct cause of juvenile obesity (Whitney & Rolfes, 2002; Anon, 2004; Ara *et al.,* 2004; Dao *et al.*, 2004). Young people are less active due to the advancement of the internet, television, computer and play-station games. Unsafe traffic and poor road safety as well as a decrease in safe outdoor playgrounds and physical activity during school time, create an almost compulsory sedentary lifestyle for the youth of today (Whitney & Rolfes, 2002). Several studies reported that 26% American children watch more than four hours television per day and 67% watch more than two hours per day (Anderson, Crespo, Bartlett, Cheskin & Pratt, 1998; Engelbrecht, Pienaar & Coetzee, 2004; Evans & Gates-Wienake, 2004). These children have a higher prevalence of overweight than those watching one or fewer hours of television per day. Today approximately 10% of children in the world - 155 million individuals - are overweight and 30 – 45 million are classified as obese, these results are based on the commonly agreed measurement, the BMI (Voûte & Valentin, 2005). According to the South African National Food Consumption Survey (NFCS) 17.1% of children aged 1 – 9 years in South Africa are overweight/obese (Labadarios, Steyn, Maunder, Macintryre, Gericke, Swart, Huskisson, Dannhauser, Voster, Nesmvuni & Nel, 2005). This rate is also comparable to that of other developing countries such as China (7%), Egypt (14%) and India (16%) (Wang, 2001).

Physical activity is defined as "bodily movement produced by skeletal muscles that result in energy expenditure" (Meyers, Strikmiller, Webber & Berenson, 1996; Summerfield, 1998). Literature shows that regular physical activity has significant health benefits, such as (a) beneficial influence on the largest number of chronic disease risk factors including coronary heart diseases, obesity, hyperlipidemia, hypertension and T2DM (Treiber, Strong, Rensman & Gruber, 1989; Meyers *et al.*, 1996; Summerfield, 1998) (b) it increases bone density and bone mass, especially in children as they are still growing and developing new bone cells each day (Meyers *et al.*, 1996; Summerfield, 1998; Sothern, Loftin, Suskind, Udall & Blecker, 1999), (c) Colchino, Zybet & Basch (2000) found a significant improvement in cardiovascular endurance, muscular strength, muscular endurance and flexibility (d) physical activity reduces anxiety levels and improves self image and moods of children (Summerfield, 1998) and (e) cognitive and mental ability will improve, consequently improvement in academic performance and concentration levels (Summerfield, 1998).

It is, therefore, of great importance that upward trends in the physical activity patterns of children will be developed in every situation a child finds himself in.

The objective of this study was, therefore, to determine whether a ten month physical activity intervention programme (PAI) will have an influence on the body composition of 9 – 13 year old boys.

3.2 MATERIALS AND METHODS

3.2.1 Subjects

A cross-sectional experimental design was used. A total of 322, 9 -13 year old boys formed part of the study. The ten month intervention by means of physical activity was done and also included pre and post-tests. Two schools were selected to represent an experimental and a control group. School A, the experimental group (EG) was represented by 173 subjects and School B, the control group (CG) was represented by 149 subjects. The two schools were approximately seven kilometers from each other, were in the Gauteng Province and the schools also participated against each other during sporting events (see Table 3.1).

The children were not randomly allocated to the two groups, but the two schools were considered as being representative of equal socio-economic children in the Gauteng Province as these subjects were all in the same socio-economic class. There was, however, a possibility of bias because the effects of the programme might have been confounded by factors not taken into account by a random allocation. The participants of school A took part in half hour sessions of physical activity twice per week and the participants from school B did not take part in the physical activity intervention programme. The study was explained to all the parents and also confirmed with a letter which was signed to give each child the appropriate permission to take part in this study.

Table 3.1: Total population of the EG and CG

Experimental Group (*n*=173)		Control Group (*n*=149)	
Age (year)	*n*	Age (year)	*n*
9	35	9	26
10	39	10	44
11	45	11	34
12	36	12	34
13	18	13	11
TOTAL	173		149

3.2.2 Measurements

Baseline measurements: First two weeks of February 2005.

Post intervention measurements: Last two weeks of November 2005.

3.2.3. Anthropometry

Measurements of anthropometrical data were done by qualified anthropometrists with guidance from a Level III qualified anthropometrist. Anthropometric data were collected according to standard protocol proposed by International Society for the Advancement of Kinanthropometry (ISAK, 2001). The various measurements taken, included body mass, stature, triceps, subscapular and calf skinfolds and humerus and femur breadth. The apparatus used for taking the measurements, was a stadiometer for stature (to the nearest 0.1cm), with the head in the Frankfort plane. Body mass was measured with an electronic scale (Precision Health Scale®) to the closest 0.1kg. Skinfold measurements were done with a Harpenden® Skinfold Caliper with constant pressure of 10g/mm² to the closest 0.2mm according to ISAK (2001) guidelines. Body Mass Index (BMI) was used to predict obesity and was interpreted according to the tables of Flegal and Troiano (2000) and Cole, Bellizzi, Flegal and Dietz (2000). These tables present the average BMI values for children and adolescents (8 – 14 years) as well as international cut-off points for BMI for overweight and obese children (8.5 – 14 years). Percentage body fat was determined according to the formula used by Boileau, Lohman and Slaughter (1985) and classified according to the classifications of Lohman (1992) for obesity in children.

To determine BMI levels, the following formula (Whitney & Rolfes, 2002) were used:

$$\text{Body Mass Index (BMI)} = \frac{\text{Body mass (kg)}}{\text{Stature (m)}^2}$$

$$\text{Body Mass Index (BMI)} = \text{kg/m}^2$$

To determine percentage body fat, the following formulas of Boileau *et al.* (1985) were used:

Boys 6 – 11 years: % Body fat = (sum of triceps- and subscapular skinfolds) – 0.012 (sum of triceps and subscapular skinfolds) ^{2} - 3.4

Boys 12 – 14 years: % Body fat = (sum of triceps- and subscapular skinfolds) – 0.012 (sum of triceps and subscapular skinfolds) ^{2} - 4.4

Table 3.2: Percentage body fat was divided into 4 groups according to Lohman (1992) for classifications of obesity in children

Classification Level	Percentage body fat (girls)	Percentage body fat (boys)
Low percentage body fat UNDERWEIGHT	< 12 %	< 12 %
Normal percentage body fat NORMAL	12.1 – 24.9 %	12.1 – 19.9 %
High percentage body fat OVERWEIGHT	> 25 %	> 20 %
High percentage body fat OBESE	> 30 %	> 25 %

3.2.4 Physical activity intervention (PAI) programme

Subjects in the CG did not participate in any physical activity programme. Subjects included in the EG participated in a physical activity programme. Subjects took part in this programme twice per week for a 30 min period and the programme contained components focusing on agility, cardiovascular endurance, strength, muscular endurance, flexibility and speed. Each lesson consisted of a warm-up with stretch exercises, fitness, speed, strength, balance and cool down exercises. The EG participated in this physical activity programme for ten months from the beginning of February 2005 until the end of November 2005.

3.2.5 Statistical Analysis

The data on the data sheets were computerized by the researcher. Descriptive statistics were used to define information on all the variables. The pre and post-test comparisons were determined by use of a dependent t-test and age groups were compared by using independent t-tests (Thomas, Nelson & Silverman, 2005). Statistical significance was set at $p < 0.05$ and a small practically significant level were set at $d \geq 0.2$, a substantial or medium practically significant effect were set at $d \geq 0.5$ and a large practically significant level were set at $d \geq 0.8$. (Ellis & Steyn, 2003; Steyn, 2005; Thomas *et al.*, 2005). All statistical analyses were done with Statistica (Statsoft, Inc. 2008) which is available on the network of the North-West University (Potchefstroom Campus).

3.3 RESULTS

Table 3.3 presents the results of the EG in terms of the different body composition variables in the five different age groups as well as in the total group. Table 3.4 presents the results of the CG also in terms of the different body composition variables in the five different age groups and in the total group. The differences between the pre and post-tests for the EG and CG are illustrated and discussed by ways of graphs (Figure 3.1 – 3.4). Finally BMI values and percentage body fat values will be classified and discussed (Table 3.5).

In Table 3.3 the values for the EG are reported. As illustrated in Table 3.3, there were statistically significant increase in stature ($p<0.05$) from the pre-test to the post-test in the 9, 10, 11, 12 and 13 year old boys, as well as the total group of boys. As far as practically significance is concerned, there was a medium practically effect ($d\geq0.5$) in the 9 and 10 year old boys and a large practically significant effect for the 11, 12 and 13 year old boys. Body mass increase is relatively higher in the 11, 12 and 13 year old boys, where the 11 year old boys shows a mean mass increase of 2.25 kg, the 12 year old boys an increase of 2.97 kg and the 13 year old boys an increase of 3.22 kg.

Table 3.3: The influence of physical activity intervention programme (PAI) on the body composition parameters of the EG (n=173)

Variables	Ages	*n*	$\bar{X}$ Pre-Test	$\bar{X}$ Post-Test	$\bar{X}$ Difference	SD Difference	p-values	Effect Size d-value
Body mass (kg)	9 Years	35	30.92	32.53	1.61	2.14	<0.00*	0.75***
	10 Years	39	35.90	37.69	1.79	2.59	<0.00*	0.69***
	11 Years	45	41.43	43.68	2.25	2.61	<0.00*	0.86****
	12 Years	36	46.06	49.03	2.97	2.39	<0.00*	1.24****
	13 Years	18	48.42	51.64	3.22	2.35	<0.00*	1.37****
	Total Group	173	39.75	42.02	2.27	2.49	<0.00*	0.91****
Stature (cm)	**9 Years**	**35**	**135.89**	**141.21**	**5.32**	**9.33**	**<0.00***	**0.57*****
	10 Years	**39**	**141.24**	**145.13**	**3.89**	**0.97**	**<0.00***	**4.01******
	11 Years	**45**	**148.72**	**153.09**	**4.37**	**1.60**	**<0.00***	**2.73******
	12 Years	**36**	**154.58**	**158.15**	**3.58**	**6.45**	**<0.00***	**0.56*****
	13 Years	**18**	**158.98**	**164.41**	**5.43**	**1.71**	**<0.00***	**3.18*****
	Total Group	**173**	**146.73**	**151.12**	**4.40**	**5.23**	**<0.00***	**0.84******
BMI (kg/m²)	9 Years	35	16.60	16.27	-0.33	1.54	0.21	-0.21
	10 Years	39	17.82	17.73	-0.09	1.23	0.66	-0.07
	11 Years	45	18.58	18.46	-0.11	0.98	0.44	-0.11
	12 Years	36	19.22	19.72	0.51	2.41	0.22	0.21**
	13 Years	18	18.99	18.90	-0.08	0.60	0.56	-0.13
	Total Group	173	18.18	18.16	-0.02	1.53	0.87	-0.01
Percentage Body Fat (%)	**9 Years**	**35**	**14.77**	**16.24**	**1.47**	**2.96**	**<0.00***	**0.50*****
	10 Years	**39**	**19.90**	**21.02**	**1.12**	**2.00**	**<0.00***	**0.56*****
	11 Years	**45**	**19.84**	**20.41**	**0.57**	**2.75**	**0.17**	**0.21****
	12 Years	**36**	**20.68**	**20.36**	**-0.32**	**2.67**	**0.47**	**-0.12**
	13 Years	**18**	**18.39**	**17.36**	**-1.03**	**3.11**	**0.18**	**-0.33**
	Total Group	**173**	**18.85**	**19.37**	**0.52**	**2.79**	**0.01**	**0.19**

*statistic significant effect (p- value < 0.05); **small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); SD: Standard Deviation; $\bar{X}$: Average

With regard to stature, the 9, 10, 11, 12 and 13 year old boys, as well as the total group of boys showed a statistically significant increase in stature ($p<0.05$) from the pre-test to the post-test (see Table 3.3). As far as practically significance is concerned, there was a medium practically effect ($d\geq0.5$) in the 9, 12 and 13 year old boys and a large practically significant effect for the 10 and 11 year old boys as well as in the total group.

When BMI is examined for all the age groups, there were no statistically significant differences from baseline to end between any of the age groups or the total group of boys. The only practically significant difference is for the 12 year old boys, who show a small practically significant effect (d≥0.2). According to values proposed by Cole *et al.* (2000), no values for any of the groups could be classified as overweight or obese. The mean baseline/end values for the 10, 11, 12 and 13 year old boys were, however, above the average values reported in the NHANES III study for comparable age groups (Flegal & Troiano, 2000). Except for the 12 year old boys, there were decreases in all the age groups as well as in the total group's BMI values.

As seen in Table 3.3, there were statistically significant differences in the 9 and 10 year old boys and medium practically significant effects for percentage body fat between the pre and post-tests of the EG in the 9 and 10 year old boys and a small practically significant effect in the 11 year old boys. The 9, 10 and 11 year old boys as well as the total group showed a slight increase in percentage body fat whereas the 12 and 13 year old boys showed a decrease.

In Table 3.4, the results for the CG with regard to body composition between the pre and post-test for all age groups are reported. The results show statistically significant effects for 9, 10, 11, 12 and 13 year old boys as well as for the total group. As far as practically significant effects are concerned all ages shows an increase, where the 9, 10, 11 and 13 year old boys as well as the total group indicates large practically significant effects and the 12 year old boys indicates a medium practically significant effect.

The results for the stature of the 9 – 13 year old boys indicate that all ages had a statistically significant increase as well as a large practically significant increase between the pre and post-tests.

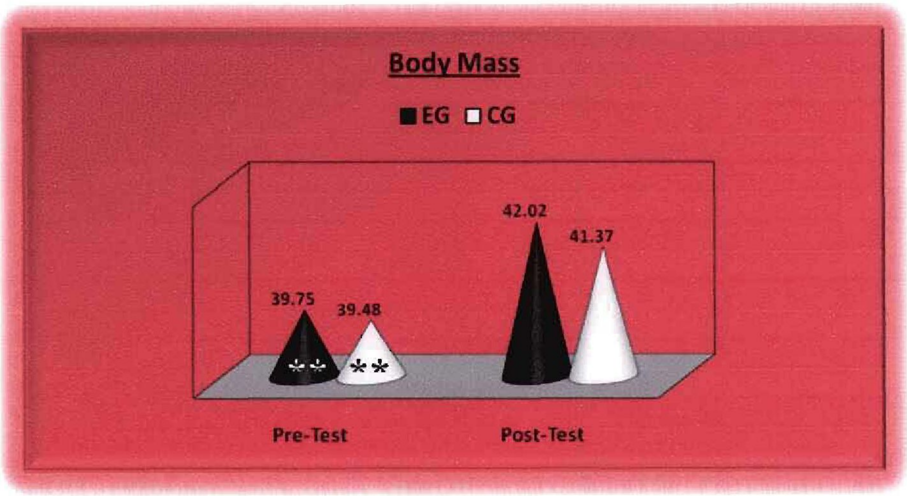
There were no statistically differences in the BMI values for any of the age groups or the total group according to Table 3.4, a small practically significant effect in the 12 year old boys and a medium practically significant effect in the 13 year old boys. The BMI values changed little during the intervention period.

Table 3.4: The influence of physical activity intervention programme (PAI) on body composition parameters on the CG (n=149)

Variables	Ages	*n*	$\bar{X}$ Pre-Test	$\bar{X}$ Post-Test	$\bar{X}$ Difference	SD Difference	p-values	Effect Size d-value
Body mass (kg)	9 Years	26	35.28	37.06	1.77	1.81	<0.00*	0.98****
	10 Years	44	35.72	37.06	1.34	1.40	<0.00*	0.96****
	11 Years	34	38.39	40.17	1.77	1.55	<0.00*	1.14****
	12 Years	34	46.94	49.18	2.24	3.24	<0.00*	0.69***
	13 Years	11	44.76	48.29	3.53	1.61	<0.00*	2.19****
	Total Group	149	39.48	41.37	1.88	2.12	<0.00*	0.89****
Stature (cm)	9 Years	26	141.99	144.89	2.90	1.07	<0.00*	2.71****
	10 Years	44	141.86	144.56	2.70	1.19	<0.00*	2.27****
	11 Years	34	147.15	150.17	3.02	1.19	<0.00*	2.54****
	12 Years	34	156.03	158.97	2.94	2.73	<0.00*	1.08****
	13 Years	11	158.45	162.26	3.81	3.98	<0.00*	0.96****
	Total Group	149	147.55	150.49	2.94	1.93	<0.00*	1.52****
BMI (kg/m^2)	9 Years	26	17.43	17.55	0.12	0.78	0.43	0.15
	10 Years	44	17.66	17.64	-0.02	0.63	0.83	-0.03
	11 Years	34	17.66	17.74	0.08	0.62	0.44	0.13
	12 Years	34	19.19	19.36	0.17	0.87	0.26	0.20**
	13 Years	11	17.77	18.30	0.53	0.90	0.08	0.59***
	Total Group	149	17.98	18.09	0.11	0.74	0.07	0.15
Percentage Body Fat (%)	9 Years	26	16.28	20.49	4.22	3.33	<0.00*	1.27****
	10 Years	44	17.16	19.84	2.68	2.67	<0.00*	1.00****
	11 Years	34	16.91	19.75	2.84	3.21	<0.00*	0.88****
	12 Years	34	18.77	20.39	1.62	2.20	<0.00*	0.74***
	13 Years	11	14.48	16.79	2.31	2.06	<0.00*	1.12****
	Total Group	149	17.12	19.83	2.72	2.88	<0.00*	0.94****

*statistic significant effect (p- value < 0.05); **small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); SD: Standard Deviation; $\bar{X}$: Average

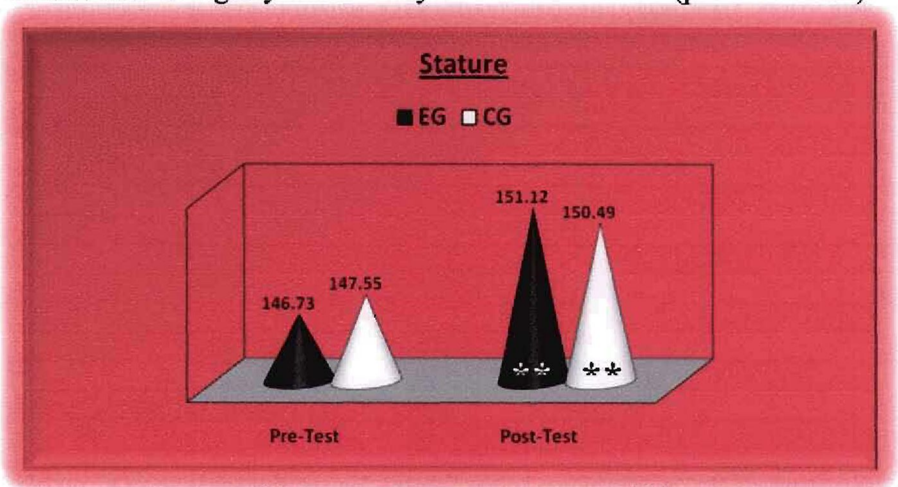
When analyzing the percentage body fat of the CG group as indicated in Table 3.4, it is noticeable that there was an increase in all of the age groups. The 9, 10, 11, 12 and 13 year old boys as well as the total group showed statistically significant increases ($p<0.05$) and large practically significant increases ($d\geq0.8$) were evident in all groups except for the 12 year old boys who showed a medium practically significant increase ($d\geq0.5$).



*statistic significant effect (p- value < 0.05); ** small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 3.1: A comparison between the EG and the CG for body mass (kg)

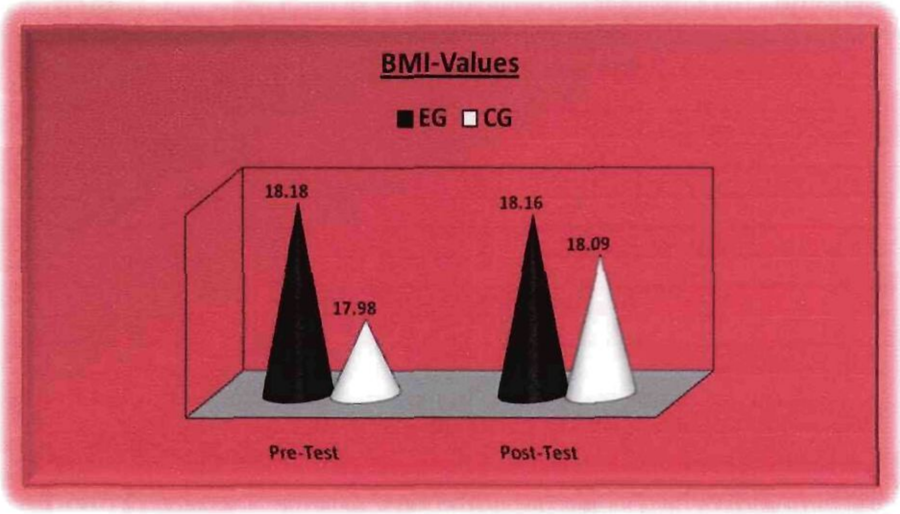
To study the comparison between the EG and CG regarding the influence of the physical activity intervention programme on body composition, independent t-tests were calculated and results are presented in the figures. In Figure 3.1 no statistically significant difference between the EG and the CG's pre-tests or their post-test values with regard to body mass, was found. The only significant difference was a small practically significant difference (d≥0.2), where the CG started with a slightly lower body mass than the EG (pre-test value).



*statistically significant effect (p- value < 0.05); **small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 3.2: A comparison between the EG and the EG for stature (cm)

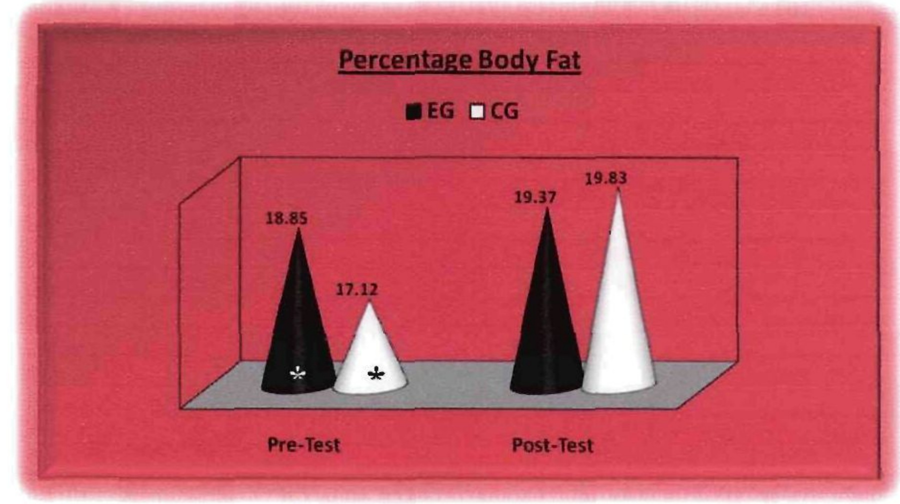
In Figure 3.2 there are no statistically significant differences between the pre-tests or the post-tests of the EG and CG. There is a small practically significant difference (d≥0.2) between the post-test results of the EG and CG, with the EG practically significant taller than the CG.



*statistically significant effect (p- value < 0.05); **small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 3.3: A comparison between the EG and the CG for body mass index (BMI) values (kg/m²)

There were no statistically significant nor practically significant differences between the EG and CG's with regard to the pre or post-tests when looking at the BMI (figure 3.3). Even though there was no significant differences, the EG showed a trend of decrease in BMI after ten month of intervension.



*statistic significant effect (p- value < 0.05); **small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 3.4: A comparison between the EG and the CG for percentage body fat (%)

A statistically significant effect is evident between the EG and CG's pre-test results where the EG had a significant higher percentage body fat than the CG. Although no other statistically significant or practically significant effects can be seen, there is a trend that the EG gained less fat than the CG where the EG gained 0.52% body fat and the CG gained 2.71% body fat.

Table 3.5: Comparing the mean BMI values of experimental and control group per age group with international body mass index (BMI) cut-off points for overweight and obese children (Cole *et al.*, 2000)

Age (years)	N	Pre-Test	Post-Test	N	Pre-Test	Post-Test	OVERWEIGHT*	OBESE*
		Experimental Group			Control Group		(BMI 25 kg/m² - Adults)*	(BMI 30 kg/m² - Adults)*
9	35	16.60	16.27	26	17.43	17.55	19.1	22.8
10	39	17.82	17.73	44	17.66	17.64	19.8	24.0
11	45	18.58	18.46	34	17.66	17.74	20.6	25.1
12	36	19.22	19.72	34	19.19	19.36	21.2	26.0
13	18	18.99	18.39	11	17.77	18.30	21.9	26.8

* Proposed by Cole *et al.*, (2000); N: Number

After examining Table 3.5, it is apparent that not one of the average BMI values for the EG or the CG could be classified as overweight or obese according to the international cut-off values proposed by Cole *et al.* (2000).

Table 3.6: Comparing the mean BMI values of experimental and control group per age group with the average body mass index (BMI) values for children (Flegal & Troiano, 2000)

Age (years)	N	Pre-Test	Post-Test	N	Pre-Test	Post-Test	NHES II & III (1963 – 1970)	NHANES III (1988 – 1994)
		Experimental Group			Control Group			
9	35	16.60	16.27	26	17.43	17.55	16.9	18.0
10	39	17.82	17.73	44	17.66	17.64	17.1	18.4
11	45	18.58	18.46	34	17.66	17.74	17.9	19.4
12	36	19.22	19.72	34	19.19	19.36	18.4	20.1
13	18	18.99	18.39	11	17.77	18.30	19.4	20.5

N: Number; NHES II & III = National Health Examination Survey, VSA 1963 – 1970; NHANES III = National Health and Nutrition Examination Survey, VSA 1988 - 1994

When comparing the average BMI values of NHES II, NHES III study to the BMI values of the EG and CG, it was found that the average values of the 10, 11 and 12 year old boys of the EG's pre and post-tests are slightly higher than the average values reported in these studies and the 9 and 13 year old boys have slightly lower average values than the values in the NHES II and NHES III study (Lohman, 1992). According to the values of the NHANES III study, all groups in the EG had lower values. As for the CG's pre and post-tests the mean BMI values of the 9, 10 and 11 year old boys are slightly higher than the averages reported in these studies where the 11 and 13 year old boys are slightly below average. According to the values of the NHANES III study, all groups in the CG had lower values.

3.4 DISCUSSION

Although the influence of the physical activity intervention programme on the body composition of 9 -13 year old boys of the EG is not very clear, the results of this study show that there is a trend that body composition slightly improves with an increase in physical activity. From the results of the present study, improvement in body composition in the EG was evident compared to the CG.

When comparing the pre and post-test values of body mass, the EG and CG showed a statistically significant increase ($p<0.05$) in all the groups as well as practically significant increases, where the EG showed medium practically significant increases ($d\geq0.5$) for the 9 and 10 year old boys and large practically significant increases ($d\geq0.8$) for the 11,12 and 13 year old boys as well as for the total group. The CG showed medium practically significant increases ($d\geq0.5$) for the 9 old boys and large practically significant increases ($d\geq0.8$) for the 10, 11, 12 and 13 year old boys as well as for the total group. Armstrong and McManus (1996), stated that body mass increases 40 – 45% in 5 to 13 year old children due to growth and as a result of increased muscle mass. From birth to early adulthood weight changes in four phases: in early childhood and infancy rapid weight gain is evident, a steady gain during childhood and then rapid again during the adolescent years (growth spurt). After this phase weight increases and decreases according to the energy balance maintained by each individual (Malina, Bouchard & Bar, 2004). Therefore the trend of the increased body mass may be due to growth and an increase in muscle mass. This is similar to the results of this study in view of the fact that the EG had a larger increase in body mass than the CG. When comparing the total group values, the EG showed an increase of 2.27kg and the CG showed an increase of 1.88kg. The reason for this may be that the EG participated in physical activity which might have increased the EG's muscle mass more than the CG's muscle mass, providing for a larger increase in body mass.

The stature of the 9, 10, 11, 12 and 13 year old boys, as well as the total group of the EG and the CG, show statistically meaningful increases ($p<0.05$). There were medium practically increases ($d\geq0.5$) for the 9, 12 and 13 year old boys of the EG and large practically increases ($d\geq0.8$) in the 10, 11 and total group of the EG. The CG showed large practically increases ($d\geq0.8$) for all groups. These significant increases in stature is predictable since the subjects were all in the middle of their "growth spurt", thus the stature of children increases gradually since birth until they reach their adolescent growth acceleration years ("growth spurt"), from where stature increases drastically. The maximal increase in stature for boys is found when boys are approximately 14.2 years of age (Armstrong & McManus, 1996). Visagie (1981) conducted a study on mainly white boys in the Durbanville area and reported almost the same occurrence where there was an evident increase in the increase of stature of 10 and 11 year old boys. Visagie (1981) also reported that stature growth change between 14 and 15 year old boys is only 2.9 cm and is much less than the stature growth for 12 and 13 year old boys, which is comparable to this study, since the largest difference was found in the 9, 11 and 13 year old boys in the EG and 11, 12 and 13 year old boys in the CG. It is interesting to find that the increases among the EG (Table 3.3) are higher than the increases in stature for the CG (Table 3.4). For the total CG the stature increase was 2.93 cm vs. the increase of 4.40 cm for the EG. According to Malina *et al.* (2004), regular physical activity has a stimulatory influence on growth and maturity, which explains why the EG had larger increases in stature and more significant in comparison to the CG. Malina *et al.* (2004) states that physical activity stimulates growth of children. These children had an increase in stature which might be related to the ten month intervention programme.

The only significant effect for BMI values in the EG and the CG was a small practically significant increase in the 12 year old boys. The CG also showed a medium practically significant increase in the 13 year old boys. According to several researchers, an inverted relation exists between BMI values and physical activity. In the case of increased participation in physical activity, the BMI values decrease (Martinez, 2000; Parsons, Power & Manor, 2005). BMI has the limitation of requiring the height of a person and as children still grow linearly and especially for these age groups, this occurrence demands an additional measurement method to determine the risk status of a child, thus whether a child can be classified as overweight or obese (Evans & Gates-Wienake, 2004; NCCDPHP, 2005). According to Martinez (2000) and WHO (2000), an inverted effect exists between physical activity and BMI in adults. During the growth spurt period there is also a natural increase in stature and body weight which is the components of BMI values (Malina *et al.*, 2004; Pienaar, 2005).

As far as the percentage body fat of the EG is concerned, there was a trend that percentage body fat increased slightly in the 9, 10 and 11 year old boys and started to decrease in the 12 and 13 year old boys. The 9 and 10 year old boys showed statistically significant increase ($p<0.05$) and a medium practically significant increase ($d\geq0.5$) in percentage body fat and a small practically significant increase in the 11 year old boys. Since growth also has an effect on percentage body fat, growth might be the reason for the small increase in the 9, 10 and 11 year old boy's percentage body fat. The reason for the small differences between the pre and post-test for all the ages might be due to the fact that not one of the groups was classified as overweight. All age groups' mean body percentage body fat could be classified as normal, thus between 12.1% body fat and 24.9% body fat (Lohman, 1992).

With reference to the CG who did not participate in any physical activity intervention programme, statistically significant increases ($p<0.05$) as well as practically significant increases, were seen in the percentage body fat of all the groups. A medium practically significant increase ($d\geq0.5$) were seen in the 12 year old boys and a large practically significant increase ($d\geq0.8$) were seen in the 9, 10, 11 and 13 year old boys as well as in the total group. Considering that this group did not participate in any physical activity, it is suggested, according to Malina *et al.* (2004), that regular physical activity is associated with a decrease in body fatness and since the CG had not participated in the physical activity intervention programme, this could be an explanation for these results. Physical activity affects total fat oxidation (utilization) and fat balance especially during adolescence since the "fat stores" in the body are in the final stage of development (Rowland, 1990; Burniat, Cole, Lissau & Poskitt, 2002). Thus children being overweight during this time will tend to grow up having the risk of being overweight/obese adults (Burniat *et al.*, 2002). Since this group did not participate in any physical activity the trend of an increase in percentage body fat is expected. As seen in the literature the etiology of overweight and obesity is multi-factorial, and the main contributing factors to juvenile obesity include physical inactivity, diet and genetics (Steinbeck, 2001; Fox, 2004). Although these subjects are not classified as overweight or obese, this is a possible threat since the Youth Risk Behaviour Survey reported than 17% of South African children are overweight and 4% are obese (Reddy, Panday, Swart, Jinabhai, Amosun, James, Monyeki, Stevens, Morejele, Kambaran, Omardien & Van den Borne, 2002). Thus the ultimate possible treatment and preventative method for obesity is correcting the energy balance disturbance via decreasing sedentary time, increasing physical activity and developing healthy childhood eating patterns (Steinbeck, 2001; Verster, 2001; Van der Merwe, 2002; Fox, 2004).

When comparing the EG and CG with each other, there was no differences at the initial baseline tests except for the body mass of the CG which showed a small practically significant ($d\geq0.2$) effect and was slightly lower than the EG's body mass. Since the EG participated in the physical activity intervention programme it is most likely that they gained more muscle mass than the CG. Although there was no significant difference, the results show that the EG gained 2.32 kg during the ten month physical activity intervention period and the CG gained 1.89 kg. No statistically significant differences ($p<0.05$) were present between the pre-tests or the post-tests of the EG and CG for stature. There was a small practically significant difference ($d\geq0.2$) between the post-test results of the EG and CG, with the EG practically significant taller than the CG.

No statistically significant nor practically significant differences between the EG and CG's with regard to the pre or post-tests were seen. The EG showed a trend of decrease in BMI after ten month of intervension. These findings are, therefore, in agreement with what was reported in the literature that an inverted effect exists between physical activity and BMI (Martinez, 2000; WHO, 2000). Therefore, it was an expected result that the BMI values of the EG decreased after participation in a physical activity intervention programme and since the CG did not take part in any physical activity programme, an expected increase is observed.

The averages of the BMI values and the percentage body fat of the boys indicate that they could mostly be classified as below average and only three groups could classified as slightly above average, the 9, 10 and 12 year old boys according to the NHES II & III study presented by Cole *et al.* (2000). This is due to growth, since stature, body mass, body fat and muscle mass develop intensively during the adolescent acceleration growth phase (growth spurt) (Rowland, 1990; Burniat *et al.*, 2002; Malina *et al.*, 2004).

In the pre-test results between the EG and CG's, a statistically significant effect is evident, where the EG had a significant higher percentage body fat than the CG. Although no other statistically significant or practically significant effects can be seen, there is a trend that the EG gained less fat than the CG where the EG gained 0.52% body fat and the CG gained 2.71% body fat. To control the increase of body fat it is important to participate in regular physical activity and thus to enhance the positive energy balance (Malina *et al.*, 2004).

From this study it was possible to determine the influence of physical activity intervention on body composition though the influence was not large. Though the study was able to determine the influence of physical activity intervention on body composition, it has some limitations such as: due to the small number of the subjects, the findings may not be generalized for the entire population, ethnicity was not considered in the study, and sophisticated instruments of measuring percentage body fat not used. Therefore, it is recommended that more studies which would incorporate larger population and ethnicity from a wider spectrum of the South African school children as well as sophisticated instruments to measure percentage body fat and lean mass be conducted. Given this findings, the study further recommends the inclusion of physical activity programmes in schools and after school community physical activity programmes.

3.5 ACKNOWLEDGEMENT

A word of thanks is directed to the two principals of the participating schools as well as to all the children who participated in the study. Thank you to all the Human Movement Science students and staff who helped with the measurements of this study.

3.6 REFERENCES

ANDERSON, R.E., CRESPO, C.J., BARTLETT, S.J., CHESKIN, L.J. & PRATT, M. 1998. Relationship of physical activity and television watching with body mass and level of fatness among children. *Journal of the American Medical Association (JAMA)*, 279(12):938-942.

ANON. 2004. Inactivity cited in overweight youths. *Journal of physical education, recreation and dance*, 75(9):5.

ARA, I., VINCENTE-RODRIGUEZ, G., JIMENEZ-ROMIRES, J., DORADO, C., SERRANO-SANCHEZ, J.A. & CALBET, J.A.L. 2004. Regular participation in sports is associated with enhanced physical fitness and lower fat mass in prepubertal boys. *International journal of obesity* 28:1585-1593.

ARMSTRONG, N. & MCMANUS, A. 1996. Growth, maturation and physical education. (*In* Armstrong, N., *ed.* New direction in physical education. London: Changes and Innovation. p. 19-51.)

BOILEAU, R.A., LOHMAN, T.G. & SLAUGHTER, M.H. 1985. Exercise and body composition of children and youth. *Scandinavian journal of sport science*, 7(1):17-27.

BRUTON, G., HARDEN, A., REES, R., KAVANAGH, J.M., OLIVER, S. & OAKLEY, A. 2003. Children and physical activity: a systematic review of barriers and facilitators. http://www.eppi.ioe.ac.uk Access date: 25 July 2005.

BURKE, V., BEILIN, L.J., SIMMER, K., ODDY, W.H., BLAKE, K.V., DOHERTY, D., KENDALL, G.E., NEWNHAM, J.P., LANDAU, L.I. & STANLEY, F.J. 2005. Predictors of body mass index and associations with cardiovascular risk factors in Australian children: a prospective cohort study. *International journal of obesity,* 29(1):15-23.

BURNIAT, W., COLE, T., LISSAU, I. & POSKITT, E. 2002. Child and adolescent obesity: causes and consequences, prevention and management. Cambridge: Cambridge University Press. 416 p.

COLCHINO, K., ZYBET, P. & BASCH, C.E. 2000. Effects of after school physical activity on fitness, fatness and cognitive self-perception: a pilot study among urban, minor adolescent girls. *American journal of public health,* 9(6):977-978.

COLE, T.J., BELLIZZI, M.C., FLEGAL, K.M. & DIETZ, W.H. 2000. Establishing a standard definition for child overweight and obesity worldwide: international survey. *British medical journal,* 320:1240-1243, May.

DAO, H.H., FRELUT, M.L., OBERLIN, F., PERES, G., BOUTGEOIS, P. & NAVARRO, J. 2004. Effects of a multidisciplinary weight loss intervention on body composition in obese individuals. *International journal of obesity,* 28:290-299.

ELLIS, S.M. & STEYN, H.S. 2003. Practical significance (effect sizes) versus or in combination with statistical significance (p-values). *Management dynamics,* 12(4): 51-53.

ENGELBRECHT, C., PIENAAR, A.E. & COETZEE, B. 2004. Racial background and possible relationships between physical activity and physical fitness of girls: The Thusa Bana Study. *South African journal for research in sport, physical education and recreation,* 26(1):41-53.

EVANS, E.M. & GATES-WIENAKE, P. 2004. Juvenile obesity: a call for fitness professionals. *ACSM's certified news*, 14(1):1-5.

FLEGAL, K.M. & TROIANO, R.P. 2000. Changes in the distribution of body mass index of adults and children in the US population. *International journal of obesity*, 24:807-818.

FORD, E.S., MOKDAD, A.H. & AJANI, U.A. 2004. Trends in risk factors for cardiovascular disease among children and adolescents in the United States. *Pediatrics*, 114(6):1534-1544.

FOX, K.R. 2004. Tackling obesity in children through physical activity: a perspective from the United Kingdom. *Quest*, 56:28-40.

FRITZ, G.K., STOVELL, K., SYDNEY, C.G. & MERRILL, S. 2005. Obesity and your child: know the facts. *Browns University child and adolescent behavior letter,* 21(2):9-10.

GANCE-CLEVELAND, B., HARRIS, M. & WARD-BEGNOCHE, W. 2005. Working with schools to connect with families of overweight children. *Journal for specialists in pediatric nursing,* 10 (1):40-43.

GREEN, J., WATERS, E., HAIKERWAL, A., O'NEILL, E., RAMAN, S., BOOTH, H.L. & GIBBONS, K. 2003. Social cultural and environmental influences on child activity and eating in Australian migrant communities. *Child: Care, health and development*, 29(6):441-448.

INTERNATIONAL SOCIETY FOR ADVANCED KINANTROPOMETRY (ISAK.) 2001. National Library of Australia. The International Society for the Advancement of Kinanthropometry. 133 p.

ISAK *see* INTERNATIONAL SOCIETY FOR ADVANCED KINANTROPOMETRY

JANSSEN, I., KATZMARZYK, P.T, BOYCE, W.F., KING, M.A. & PICKETT, W. 2004. Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *Journal of adolescent health*, 35:360-367.

LABADARIOS, D., STEYN, N.P., MAUNDER, E., MACINTRYRE, U., GERICKE, G., SWART, R., HUSKISSON, J., DANNHAUSER, A., VORSTER, H.H., NESMVUNI, A.E. & NEL, J.H. 2005. The National Food Consumption Survey (SA NFCS): South Africa, 1999. *Public health nutrition*, 8(5):533-543.

LOHMAN, T.G. 1992. The prevalence of obesity in children in the United States (*In* Heyward, V.H. & Stolarzyk, L.M., *eds.* Advances in body composition assessment. Champaign, Ill.: Human Kinetics Publishers. p. 150.)

MALINA, R.M., BOUCHARD, C. & BAR, O.R. 2004. Growth maturation and physical activity. 2nd ed. Champaign, Ill.: Human Kinetics. 710 p.

MANIOS, Y., KAFATOS, A. & CODRINGTON, C. 1999. Gender differences in physical activity and physical fitness in young children in Crete. *Journal of sports medicine and physical fitness*, 39:24-30.

MARTINEZ, J.A. 2000. Body weight regulation: causes of obesity. *Proceedings of the Nutrition Society*, 59:337-345.

MEYERS, L. STRIKMILLER, P.K., WEBBER, S. & BERENSON, G.S. 1996. Physical and sedentary activity in school children grades 5 - 8: The Bogolusa Heart Study. *Medical and science in sport and exercise*, 28(7):852-859.

MORROW, J.R. Jr., JACKSON, A.W. & PAYNE, V.G. 1999. Physical activity promotion and school physical education. *President's council on physical fitness and sports research digest,* Series 3(7):1-9.

NCCDPHP (National Center for Chronic Disease Prevention And Health Promotion, United States of America). 2005. The Centers for Disease Control and Prevention. http://www.cdc.gov/nccphp/dnpa/bmi/bmi-for-age.htm. Access date: 15 June 2005.

PARSONS, T.J., POWER, C. & MANOR, O. 2005. Physical activity, television viewing and body mass index: a cross-sectional analysis from childhood to adulthood in the 1958 British cohort. *International journal of obesity,* 29(10):1212-1221, Oct.

PIENAAR, A.E. 2005. Perseptueel-motoriese leer: teorie en praktyk. Pothefstroom,: Noord-Wes Universiteit.

REDDY, S.P., PANDAY, S., SWART, D., JINABHAI, C.C., AMOSUN, S.K., JAMES, S., MONYEKI, K.D., STEVENS, G., MOREJELE, N., KAMBARAN, N.S., OMARDIEN, R.G. & VAN DEN BORNE, H.W. 2003. Umthenthe Uhlaba Usamila – The South African Youth Risk Behaviour Survey 2002. Cape Town: South African Medical Research Council.

ROWLAND, T.W. 1990. Exercise and children's health. Champaign, Ill.: Human Kinetics Books. 356 p.

SHEPHARD, R.J. 1997. Curricular physical activity and academic performance. *Pediatric exercise science,* 9:113-126.

SOTHERN, M.S., LOFTIN, M., SUSKIND R.M., UDALL, J.N. & BLECKER, U. 1999. The health benefits of physical activity in children and adolescents: implications for chronic disease prevention. *European journal for pediatrics,* 158:271-274.

STATSOFT, INC. 2008. STATISTICA (data analysis software system), version 7. www.statsoft.com.

STEINBECK, K.S. 2001. The importance of physical activity in the prevention of overweight and obesity in childhood: a review and an opinion. *International association for study of obesity reviews*, 2:117-130.

STEYN, H.S. 2005. Handleiding vir bepaling van effekgrootte-indekse en praktiese betekenisvolheid. Potchefstroom. 182 p.

SUMMERFIELD, L.M. 1998. Promoting physical activity and exercise among children. *Eric digests,* 1-17.

THOMAS, J.R., NELSON, J.K. & SILVERMAN, S.J. 2005. Research methods in physical activity. 5th ed. Champaign, Ill.: Human Kinetics. 454 p.

TREIBER, F.A., STRONG, W.B., RENSMAN, F.W. & GRUBER, M. 1989. Relationship between habitual physical activity and cardiovascular responses to exercise in young children. (*In* Oseid, S. & Carlsen, K., *eds. Children and exercise XIII.* Champaign, Ill.: Human Kinetics. p. 285-293.)

TROST, S.T., SALLIS, J.F., PATE, R.R., FREEDSON, P.S., TAYLOR, W.C. & DOWDA, M. 2003. Evaluating a model of parental influence on youth physical activity. *American journal of preventive medicine*, 25(4):277-282.

VAN DER MERWE, M.T. 2002. The epidemiology and pathogenesis of obesity - where do we stand in 2002? *Geneeskunde, The medicine journal,* 44:43-46.

VERSTER, J. 2001. Causes, risks and dietary treatment of obesity. *Geneeskunde, The medical journal,* 43:15-18.

VISAGIE, I.H.J. 1981. Antropometriese en motoriese toetsverskille tussen seuns en dogters: ouderdomme 7- tot 15-jaar. Stellenbosch: Universiteit van Stellenbosch. (Verhandeling - MA.) 156 p.

VOÛTE, J. & VALENTIN, F. 2005. Fatness to fitness. *Global agenda,* 3:214-215.

WANG, Y. 2001. Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. *International journal,* 30(5):1129-1136.

WHITNEY, E.N. & ROLFES, S.R. 2002. Understanding nutrition. 9th ed. Belmont, Calif.: Wadsworth. 697 p.

WHO *see* WORLD HEALTH ORGANIZATION (WHO)

WORLD HEALTH ORGANIZATION (WHO). 2000. Obesity: preventing and managing the global epidemic. (Report of a WHO Consultation of Obesity. World Health Organization. Technical report serial, 894.) Geneva: WHO. 253 p.

YRBS *see* REDDY, S.P., PANDAY, S., SWART, D., JINABHAI, C.C., AMOSUN, S.K., JAMES, S., MONYEKI, K.D., STEVENS, G., MOREJELE, N., KAMBARAN, N.S., OMARDIEN, R.G. & VAN DEN BORNE, H.W. The South African Youth Risk Behaviour Survey 2002 (YRBS)

Chapter 4

THE INFLUENCE OF A PHYSICAL ACTIVITY INTERVENTION PROGRAMME (PAI) ON THE HEALTH RELATED PHYSICAL FITNESS OF 9 – 13 YEAR OLD BOYS

Miss. S.M. du Preez, Prof. J.H. de Ridder, & Dr. M.A. Monyeki

Presented for publication in the "African Journal for Physical, Health Education, Recreation and Dance"

Miss. SUSANNA MARIA DU PREEZ (Hons BSc) School for Biokinetics, Recreation and Sport Science, North-West University (Potchefstroom Campus), Potchefstroom, Republic of South Africa. Email: sanridup@netactive.co.za

Prof. J. HANS DE RIDDER, (PhD) School for Biokinetics, Recreation and Sport Science, North-West University (Potchefstroom Campus), Private Bag X 6001, Potchefstroom, 2550, Republic of South Africa. Email: Hans.DeRidder@nwu.ac.za Tel: 018-299 1791 Fax: 018-299 1825 ***(Correspondence address)***

Dr. M. ANDRIES MONYEKI, (PhD) School for Biokinetics, Recreation and Sport Science, North-West University (Potchefstroom Campus), Potchefstroom, Republic of South Africa. Email: Andries.Monyeki@nwu.ac.za

PHYSICAL ACTIVITY INTERVENTION PROGRAMME AND HEALTH RELATED PHYSICAL FITNESS

ABSTRACT

The objective of this study was to determine whether a ten month physical activity intervention programme (PAI) will have an influence on the health related physical fitness of 9 – 13 year old boys. A total of 322 (173 = experimental group (EG) and 149 = control group (CG)) subjects were measured and the EG participated in a ten month intervention programme of physical activity. The subjects were from two schools in the Gauteng Province, South Africa (School A, the EG and School B, the CG). Selected EUROFIT (1988) tests were used to determine the physical fitness of both groups pre and post-intervention. These tests included the 10 x 5m shuttle run (seconds) (running speed), standing broad jump (cm) (explosive strength), sit and reach (cm) (lower back/upper thigh flexibility), sit-ups (count per 30 seconds) (functional strength), bent arm hang (sec) (arm strength), grip strength (kg) (arm strength) and endurance shuttle run (levels) (Bleep test) (cardiorespiratory endurance). Pre and post-test data were analyzed by the use of Statistica 2004. Descriptive statistics, pre-test and post-test comparisons were done by dependent t-tests, and age groups were compared by using independent t-tests. Statistical significance was set at $p < 0.05$ and a small practically significant level were set at $d \geq 0.2$, a substantial or medium practically significant effect were set at $d \geq 0.5$ and a large practically significant level were set at $d \geq 0.8$. After ten months of physical activity intervention the EG showed statistically significant improvement in agility, speed, trunk muscular strength, cardiovascular endurance, functional strength, arm and shoulder muscular endurance and static strength, as opposed to the CG. From the findings in the present study it can be concluded that when physical activity is monitored over a ten month period health related physical fitness improves, which may have a beneficial influence on an individual's lifestyle and may prevent a large number of chronic diseases.

Key words: Physical fitness, physical activity, body composition, anthropometry, children, health, sedentary lifestyle, hypo-kinetic diseases

4.1 INTRODUCTION

The decline observed in physical activity levels among youth in the last decade is alarming (Barnett, O'Loughlin, Paradis, 2002). The critical period, during which declines in activity begin to occur are not known, but various studies showed that the declines among children happen at age 9–14 years (Bradley, McMurray, Harrel & Deng, 2000; Sallis, 2000). The unhealthy lifestyle of today's youth, including a diet high in fat and calories and a lack of physical activity leads to many problems and risks for the future of these children. Many incidences of pathologies appear as a result of inactivity, such as obesity, impaired glucose tolerance and non insulin dependent T2DM (Annesi, Westcott, Faigenbaum & Unruh, 2005; Shaibi, Ball, Crus, Weigenberg, Salem & Goran, 2006). According to Shaibi *et al.* (2006), 30% of overweight children have impaired glucose tolerance, that may lead to T2DM. Reduced cardiovascular fitness is an early aberration in healthy adults at risk for T2DM, where high levels of cardiovascular fitness and physical activities are protective against future development of impaired glucose tolerance and diabetes. It is therefore, evitable that low fitness levels and inactivity are main determinants of impaired glucose tolerance in children (Shaibi *et al.*, 2006).

Research shows that regular childhood physical activity has significant health benefits, such as a beneficial influence on the largest number of chronic disease risk factors including coronary heart diseases, obesity, hyperlipidemia, hypertension and T2DM (Treiber, Strong, Rensman & Gruber, 1989; Meyers, Strikmiller, Webber & Berenson, 1996; Summerfield, 1998). In addition physical activity increases bone density and bone mass, especially in children as they are still growing and developing new bone cells each day (Meyers *et al.*, 1996; Summerfield, 1998; Sothern, Loftin, Suskind, Udall & Blecker, 1999). Furthermore, Colchino, Zybet and Basch (2000) found significant improvements in cardiovascular endurance, muscular strength, muscular endurance and flexibility after participation in physical activity. Physical activity also reduces anxiety levels, improves self image and moods, improves cognitive and mental ability and consequently improves academic performance and concentration levels (Summerfield, 1998).

It has been suggested by many researchers that schools play an important part in fostering positive health behaviours in children that may carry through their lifespan. Schools have the potential to influence the habitual physical activity of children by encouraging increased participation in extracurricular sport activities (Annesi *et al.*, 2005; Trudeau & Shephard, 2005). Trudeau and Shephard (2005) reported that there is a global trend to reduce or end the time allocated for physical education in schools. Time spent on physical education is reduced due to the emphasis and time devoted to academic subjects, television, internet and computer games. At home youth rely mainly on motorised transport, parental activity may be poor and thus a poor example for their children, leading to motivated juvenile inactivity. Many of the popular activities among adults, such as jogging are individual activities and not a social or group activity designed to engage youth in the activities (Barnett *et al.*, 2002; Luepker, 1999). Unsafe traffic and poor road safety as well as a decrease in safe outdoor playgrounds, create an almost compulsory sedentary lifestyle for the youth of today (Whitney & Rolfes, 2002). Trudeau and Shephard (2005) documented that in the US, results from the Youth Risk Behaviour Survey indicated that between 1991 and 1995, attendance to daily physical education decreased from 41.6% to 25.4% and remained the same between 1995 and 2003. The decrease in physical activity may lead to overweight and obesity. According to the South African National Food Consumption Survey (NFCS), 17.1% of children aged 1 – 9 years, in South Africa are overweight/obese (Labadarios, Steyn, Maunder, Macintryre, Gericke, Swart, Huskisson, Dannhauser, Voster, Nesmvuni & Nel, 2005). The Youth Risk Behaviour Survey reported that 17% of South African children are overweight and 4% are obese (Reddy *et al*, 2002) and further more, Armstrong, Lambert, Sharwood & Lambert (2006) conducted a study where 5611 South African boys aged 6 – 13 years were tested and 3.2 % of the subjects were overweight and 14% obese, 4584 South African girls aged 6 – 13 years were tested and 4.9% were overweight and 17.9% were obese. These rates for obesity are also comparable to those in other developing countries such as China (7%), Egypt (14%) and India (16%) (Wang, 2001). Obesity during childhood and adolescence is reasoned to be an important determinant of whether a subject will become obese as an adult. An important fact is that, independently of adults' weight, adults that were obese during childhood also have a higher cardiovascular disease morbidity and mortality (Guerra, Teixeira-Pinto, Ribeiro, Ascnsao, Magalhaes, Andersen, Duarte & Mota, 2006).

It is thus important that schools should incorporate well designed, quality physical education in the school curriculum. For an increasing majority of children, the physical education period is the only opportunity to engage in moderate-to-intense physical activity. Since almost all children attend school, a quality physical education programme has the potential to reach most children (Barnett *et al.*, 2002; Annesi *et al.*, 2005; Trudeau & Shephard, 2005). It is noted that some physical education programmes are unsuccessful as the intensity and quality of the programme and the educator is not up to standard. A well designed programme will thus ensure a higher percentage of class time devoted to moderate to high intensity physical activity during the physical education period (Trudeau & Shephard, 2005). These programmes have to be presented by educated personnel or regular classroom teachers who have to be trained in each of these physical education programmes to be presented to the children (Luepker, 1999). Many regular classroom teachers are qualified to lead these programmes and activities (Luepker, 1999). According to Trudeau and Shephard (2005), physical education programmes can result in an enhancement of school spirit, increase participant's self-esteem, greater academic progress, alleviation of learning disabilities, improve fundamental motor skills, increase bone mass and reduce hypo kinetic disease risks, such as diabetes mellitus, obesity, respiratory diseases, coronary arterioscleroses and mortality (Ford, Mokdad & Ajani, 2004; Janssen, Katzmarzyk, Boyce, King & Pickett, 2004; Burke, Beilin, Simmer, Oddy, Blake, Doherty, Kendall, Newnham, Landau & Stanley, 2005; Fritz, Stovell, Sydney, Merrill, 2005; Gance-Cleveland, Harris & Ward-Begnoche, 2005; Voûte & Valentin, 2005). The low degree of physical fitness and physical activity was associated with elevated blood pressure in South African children, which may have a negative effect on childhood health (Monyeki, Kemper & Makgae, 2006).

The purpose of this study was, therefore, to determine the influence of a ten month physical activity intervention programme (PAI) (designed by professionals in the health and fitness industry) on the health related physical fitness of 9 – 13 year old boys.

4.2 MATERIALS AND METHODS

4.2.1 Subjects

A cross-sectional experimental design was used. A total of 322, 9 - 13 year old boys formed part of the study. The ten month intervention by means of physical activity also included pre and post-tests. Two schools in the Gauteng Region were purposely selected to represent an experimental and control group. School A, the experimental group (EG) was represented by

173 subjects and School B, the control group (CG) was represented by 149 subjects. The two schools were approximately seven kilometers from each other and the schools also participated against each other during sporting events (see Table 4.1)

The children were not randomly allocated to the two groups, but the two schools were considered as being representative of equal socio-economic children in the Gauteng Province as these subjects were all in the same socio-economic class. There was, however, a possibility of bias because the effects of the programme might have been confounded by factors not taken into account by a random allocation. The participants of school A took part in half hour sessions of physical activity twice per week and the participants from school B did not take part in the physical activity intervention programme. The study was explained to all the parents who signed informed consent forms to give each child the appropriate permission to take part in this study.

Table 4.1: Total population of the EG and CG

Experimental Group (*n*=173)		Control Group (*n*=149)	
Age (year)	Number (*n*)	Age (year)	Number (*n*)
9	35	9	26
10	39	10	44
11	45	11	34
12	36	12	34
13	18	13	11
TOTAL	173		149

4.2.2 Measurements

Baseline measurements: First two weeks of February 2005.

Post intervention measurements: Last two weeks of November 2005.

4.2.3 Physical activity intervention programme (PAI)

Subjects included in the EG participated in a physical activity programme. Subjects took part in this programme twice per week for a 30 min period and the programme contained components focusing on agility, cardiovascular endurance, strength, muscular endurance, flexibility and speed. Each lesson consisted of a warm-up with stretch exercises, fitness, speed, strength, balance and cool down exercises. The EG participated in this physical activity programme for ten months from the beginning of February 2005 until the end of November 2005.

4.2.4 Measurement of physical fitness

A pre-test was done in the beginning of the intervention period and a follow-up post-test evaluation was done ten months subsequent to the onset of the programme. The criteria of EUROFIT tests were used (explained in Table 4.2), as these are designed primarily for school-aged children (6 – 18 years) (Eurofit, 1988). The EUROFIT test is a sensitive, individual and reliable instrument for assessing its various principal dimensions, cardiovascular endurance, agility, strength, muscular endurance, flexibility and speed. EUROFIT takes account of the normal school/class environment. These different dimensions are tested for the outcomes of different results.

Table 4.2: EUROFIT dimensions used to assess the physical activity programme EUROFIT (1988)

Test	Component	Apparatus
Shuttle run 10 x 5 meters (seconds)	• Agility • Speed	Cones, stopwatch
Endurance shuttle run/Multi phase fitness test (Levels and stages) ("Bleep test")	• Cardiovascular endurance	Cones, bleep-test CD
Standing broad jump (cm)	• Strength (explosive strength)	Steel measure tape and standing broad jump carpet
Sit and reach (cm)	• Flexibility	Sit and reach box
Sit ups (count per 30 seconds)	• Strength (trunk) • Muscular endurance (trunk muscular)	Stopwatch
Bent arm hang (seconds)	• Strength (functional strength) • Muscular endurance (arm and shoulder)	Horizontal bar, stopwatch
Handgrip strength (kilograms)	• Strength (static strength)	Dynamometer

4.2.5 Statistical Analysis

The data on the data sheets were computerized by the researcher. Descriptive statistics were used to define information on all the variables. The pre and post-test comparisons were determined by use of a dependent t-test and age groups were compared by using independent t-tests (Thomas, Nelson & Silverman, 2005). Statistical significance was set at $p < 0.05$ and a small practically significant level were set at $d \geq 0.2$, a substantial or medium practically significant effect were set at $d \geq 0.5$ and a large practically significant level were set at $d \geq 0.8$ (Ellis & Steyn, 2003; Steyn, 2005; Thomas *et al.*, 2005). All statistical analyses were done with Statistica (Statsoft, Inc. 2008) which is available on the network of the North-West University (Potchefstroom Campus).

4.3 RESULTS

Table 4.3 presents the results on the influence of the physical activity intervention programme on the physical fitness variables of the EG in the five different age groups as well as the total group. Table 4.4 presents the results of the CG also in terms of the different physical fitness variables in the five different age groups and also for the total group. The differences between the pre-tests of the EG and CG as well as the post-test of the EG and the CG are illustrated and discussed by ways of graphs (Figures 4.1 – 4.7). A conclusion on the influence of a ten month physical activity intervention programme follows the results to summarize all findings regarding the influence of the intervention programme on the health related fitness of 9 – 13 year old boys.

Table 4.3: The influence of the physical activity intervention programme (PAI) on the physical fitness parameters of the EG (n=173)

Variables	Ages	*n*	$\bar{X}$ Pre-Test	$\bar{X}$ Post-Test	$\bar{X}$ Difference	SD Difference	p-values	Effect Size d-value
10 x 5 Shuttle run (sec)	9 Years	35	22.23	21.07	-1.16	1.44	<0.00*	-0.81
	10 Years	39	22.74	21.57	-1.16	1.25	<0.00*	-0.93
	11 Years	45	21.80	21.13	-0.67	1.43	<0.00*	-0.47
	12 Years	36	21.62	20.68	-0.94	1.31	<0.00*	-0.72
	13 Years	18	20.69	19.63	-1.05	1.73	<0.00*	-0.61
	Total Group	173	21.94	20.97	-0.98	1.35	<0.00*	-0.73
Multi phase fitness Test "Bleep" (VO_2Max) (ml/kg/min)	**9 Years**	**35**	**27.97**	**37.00**	**9.03**	**7.71**	**<0.00***	**1.17********
	10 Years	**39**	**28.03**	**37.56**	**9.53**	**8.41**	**<0.00***	**1.13********
	11 Years	**45**	**29.40**	**39.55**	**10.15**	**7.17**	**<0.00***	**1.42********
	12 Years	**36**	**30.02**	**41.51**	**11.49**	**9.46**	**<0.00***	**1.21********
	13 Years	**18**	**30.36**	**46.60**	**16.24**	**7.83**	**<0.00***	**2.07********
	Total Group	**173**	**29.03**	**39.73**	**10.70**	**8.31**	**<0.00***	**1.29********
Standing broad jump (cm)	9 Years	35	152.51	152.09	-0.43	13.96	0.86	-0.03
	10 Years	39	148.45	154.74	6.29	24.07	0.11	0.26**
	11 Years	45	161.84	163.87	2.02	10.50	0.20	0.19
	12 Years	36	163.69	168.61	4.92	12.99	0.03*	0.38**
	13 Years	18	181.22	181.39	0.17	17.43	0.97	0.01
	Total Group	173	159.34	162.24	2.90	16.30	0.02*	0.18
Sit and Reach (cm)	**9 Years**	**35**	**16.33**	**16.21**	**-0.12**	**3.88**	**0.85**	**-0.03**
	10 Years	**39**	**14.59**	**14.88**	**0.29**	**4.29**	**0.68**	**0.07**
	11 Years	**45**	**16.11**	**15.47**	**-0.64**	**5.38**	**0.43**	**-0.12**
	12 Years	**36**	**15.26**	**16.93**	**1.67**	**3.48**	**0.01***	**0.48****
	13 Years	**18**	**17.89**	**17.36**	**-0.54**	**5.06**	**0.66**	**-0.11**
	Total Group		**15.82**	**15.99**	**0.17**	**4.49**	**0.63**	**0.04**
Sit-Ups (count per 30 seconds)	9 Years	35	19.26	23.77	4.51	4.95	<0.00*	0.91****
	10 Years	39	21.74	22.21	0.46	24.30	0.91	0.02
	11 Years	45	22.39	23.51	1.12	4.81	0.13	0.23**
	12 Years	36	22.69	25.94	3.25	5.69	<0.00*	0.57***
	13 Years	18	23.11	27.33	4.22	7.89	0.04*	0.53***
	Total Group	173	21.75	24.17	2.42	12.52	0.01*	0.19
Bent arm hang (per seconds)	**9 Years**	**35**	**16.14**	**28.18**	**12.05**	**16.23**	**<0.00***	**0.74******
	10 Years	**39**	**9.72**	**17.25**	**7.53**	**12.68**	**<0.00***	**0.59******
	11 Years	**45**	**15.06**	**18.88**	**3.82**	**10.58**	**0.12**	**0.36****
	12 Years	**36**	**13.61**	**20.03**	**6.41**	**14.34**	**0.12**	**0.45****
	13 Years	**18**	**20.60**	**28.21**	**7.60**	**9.97**	**<0.00***	**0.76******
	Total Group	**173**	**14.35**	**21.60**	**7.25**	**13.26**	**<0.00***	**0.55******

Variables	Ages	*n*	$\bar{X}$ Pre-Test	$\bar{X}$ Post-Test	$\bar{X}$ Difference	SD Difference	p-values	Effect Size d-value
Grip strength (kg)	9 Years	35	18.29	20.57	2.28	4.25	<0.00*	0.54***
	10 Years	39	19.69	21.74	2.05	3.28	<0.00*	0.63***
	11 Years	45	23.24	26.04	2.80	3.21	<0.00*	0.87****
	12 Years	36	25.61	29.78	4.17	4.41	<0.00*	0.95****
	13 Years	18	28.00	33.00	5.00	3.66	<0.00*	1.37****
	Total Group	173	22.43	25.47	3.04	3.86	<0.00*	0.79***

*statistic significant effect (p- value < 0.05); **small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); SD: Standard Deviation; $\bar{X}$: Average

The results show statistically significant decreases (p<0.05) in the 10 x 5m shuttle run test time across all the ages, but no practically significant effect, it is thus evident that the physical activity intervention programme improved the agility and speed, of the EG.

When considering the "Bleep-Test" which was a measure of cardiorespiratory fitness (CRF), it is evident that the CRF of the EG improved after participation in the ten month intervention programme. Statistically significant increases (p<0.05) from the pre- to the post-test in all the age groups were observed. Large practically significant improvement (d≥0.8) for all the age groups, can also be seen

With regard to the standing broad jump, there was a trend that all the age groups in the EG improved their jumping distance except for the 9 year old boys. Statistically significant differences (p<0.05) were observed between the pre and post-test for the 12 year old boys and for the total group, small practically significant improvement (d≥0.2) at age 12 and in the total group was observed.

Statistically significant improvement (p<0.05) were seen in the sit and reach test of the EG for the 12 year old boys as well as a small practically significant improvement (d≥0.2) were seen. For the sit-up test, the 9, 12 and 13 year old boys as well as the total group showed statistically significant increases (p<0.05). A large practically significant improvement (d≥0.8) was observed in the 9 year old group, with a small practically significant improvement (d≥0.2) in the 11 year old group and a medium practically significant improvement (d≥0.5) in the 12 and 13 year old boys.

The 9, 10 and 13 year old boys as well as the total group had a statistically significant improvement ($p<0.05$) in the bent arm hang test. As far as practically significance is concerned, a medium practically significant improvement ($d\geq0.5$) was found for the 9, 10, and 13 year old and the total group and a small practically significant ($d\geq0.2$) improvement for the 10 and 11 year old groups.

The grip-strength test showed a statistically significant effect ($p<0.05$) for all the age groups and for the total group, a medium practically significant improvement ($d\geq0.5$) for the 9 and 10 year old boys and for the total group and a large practically significant improvement ($d\geq0.8$) for the 11, 12 and 13 year old boys.

Table 4.4: The influence of physical activity intervention programme (PAI) on the physical fitness parameters of the CG (n=149)

Variables	Ages	*n*	$\bar{X}$ Pre-Test	$\bar{X}$ Post-Test	$\bar{X}$ Difference	SD Difference	p-values	Effect Size d-value
10 x 5 Shuttle run (sec)	9 Years	26	22.56	22.46	-0.11	1.23	0.66	-0.09
	10 Years	44	22.12	22.14	0.02	1.60	0.94	0.01
	11 Years	34	21.65	21.16	-0.48	1.12	0.01*	-0.43
	12 Years	34	21.94	21.20	-0.74	1.43	<0.00*	-0.52
	13 Years	11	21.50	20.76	-0.74	0.93	0.02*	-0.80
	Total Group	149	22.00	21.66	-0.35	1.38	<0.00*	-0.25
Multi phase fitness Test "Bleep" (VO_2Max) (ml/kg/min)	9 Years	26	32.37	30.18	-2.18	4.42	0.02*	-0.49
	10 Years	44	31.68	31.36	-0.32	3.92	0.52	-0.08
	11 Years	34	34.70	32.83	-1.87	4.39	0.02*	-0.43
	12 Years	34	34.71	32.42	-2.29	5.01	0.01*	-0.46
	13 Years	11	36.51	36.92	0.41	4.91	0.79	0.08
	Total Group	149	33.54	32.14	-1.39	4.50	<0.00*	-0.31
Standing broad jump (cm)	9 Years	26	144.23	151.65	7.42	10.67	<0.00*	0.70***
	10 Years	44	147.91	150.07	2.16	9.93	0.16	0.22**
	11 Years	34	152.65	155.19	2.55	29.07	0.61	0.09
	12 Years	34	161.76	170.35	8.59	20.06	0.02*	0.43**
	13 Years	11	166.55	174.36	7.82	10.91	0.04*	0.72***
	Total Group	149	152.89	157.94	5.05	18.50	<0.00*	0.27**

Variables	Ages	n	$\bar{X}$ Pre-Test	$\bar{X}$ Post-Test	$\bar{X}$ Difference	SD Difference	p-values	Effect Size d-value
Sit and Reach (cm)	9 Years	26	14.69	16.35	1.66	4.06	0.05	0.41**
	10 Years	44	15.52	16.79	1.27	4.87	0.09	0.26**
	11 Years	34	15.56	15.44	-0.11	3.15	0.83	-0.03
	12 Years	34	17.02	16.93	-0.09	5.18	0.92	-0.02
	13 Years	11	10.27	12.29	2.02	4.53	0.17	0.45**
	Total Group	149	15.34	16.10	0.77	4.46	0.04*	0.17
Sit-Ups (count per 30 seconds)	9 Years	26	17.65	19.85	2.19	3.23	<0.00*	0.68***
	10 Years	44	18.36	19.09	0.73	2.70	0.08	0.27**
	11 Years	34	20.50	20.71	0.21	2.59	0.65	0.08
	12 Years	34	23.74	22.53	-1.21	3.44	0.05	-0.35
	13 Years	11	21.90	22.90	1.00	3.19	0.32	0.31**
	Total Group	149	20.21	20.66	0.44	3.15	0.09	0.14
Bent arm hang (per seconds)	9 Years	26	14.67	15.85	1.17	7.95	0.46	0.15
	10 Years	44	13.70	15.70	2.00	7.78	0.10	0.26**
	11 Years	34	13.83	16.94	3.11	6.70	0.01*	0.46**
	12 Years	34	19.90	19.19	-0.71	12.47	0.74	-0.06
	13 Years	11	24.00	26.97	2.96	5.93	0.13	0.50***
	Total Group	149	16.08	17.64	1.56	8.80	0.03*	0.18
Grip strength (kg)	9 Years	26	20.50	24.62	4.12	13.29	0.13	0.31**
	10 Years	44	21.57	21.20	-0.36	4.15	0.56	-0.09
	11 Years	34	23.44	23.88	0.44	3.82	0.51	0.12
	12 Years	34	26.91	29.06	2.15	5.89	0.04*	0.37**
	13 Years	11	27.55	28.82	1.27	4.61	0.38	0.28**
	Total Group	149	23.47	24.77	1.30	7.06	0.03*	0.18

*statistic significant effect (p- value < 0.05); **small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); $\bar{X}$: Average

Table 4.4 presents the results for the CG who did not participate in the physical activity intervention programme. The 11, 12 and 13 year old boys showed statistically significant improvement (p<0.05) in the running time which indicates an improvement in the agility and speed of the boys. There was no practically significant improvement in any of the groups.

Statistically significant effects (p<0.05)was observed in the multi-phase fitness test (Bleep test) for the 9, 11, 12 year old boys and the total group in the CG which indicates a decreasing trend in the VO_2Max values of the CG and thus a deteriorating effect in CRF of the CG.
With regard to the standing broad jump test, there were statistically significant effects (p<0.05) in the 9, 11, 12 year old groups and in the total group. As for the practically

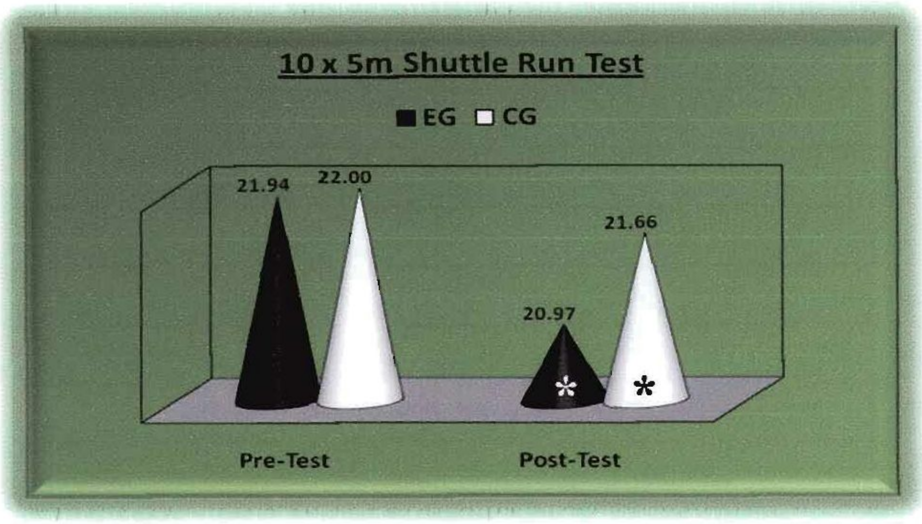
significant effect, only the 10 and 12 year old boys and the total group show a small practically significant improvement (d≥0.2) in the distance jumped and the 9 and 13 year old group showed a medium practically significant improvement (d≥0.5).

As far as the back and hip flexibility test (sit and reach) is concerned, only the total group shows statistically significant improvement (p<0.05) and the 9, 10 and 13 year old boys shows a small practically significant improvement (d≥0.2).

Statistically significant effect (p<0.05) between the pre and post-test for the sit-ups in the CG was observed only for the 9 year old boys. There were small practically significant increases (d≥0.2) in the 9, 10 and 13 year old boys. In the 11 and 12 year old age group, a decrease in the sit up count per 30 seconds was observed. The practically significant effect might be as a consequence of natural play amongst these children.

In the bent arm hang, indicating the functional strength of the CG, statistically significant effect (p<0.05) was seen between the pre- and post-test, for the 11 year old group and the total group. The bent arm hang time for the 10 and 11 year old boys showed a small practically significant decrease (d≥0.2) and a medium practically significant decrease (d≥0.5) for the 13 year old group.

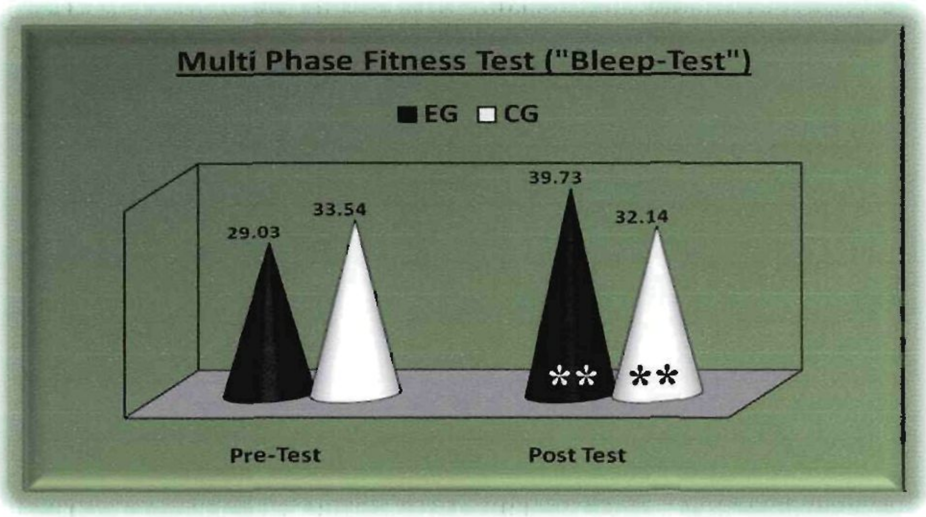
With regard to the static strength which was tested by means of a grip strength test, statistically significant effects (p<0.05) were found in the 12 year old group and the total group. The only practically significant effects found were small increases in grip strength of the 9, 12 and 13 year old boys.



* statistic significant effect (p- value < 0.05); ** small practical effect (d-value ≥ 0.2); *** medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 4.1: A comparison between the EG and the CG regarding 10 x 5m shuttle run (sec)

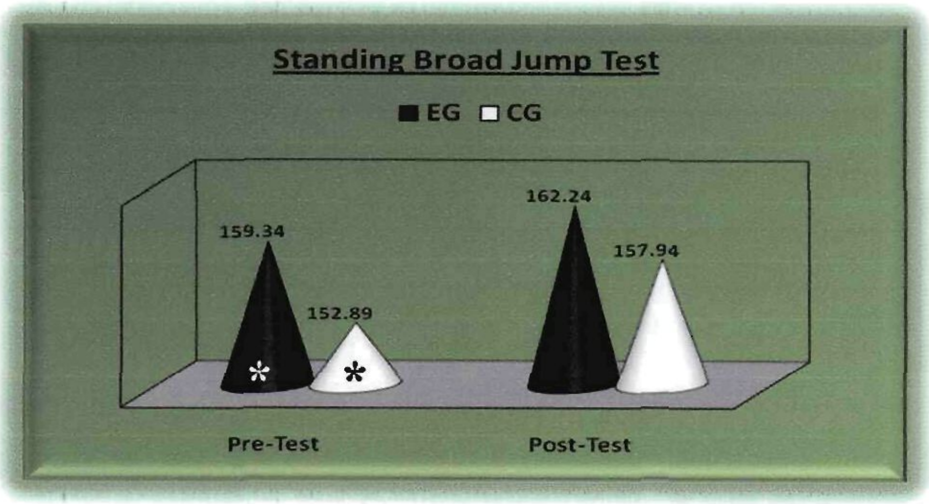
To study comparisons between the EG and CG, independent t-tests was calculated as shown in Figures 4.1 – 4.7. When comparing the averages of the EG and CG's pre and post-tests (Figure 4.1) with each other, as far as the pre-test is concerned there was no statistically or practically significant difference between the EG and the CG. There was, however, a statistically significant difference between the two groups's post-tests. The EG showed a statistically significant improvement in their agility and speed when comparing the results to the CG's results. The EG participated in the physical activity intervention programme and the CG did not participate in any physical activity programme. Therefore, it can be stated that the ten month physical activity intervention programme improved the agility and speed of the EG.



* statistic significant effect (p- value < 0.05); ** small practical effect (d-value ≥ 0.2); *** medium practical effect (d-value ≥ 0.5); **** large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 4.2: A comparison between the EG and the CG regarding the multi phase fitness test ("Bleep test") (ml/kg/min)

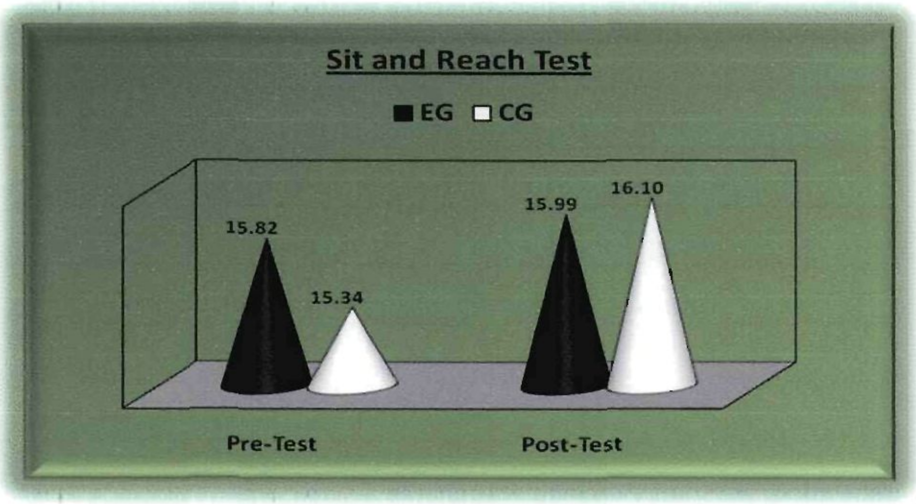
As illustrated in figure 4.2, no significant difference was observed in the pre-test between the EG and the CG. A small practically significant difference was seen when comparing the post-test of the EG and the CG. Thus the CRF levels for the EG improved practically significant compared to the CG after the ten month physical activity programme whereas the CG's CRF levels decreased without participating in physical activity.



* statistic significant effect (p- value < 0.05); ** small practical effect (d-value ≥ 0.2); *** medium practical effect (d-value ≥ 0.5); **** large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 4.3: A comparison between the EG and the CG regarding the standing broad jump (cm)

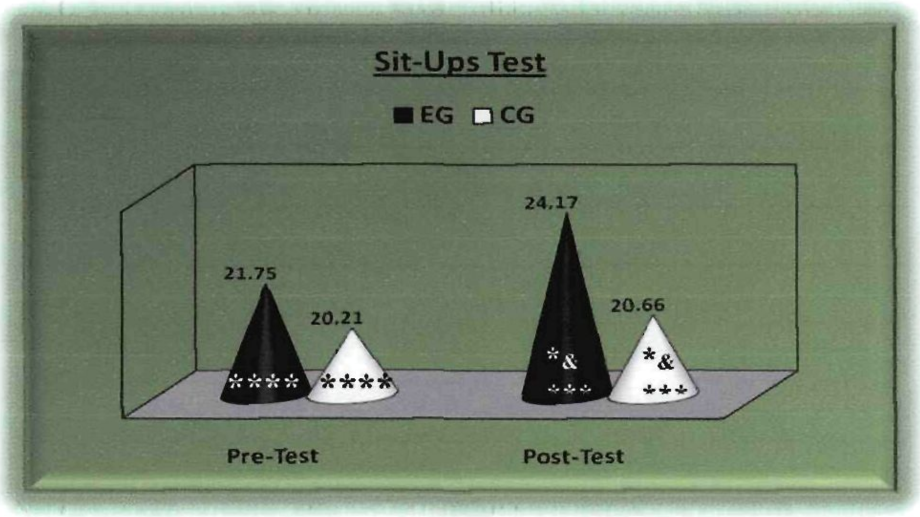
Figure 4.3 illustrates the results of the standing broad jump test for the EG and CG. With regards to the pre-test, there was a statistically significant difference between the two groups. The EG had relatively higher explosive strength to start with, but no practically significant difference was observed. No statistically or practically effect was observed when comparing the post-test of the EG with the CG. The EG jumped an average of 5.05 cm further than the CG as observed in the post-test results. The reason, therefore, can be that the EG had a practically significant increase in stature shown in the pre-test and was taller than the CG and thus jumped further.



* statistic significant effect (p- value < 0.05); **small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); ****large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 4.4: A comparison between the EG and the CG regarding the sit and reach test (cm)

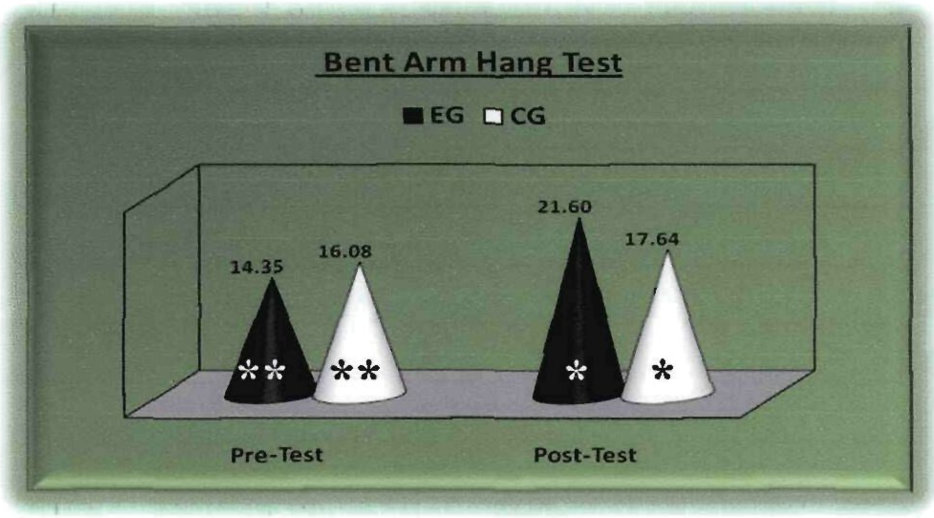
No statistically or practically significant differences were observed when comparing the pre-test of the EG and CG. A small improvement can be seen in the averages of the EG and the CG when examining the post-test.



* statistic significant effect (p- value < 0.05); ** small practical effect (d-value ≥ 0.2); ***medium practical effect (d-value ≥ 0.5); **** large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 4.5: A comparison between the EG and the CG regarding the sit-ups test (count per 30 sec)

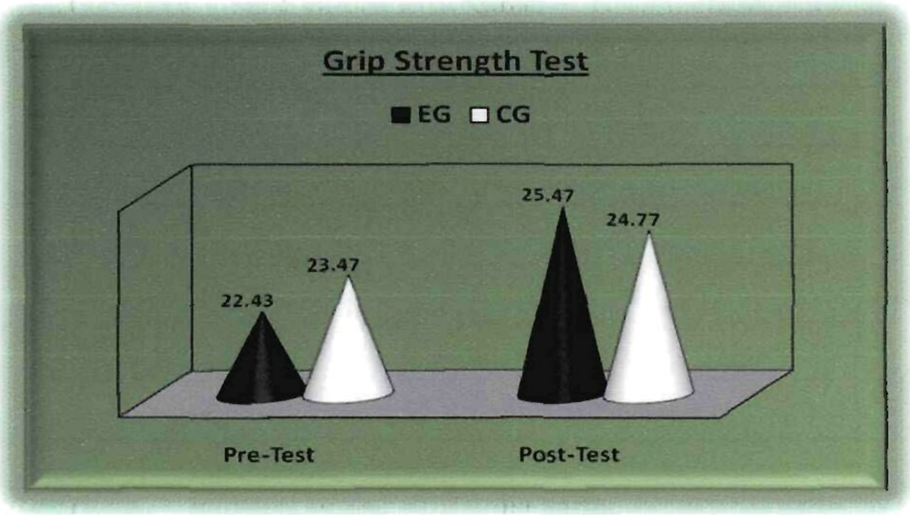
For the pre-test values of the EG and CG, there was no statistically significant difference between the two groups. There was, however, a medium practically significant difference between the EG and CG, with the EG who started with a sligthly higher trunk strength and muscular endurance. After the ten month physical activity intervention programme, there was a statistically significant difference between the post-test values of the EG and CG. As for practical significance, there was a small practically significant difference with regard to the post-test. The EG showed a very good improvement in trunk strength and muscular endurance whereas the CG did not show any improvement. This proves the success of the physical activity intervention programme.



* statistic significant effect (p- value < 0.05); ** small practical effect (d-value ≥ 0.2); *** medium practical effect (d-value ≥ 0.5); **** large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 4.6: A comparison between the EG and the CG regarding the bent arm hang test (sec)

Considering the bent arm hang test, there was no statistically significant difference for the pre-test between the EG and CG, but there was a small practically significant difference between the two groups where the CG had higher functional strength and muscular endurance to start with. When examining the results of the post-test, there was a statistically significant effect of the difference between the EG and the CG. It is interesting to see that the CG had a higher value for the bent arm hang during the pre-test and when measuring these groups after ten months, the EG has a much higher average value (4.84 sec longer) than the post-test value of the CG. The physical activity intervention programme has, therefore, consequently improved the functional strength and arm and shoulder muscular endurance for the EG.



* statistic significant effect (p- value < 0.05); ** small practical effect (d-value ≥ 0.2); *** medium practical effect (d-value ≥ 0.5); **** large practical effect (d-value ≥ 0.8); EG = Experimental Group; CG = Control Group

Figure 4.7: A comparison between the EG and the CG regarding the hand grip strength (kg)

It is evident in Figure 4.7 that the CG had a higher pre-test value than the EG. There was, however, no statistically or practically significant effect between the EG and CG's values for the pre-test. No statistically or practically significant effect was observed between the EG and CG's values for the post-test. There is a trend that shows that the EG's static hand grip strength increased more (3.04 kg) than the CG's static strength (1.3 kg) whilst participating in the physical activity intervention programme although not significantly.

4.4 DISCUSSION

The results of this study are in agreement with various results and reports of researchers across the world. Statistically significant improvement ($p<0.05$) were seen for all the groups in the EG in the 10 x 5 shuttle run time, where the CG only showed statistically significant improvement ($p<0.05$) in the 11, 12 and 13 year old groups and in the total group, indicating an higher improvement of agility and speed when participation in physical activity. Statistically ($p<0.05$) and large practically significant improvement ($d \geq 0.8$) were seen in all the groups of the EG for the multi phase fitness test, and as for the CG there is a statistically significant improvement ($p<0.05$) in VO_2Max values for the 9, 11 and 12 year old boys and in the total group, no practically significant effect were seen in the CG. This is a good indication of the influence of the ten month intervention programme on the CRF of 9 – 13 year old boys.

The VO_2Max values are used to determine the fitness levels of the subjects. Multi phase fitness test levels are converted to a laboratory measure of maximal oxygen uptake (VO_2Max) values by using the bleep test scores reference norms (Kuisis & Van Heerden, 2003).

Colchino *et al.* (2000) investigated 11 to 14 year old children (n=20) for 12 weeks whilst engaging in extracurricular physical activity. They found a significant improvement in cardiovascular endurance, muscular strength, muscular endurance and flexibility. The same results have been found in this study except for the flexibility test.

Van Rooyen (1993) reported that individuals who participate in sporting activities are generally stronger than those who do not participate in sport. Van Rooyen (1993) also indicates that an increase in muscle strength leads to an increase in muscle endurance. Many other researchers found beneficial development and enhanced physical fitness due to regular participation in physical activities. Improved physical fitness components reported by these researchers include: increased VO_2max (provided the training is vigorous and prolonged) thus improvement in aerobic fitness (cardiovascular endurance) (Klausen, Schibye & Rasmussen, 1989; Treiber *et al.*, 1989; Meyers *et al.*, 1996; Khanna, Majumdar, Saha & Mandal, 1998), increased muscular strength (Klausen *et al.*, 1989; Sothern *et al.*, 1999), increased flexibility (Folsom-Meek, 1991; Colchino *et al.*, 2000) and increased muscle endurance (Treiber *et al.*, 1989; Folsom-Meek, 1991; Sothern *et al.*, 1999).

The trend of statistically and practically significance in both the EG and the CG shows an improvement in the explosive strength of the participants, this might be due to the fact that these participants are in there growth spurt, thus increased stature and thus resulting in an increase in standing broad jump distance. According to Malina *et al.*, Bouchard and Bar, (2004), regular physical activity has a stimulatory influence on growth and maturity.

The physical activity intervention programme had a successful and positive influence on the trunk strength and muscular endurance of the 9 – 13 year old boys, since the EG showed statistically ($p<0.05$) and large practically significant improvement ($d\geq0.8$) in the 9 year old boys and statistically ($p<0.05$) and medium practically significant improvement ($d\geq0.5$) in the 12 and 13 year old boys. The 11 year old boys showed small practically significant improvement ($d\geq0.2$) and the total group showed statistically significant improvement

($p<0.05$). When comparing the CG, statistically significant improvement ($p<0.05$) as well as medium practically significant improvement ($d \geq 0.5$) were seen in the 9 year old group, small practically significant improvement ($d \geq 0.2$) were seen in the 10 and 13 year old boys. According to Brittenham and Brittenham (1997), abdominal strength is important for any type of sport. These researchers indicate that abdominal strength will contribute to an individual's stability, strength replacement, movement effectiveness and body posture. According to the literature, individuals' needs strong abdominal muscles to achieve better results effectively in a variety of different sport types with a low risk to injury (Elphinston & Pook, 1998).

Bent arm hang shows practically significant improvement in all the groups of the EG where the 9, 10 and 13 year old boys and total group shows medium practically significant improvement ($d \geq 0.5$), and the 11 and 12 year old boys shows small practically significant improvement ($d \geq 0.2$) and statistically significant improvement ($p<0.05$) for the 9, 10 and 13 year old boys as well as the total group. The CG shows a decrease in the 12 year old boys' bent arm hang time. It can thus be implied that the physical activity intervention programme positively improved the functional arm strength and muscle endurance of the arms of all the EG's age groups.

The positive results for the grip strength test indicate that the static hand strength for all the groups in the EG improved, statistically and practically significantly. No major improvements were found in the CG which proves that static strength did not improve without the implementation of the physical activity intervention programme.

To summarize the findings of the current study, it is clear that participation in physical activity improves physical fitness. It is important that children grow up in a healthy lifestyle environment, incorporating healthy eating habits and plenty of physical activity (structured and social). This will lead to a healthy lifestyle which will be present in the child's life as well as in adult life. Since children spend much time in a school environment it is crucial that schools implement a structured physical activity educational programme as well as a sporting programme. School based activities have declined in the past years and more attention is given to academic performance (Steinbeck, 2001; Orleans, Kraft, Marx & McGinnis, 2003; Janssen *et al.*, 2004). Many school boards see physical activity and physical education as wasting academic time (Shephard, 1997; Morrow, Jackson & Payne, 1999). Parental motivation and support to children to be actively involved in physical activity events, therefore, plays an important role in a child's enthusiasm to lead a physically active life (Manios, Kafatos, Codrington, 1999; Steinbeck, 2001; Bruton, Harden, Rees, Kavanagh, Oliver & Oakley, 2003; Green, Waters, Haikerwal, O'Neill, Raman, Booth, Gibbons, 2003; Rochford & Kaminsky, 2004). Regular exercise leads to a healthy and physically fit lifestyle and various other health benefits (Pienaar & Van der Walt, 1988; Verster, 2001; Vincent, Pangrazi, Raustorp, Tomson & Cuddihy, 2003). This study, therefore, proves that physical activity improves health related physical fitness in boys.

4.5 ACKNOWLEDGEMENT

A word of thanks is directed to the two principals of the participating schools as well as to all the children who participated in the study. Thank you to all the Human Movement Science students and personnel who helped with the measurements of this study.

4.6 REFERENCES

ANNESI, J.J., WESTCOTT, W.L., FAIGENBAUM, A.D. & UNRUH, J.L. 2005. Effects of a 12-week physical activity protocol delivered by YMCA after-school counselors (Youth Fitness for Life) on fitness and self-efficacy changes in 5-12 year old boys and girls. *Physical education, reaction and dance,* 76(4):468-476.

ARMSTRONG, M.E.G., LAMBERT, M.I., SHARWOOD, K.A. & LAMBERT, E.V. 2006. Obesity and overweight in South African primary school children – the Health of the Nation Study. *South African medical journal,* 96:439-444

BARNETT, T.A., O'LOUGHLIN, J. & PARADIS, G. 2002. One - and two year predictors of decline in physical activity among inner-city schoolchildren. *American journal of preventive medicine,* 23(2):121-128.

BRADLEY, C.B., McMURRAY, R.G., HARREL, J.S. & DENG, S. 2000. Changes in common activities of 3rd through 10th graders: the CHIC study. *Medical science in sports exercise,* 32:2071-2078.

BRITTENHAM, D. & BRITTENHAM, G. 1997. Stronger abs and back. Champaign, Ill.: Human Kinetics. 234 p.

BRUTON, G., HARDEN, A., REES, R., KAVANAGH, J.M., OLIVER, S. & OAKLEY, A. 2003. Children and physical activity: a systematic review of barriers and facilitators. http://www.eppi.ioe.ac.uk Access date: 25 July 2005.

BURKE, V., BEILIN, L.J., SIMMER, K., ODDY, W.H., BLAKE, K.V., DOHERTY, D., KENDALL, G.E., NEWNHAM, J.P., LANDAU, L.I. & STANLEY, F.J. 2005. Predictors of body mass index and associations with cardiovascular risk factors in Australian children: a prospective cohort study. *International journal of obesity*, 29(1):15-23.

COLCHINO, K., ZYBET, P. & BASCH, C.E. 2000. Effects of after school physical activity on fitness, fatness and cognitive self-perception: a pilot study among urban, minor adolescent girls. *American journal of public health*, 9(6):977-978.

ELLIS, S.M. & STEYN, H.S. 2003. Practical significance (effect sizes) versus or in combination with statistical significance (p-values). *Management dynamics*, 12(4):51-53.

ELPHINSTON, J. & POOK, P. 1998. The core workout. 2nd ed. Australia: Core Workout. 136 p.

EUROFIT. 1988. European test of physical fitness. Rome: Council of European Committee for Development of Sport. 72 p.

FOLSOM-MEEK, S.L. 1991. Relation among attributes physical fitness and self-concept development of elementary school children. *Perceptual and motor skills*, 73:379-383.

FORD, E.S., MOKDAD, A.H. & AJANI, U.A. 2004. Trends in risk factors for cardiovascular disease among children and adolescents in the United States. *Pediatrics*, 114(6):1534-1544.

FRITZ, G.K., STOVELL, K., SYDNEY, C.G. & MERRILL, S. 2005. Obesity and your child: know the facts. *Browns University child and adolescent behavior letter*, 21(2):9-10.

GANCE-CLEVELAND, B., HARRIS, M. & WARD-BEGNOCHE, W. 2005. Working with schools to connect with families of overweight children. *Journal for specialists in pediatric nursing*, 10(1):40-43.

GREEN, J., WATERS, E., HAIKERWAL, A., O'NEILL, E., RAMAN, S., BOOTH, H.L. & GIBBONS, K. 2003. Social cultural and environmental influences on child activity and eating in Australian migrant communities. *Child: Care, health and development*, 29(6):441-448.

GUERRA, S., TEIXEIRA-PINTO, A., RIBEIRO, J.C., ASCNSAO, A., MAGALHAES, J., ANDERSEN, L.B., DUARTE, J.A. & MOTA, J. 2006. Relationship between physical activity and obesity in children and adolescents. *Journal of sports medicine and physical fitness*, 46:79-83.

JANSSEN, I., KATZMARZYK, P.T., BOYCE, W.F., KING, M.A. & PICKETT, W. 2004. Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *Journal of adolescent health*, 35:360-367.

KHANNA, G.L., MAJUMDAR, P., SAHA, M. & MANDAL, M. 1998. Cardiorespiratory fitness and body composition in Indian children of 10 - 16 years: physical fitness and nutrition during growth. *Medical sport science*, 43:132-144.

KLAUSEN, K., SCHIBYE, B. & RASMUSSEN, T.B. 1989. A longitudinal study of changes in physical performance of 10 - 15 year old boys and girls. (*In* Oseid, S. & Carlsen, K., *eds*. Children and exercise XIII. Champaign, Ill.: Human Kinetics. p. 113-122.)

KUISIS, S & VAN HEERDEN, H.J. 2003. Modification of the 20 metre shuttle run test (20 MST) for ice-sports. Dissertation M-thesis. Pretoria : University of Pretoria. 137 p.

LABADARIOS, D., STEYN, N.P., MAUNDER, E., MACINTRYRE, U., GERICKE, G., SWART, R., HUSKISSON, J., DANNHAUSER, A., VORSTER, H.H., NESMVUNI, A.E. & NEL, J.H. 2005. The National Food Consumption Survey (NFCS): South Africa, 1999. *Public health nutrition*, 8(5):533-543.

LUEPKER, R.V. 1999. How physically active are American children and what can we do about it? *International journal of obesity*, (23):S12-S17.

MALINA, R.M., BOUCHARD, C. & BAR, O.R. 2004. Growth maturational and physical activity. 2nd ed. Champaign, Ill.: Human Kinetics. 710 p.

MANIOS, Y., KAFATOS, A. & CODRINGTON, C. 1999. Gender differences in physical activity and physical fitness in young children in Crete. *Journal of sports medicine and physical fitness*, 39:24-30.

MEYERS, L., STRIKMILLER, P.K., WEBBER, S. & BERENSON, G.S. 1996. Physical and sedentary activity in school children grades 5 - 8: The Bogolusa Heart Study. *Medical and science in sport and exercise*, 28(7):852-859.

MONYEKI, K.D., KEMPER, H.C.G. & MAKGAE, P.J. 2006. The association of fat patterning with the Ellisras longitudinal growth and health study. *International journal of epidemiology*, 35:114-120.

MORROW, J.R. Jr., JACKSON, A.W. & PAYNE, V.G. 1999. Physical activity promotion and school physical education. *President's council on physical fitness and sports research digest,* Series 3(7):1-9.

ORLEANS, C.T., KRAFT, K., MARX, J.F. & McGINNIS, J.M. 2003. Why are some neighbours active and others not? Charting a new course for research on the policy and environmental determinants of physical activity. *Annals of behavioral medicine*, 25(2):77-79.

PIENAAR, A.E. & VAN DER WALT, T.S.P. 1988. Die invloed van deelname aan 'n gimnastiek program op sekere antropometriese veranderlikes by ses tot nege jarige meisies. *South African journal for research in sport, physical education and recreation,* 11(2):39-47.

ROCHFORD, M. & KAMINSKY, E. 2004. Fighting back against childhood obesity through the Cape May County Children's Health Summit. Preventing chronic disease. *Public health research, practice and policy,* 1(4). http://www.cdc.gov/pcd/issues/2004/oct / /04_0067.htm Access date: 18 June 2005.

SALLIS, J.F. 2000. Age-related decline in physical activity: a synthesis of human and animal studies. *Medical science in sports exercise*, 32:1598-600.

SHAIBI, G.Q., BALL, G.D.C., CRUS, M.L., WEIGENSBERG, M.J., SALEM, G.J. & GORAN, M.I. 2006. Cardiovascular fitness and physical activity in children with and without impaired glucose tolerance. *International journal of obesity,* (30):45-49.

SHEPHARD, R.J. 1997. Curricular physical activity and academic performance. *Pediatric exercise science*, 9:113-126.

SOTHERN, M.S., LOFTIN, M., SUSKIND R.M., UDALL, J.N. & BLECKER, U. 1999. The health benefits of physical activity in children and adolescents: implications for chronic disease prevention. *European journal for pediatrics*, 158:271-274.

STATSOFT, INC. 2008. STATISTICA (data analysis software system), version 7. www.statsoft.com.

STEINBECK, K.S. 2001. The importance of physical activity in the prevention of overweight and obesity in childhood: a review and an opinion. *International association for study of obesity reviews*, 2:117-130.

STEYN, H.S. 2005. Handleiding vir bepaling van effekgrootte-indekse en praktiese betekenisvolheid. Potchefstroom. 182 p.

SUMMERFIELD, L.M. 1998. Promoting physical activity and exercise among children. *Eric digests*, 1-17.

THOMAS, J.R., NELSON, J.K. & SILVERMAN, S.J. 2005. Research methods in physical activity. 5th ed. Champaign, Ill.: Human Kinetics. 454 p.

TREIBER, F.A., STRONG, W.B., RENSMAN, F.W. & GRUBER, M. 1989. Relationship between habitual physical activity and cardiovascular responses to exercise in young children. (*In* Oseid, S. & Carlsen, K., *eds. Children and exercise XIII.* Champaign, Ill.: Human Kinetics. p. 285-293.)

TRUDEAU, F. & SHEPHARD, R.J. 2005. Contribution of school programmes to physical activity levels and attitudes in children and adults. *Sports medicine,* 35(2):89-105.

VAN ROOYEN, F. 1993. Effects of an enriched physical activity programme on selected anthropometrical, physiological and performance characteristics of an underprivileged ethnic group. Grahamstown: Rhodes University. (Dissertation - MSc.) 96 p.

VERSTER, J. 2001. Causes, risks and dietary treatment of obesity. *Geneeskunde, The medical journal*, 43:15-18.

VINCENT, S.D., PANGRAZI, R.P., RAUSTORP, A., TOMSON, L.M. & CUDDIHY, T.F. 2003. Activity levels and body mass index of children in the United States, Sweden and Australia. *Medical and science in sort and exercise*, 35(5):1367-1373.

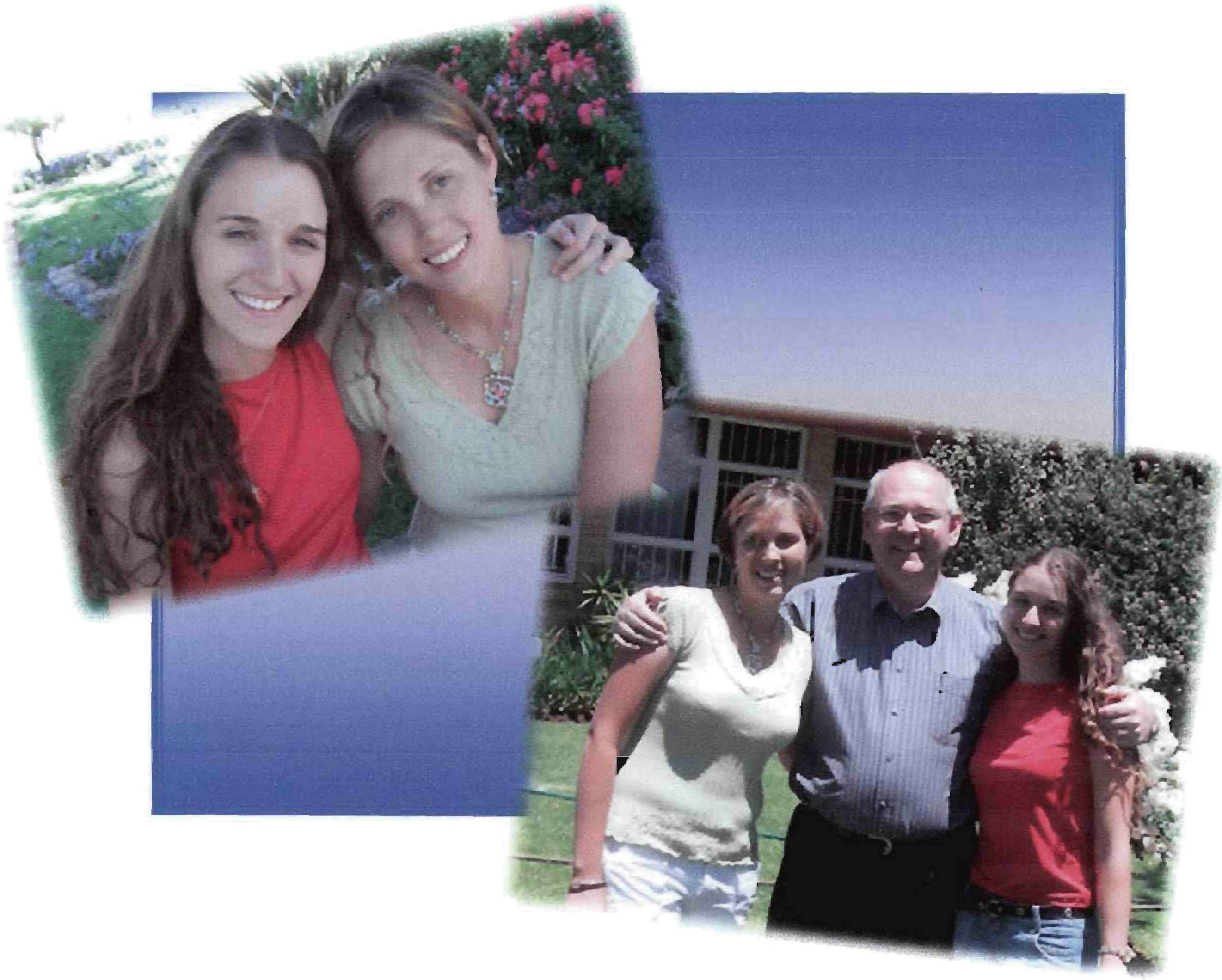
VOÛTE, J. & VALENTIN, F. 2005. Fatness to fitness. *Agenda,* 3:214-215.

WANG, Y. 2001. Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. *International journal of epidemiology*, 30(5):1129-1136.

WHITNEY, E.N. & ROLFES, S.R. 2002. Understanding nutrition. 9^{th} ed. Belmont, Calif.: Wadswort. 697 p.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS



5 Summary, conclusions and recommendations

5.1 SUMMARY

The objectives of this research study were firstly to determine whether a ten month physical activity intervention programme (PAI) will have a positive influence on the body composition of 9 - 13 year old boys. The second objective was to determine whether a ten month physical activity intervention programme (PAI) will show a statistically as well as practically significant improvement in the health related physical fitness of 9 – 13 year old boys. This chapter gives the general findings of the study, implications and recommendations.

The dissertation was presented in four main parts, namely an introduction (Chapter 1), literature review (Chapter 2), and two research articles (Chapters 3 and 4). This article format of the dissertation is approved by the Senate of the North-West University (Potchefstroom Campus), and the two research articles will be presented to appropriate and accredited journals.

In ***Chapter 1*** an overview of the current problem to motivate the study was given, objectives and hypothesis were stated and the structure of the study was explained.

From the literature in ***Chapter 2*** the focus area of the study was examined by means of the opinions and statements of other researchers in the industry. Literature regarding the relationship between physical activity, body composition and health related fitness was discussed. The focal point was on concepts such as physical activity, the benefits of regular physical activity, physical inactivity, risk factors, body composition, the prevalence of juvenile obesity, causes of juvenile sedentary lifestyles, and recommendations to improve the physical fitness levels and lives of children.

Chapter 3, were presented in the form of a research article, titled: The influence of a physical activity intervention programme (PAI) on the body composition of 9 – 13 year old boys. This article is presented for publication to the "African Journal for Physical, Health Education, Recreation and Dance".

In ***Chapter 4*** were the second research article, titled: The influence of a physical activity intervention programme on the health related physical fitness of 9 – 13 year old boys. This article is presented for publication to the "African Journal for Physical, Health Education, Recreation and Dance".

5.2 CONCLUSIONS

The conclusions that are drawn from this research project are presented in accordance with the set hypotheses (Chapter 1).

Hypothesis 1: The implementation of a ten month physical activity intervention programme (PAI) has statistically, as well as practically significant improvement on the body composition of 9 – 13 year old boys.

The first hypothesis is accordingly accepted, since there were significant relations between components of body composition and the physical activity intervention. After the implementation of the physical activity intervention programme, results showed significant improvement in the anthropometrical components for the EG regarding the body mass, stature and BMI levels. The CG's body mass, stature and percentage body fat increased statistically and practically significant. Thus the physical activity intervention programme had a positive influence on some of the variables in the EG in 9 to 13 year old boys.

Hypothesis 2: The implementation of a ten month physical activity intervention programme (PAI) has statistically, as well as practically significant improvement on the health related physical fitness of 9 – 13 year old boys.

The second hypothesis is accordingly accepted, since there were significant relations between components of health related fitness and the physical activity intervention programme. From the results reported it is observed that the agility, speed, trunk muscular strength, cardiovascular endurance, functional strength, arm and shoulder muscular endurance and static strength improved significantly for the EG, whereas the CG showed no statistically significant improvement.

5.3 RECOMMENDATIONS AND LIMITATIONS

The outcomes of this dissertation will be presented to professionals in the health and fitness industry by means of publication in scientific journals and presentations at national and international congresses, since the results from this study contributed to the lack of emphasis on the importance and benefits of physical activity and physical fitness. (Fortunate enough during the write-up of this dissertation, parts of the results were already presented at the "SASMA (South African Sport Medicine Association) Congress" in Johannesburg in 2005 as well as at the SASReCon (South African Sport and Recreation) Congress in 2006.

Though the study was able to determine the influence of a physical activity intervention on body composition and health related physical fitness, it had some limitations such as:

1. The number of the subjects per age group was relatively small and, therefore, the findings may not be generalized for the entire population.
2. Ethnicity was not considered in the study.
3. Sophisticated instruments of measuring percentage body fat were not used.
4. Physical activity sessions were only presented twice a week for a short period of thirty minutes, since it was part of the school timetable and accordingly only had specific slots during the week.
5. The CG still participated in normal sport activities during the intervention period and might have influenced their results.

Therefore, it is recommended that:

1. More studies should be conducted which would incorporate a larger population.
2. Ethnicity from a wider spectrum of the South African school children should be included, especially those in less privileged environments.
3. Sophisticated instruments to measure percentage body fat should be used.
4. Physical activity periods should be presented more times a week, at least 3 times and for longer periods, at least one hour periods.

Given the findings, the study further recommends the inclusion of physical activity programmes in schools and after school community physical activity programmes.

Appendix A

GUIDELINES FOR JOURNAL

A Guidelines for Journal

- **Article 1 and 2 (Chapter 3 and 4): African Journal for Physical, Health Education, Recreation and Dance (AJPHERD)**

"AFRICAN JOURNAL FOR PHYSICAL, HEALTH EDUCATION, RECREATION and DANCE"

The African Journal for Physical, Health Education, Recreation and Dance (AJPHERD) is a peer-reviewed journal established to:

i) provide a forum for physical educators, health educators, specialists in human movement studies and dance, as well as other sport-related professionals in Africa, the opportunity to report their research findings based on African settings and experiences, and also to exchange ideas among themselves.
ii) afford the professionals and other interested individuals in these disciplines the opportunity to learn more about the practice of the disciplines in different parts of the continent.
iii) create an awareness in the rest of the world about the professional practice in the disciplines in Africa.

GENERAL POLICY

AJPHERD publishes research papers that contribute to knowledge and practice, and also develops theory either as new information, reviews, confirmation of previous findings, application of new teaching/coaching techniques and research notes. Letters to the editor relating to the materials previously published in AJPHERD could be submitted within 3 months after publication of the article in question. Such letter will be referred to the corresponding author and both the letter and response will be published concurrently in a subsequent issue of the journal.

Manuscripts are considered for publication in AJPHERD based on the understanding that they have not been published or submitted for publication in any other journal. In submitting papers for publication, corresponding authors should make such declarations. Where part of a paper has been published or presented at congresses, seminars or symposia, reference to that publication should be made in acknowledgement section of the manuscript.

AJPHERD is published quarterly, i.e. in March, June, September and December. Supplements/Special editions are also published periodically.

SUBMISSION OF MANUSCRIPT

Three copies of original manuscript and all correspondence should be addressed to the Editor-In-Chief:

Proffessor L.O. Amusa
Centre for Biokinetics, Recreation
And Sport Science, University of Venda for
Science and Technology, P. Bag X5050,
Thohoyandou 0950
Republic of South Africa

Tel: +27 15 962 8076
Fax: +27 15 962 8647
Email: amusalbw@yahoo.com

Articles can also be submitted electronically, i.e. via e-mail attachment. However, the corresponding author should ensure that such articles are virus free. AJPHERD reviewing process normally takes 4-6 weeks and authors will be advised about the decision on submitted manuscripts within 60 days. In order to ensure anonymity during the reviewing process authors are requested to avoid self-referencing or keep it to the barest minimum.

PREPARATION OF MANUSCRIPT

Manuscripts should be type written in fluent English (using 12-point Times New Roman font and 1,5 line spacing) on one side of white A4-sized paper justified fully with 3cm margin on all sides. In preparing manuscripts, MS-Word, Office 98 or Office 2000 for Windows should be used. Length of manuscripts should not normally exceed 12 printed pages (including tables, figures, references, ets). For articles exceeding 12 typed pages US$ 10.0 is charged per every extra page. Longer manuscripts may be accepted for publication as supplements or special research reviews. Authors will be requested to pay a publication charge of US$ 150.0 to defray the very high cost of publication.

Title page:

The title page of the manuscript should contain the following information:

Concise and informative title.

Author(s') name(s) with first and middle initials. Authors' highest qualifications and main area of research specialisation should be provided.

Author(s') institutional addresses, including telephone and fax numbers.

Corresponding author's contact details, including e-mail address.

A short running title of not more than 6 words.

Abstract

An abstract of 200-250 words is required with up to a maximum of 5 words provided below the abstract. Abstract must be typed on a separate page using single line spacing, with the purpose of the study, methods, major results and conclusions concisely presented. Abbreviations should either be defined or excluded.

Text

Text should carry the following designated headings: Introduction, materials and methods, results, discussion, acknowledgement, references and appendices (if appropriate).

Introduction

The introduction should start on a new page and in addition to comprehensively giving the background of the study should clearly state the problem and purpose of the study. Authors should cite relevant references to support the basis of the study. A concise but informative and critical literature review is required.

Materials and Methods

This section should provide sufficient and relevant information regarding study participants, instrumentation, research design, validity and reliability estimates, data collection procedures, statistical methods and data analysis techniques used. Qualitative research techniques are also acceptable.

Results

Findings should be presented precisely and clearly. Tables and figures must be presented separately or at the end of the manuscript and their appropriate location in the text indicated. The results section should not contain materials that are appropriate for presentation under the discussion section. Formulas, units and quantities should be expressed in the systeme international (SI) units. Colour printing of figures and tables is expensive and could be done upon request at authors' expense.

Discussion

The discussion section should reflect only important aspects of the study and its major conclusions. Information presented in the results section should not be repeated under the discussion. Relevant references should be cited in order to justify the findings of the study. Overall, the discussion should be critical and tactfully written.

References

The American Psychological Association (APA) format should be used for referencing. Only references cited in the text should be alphabetically listed in the reference section at the end of the article. References should not be numbered either in the text or in the reference list.

Authors are advised to consider the following examples in referencing:

Examples of citations in body of the text:-

For one or two authors: Kruger (2003) and Travill and Lloyd (1998). These references should be cited as follows when indicated at the end of a statement: (Kruger, 2003); Travill & Lloyd, 1998).

For three or more authors cited for the first time in the text: Monyeki, Brits, Mantsena and Toriola (2002) or when cited at the end of a statement as in the preceding example: (Monyeki, Brits, Mantsena & Toriola, 2002). For subsequent citations of the same reference it suffices to cite this particular reference as: Monyeki *et al.* (2002).

Multiple references when cited in the body of the text should be listed chronologically in ascending order, i.e. starting with the oldest reference. These should be separated with semi colons. For example, (Tom, 1982; McDaniels & Jooste, 1990; Van Heerden, 2001; De Ridder *et al.*, 2003).

Reference List:

In Compiling the reference list at the end of the text the following examples for journal references, chapter from a book, book publication and electronic citations should be considered:

Examples of journal references:

Journal references should include the surname and initials of the author(s), year of publication, title of paper, name of journal in which the paper has been published, volume and number of journal issue and page numbers.

For one Author: McDonald, A.K. (1999). Youth sports in Africa: A review of programmes in selected countries. *International Journal of Youth Sports*, 1(4), 102-117.

For two authors: Johnson, A.G. & O'kefee, L.M. (2003). Analysis of performance factors in provincial table tennis players. *Journal of Sport performance*, 2(3), 12-31.

For multiple authors: Kemper, G.A., McPherson, A.B., Toledo, I. & Abdullah, I.I. (1996). Kinematic analysis of forehand smash in badminton. *Science of Racket Sports*, 24(2), 99-112.

Examples of book references:

Book references should specify the surname and initials of author(s), year of publication of the book, title, edition, page numbers written in brackets, city where book was published and name of publishers. Chapter references should include the name(s) of the editor and other specific information provided in the third example below.

For authored references: Amusa, L.O. & Toriola, A.L. (2003). *Foundation of Sport Science* (1st ed.) (pp. 39-45). Mokopane, South Africa: Dynasty Printers.

For edited references: Amusa, L.O. and Toriola, A.L. (Eds) (2003). *Contemporary Issues in Physical Education and Sports* (2nd ed.) (pp.20-24). Mokopane, South Africa: Dynanty Printers.

For chapter references in a book: Adams, L.L. & Neveling, I.A. (2004). Body fat characteristics of sumo wrestlers. In J.K. Manny and F.O. Boyd (Eds.), *Advances in Kinanthropometry* (pp. 21-29). Johannesburg, South Africa: The Publishers Company Ltd.

Examples of electronic references:

Electronic sources should be easily accessible. Details of Internet website links should also be provided fully. Consider the following example:

Wilson, G.A. (1997). Does sport sponsorship have a direct effect on product sales? The Cyber-Journal of Sport Marketeing (online), October, 1(4), at http://www.cad.gu.au/cjsm/wilson.html. February 1997.

PROOFREADING

Manuscript accepted for publication may be returned to the author(s) for final correction and proofreading. Corrected proofs should be returned to the Editor-In-Chief within one week of receipt. Minor editorial corrections are handled by AJPHERD.

COPYRIGHT AGREEMENT

The Africa Association for Health, Physical Education, Recreation, Sport and Dance (AFAHPER-SD) holds the copyright for AJPHERD. In keeping with copyright laws, authors will be required to assign copyright of accepted manuscripts to AFAHPER-SD. This ensures that both the published and the authors are protected from misuse of copyright information. Requests for permission to use copyright materials should be addressed to the Editor-In-Chief.

COMPLIMENTARY COPY OF AJPHERD AND REPRINTS

Principal authors will receive ten (10) complimentary copies of the relevant pages in which their article has bee published. In case of two or more joint authors the principal author distributes the copies to the co-authors. Reprints of published papers can be ordered using a reprint order form that will be sent to the corresponding author before publication. Bound copies of the journal may be ordered from: Dynasty Printers, 26 Pretorius Street, Mokopane 0600, South Africa. Tel: +27 15 4914873; Fax: +27 15 4916411; E-mail: Ahmed@dynatyprinters.com; website: www.dynatyprinters.com

Appendix B

PARENT INFORMED CONSENT

B

Parent Informed Consent

- **Experimental Group: Informed Consent form**

- **Control Group: Informed Consent form**

LIGGAAMSOPVOEDINGSPROJEK: INLIGTING RAKENDE DIE STUDIE

Geagte Ouers/Voogde

Die hedendaagse kind neem al hoe minder deel aan fisieke aktiwiteit en sit al hoe meer voor die rekenaar en die televisie. Die verlaagde hoeveelheid deelname aan fisieke aktiwiteit lei tot allerlei probleme soos obesiteit, oorgewig, swak gedrag en talle chroniese siektes. Daarom het Laerskool Roodekrans ingestem om deel te neem aan 'n studie wat deur die Noordwes Universiteit (Potchefstroom-kampus) geloods word.

Inligting rakende die studie

1. Die projek word goedgekeur deur die etiese komitee van die Noordwes Universiteit.
2. Die doel van die navorsingstudie is om die invloed van 'n gestruktureerde Lewensopvoedingprogram op die fisieke fiksheid van kinders tussen die ouderdomme van 9 en 13 jaar, in Suid-Gauteng te bepaal.
3. Die deelnemers sal geweeg word en sy/haar lengte sowel as hul omtrekke en velvoue sal gemeet word sonder dat enige kind pyn sal ervaar. Elke seun en dogter sal gevra word om in hul swemklere in die privaatheid van die klaskamer vir die betrokke metings te verskyn. Die verskillende geslag en ouderdomsgroepe sal afsonderlik gemeet word. Slegs uiters professionele biokinetici sal die metings doen en sal so te werk gaan dat geen kind in 'n verleentheid gestel word nie. Al die biokinetici is by die Mediese Raad geregistreer.
4. Die volgende komponente word tydens die navorsingstudie aangespreek: massa. lengte, velvoue, spoed, ratsheid, maagkrag, gewrigskrag, beenkrag, armkrag, balans en reaksietyd.
5. Die navorsingsprojek word gedoen as deel van die Lewensoriëntering kurrikulum en al die aspekte wat getoets word in die studie sal gedurende die jaar ingeoefen word, daarom sal die studie tot groot voordeel van u kind wees.
6. Toetse sal tweemaal gedurende dieselfde jaar geskied, aan die begin van die jaar, sowel as aan die einde van die jaar.
7. Alle inligting is vertroulik. Die inligting word anoniem gebruik om die bevindings aan ander wetenskaplikes bekend te stel.
8. U samewerking in dié verband sal hoog op prys gestel word. U sal nie spyt wees nie. Dié navorsingstudie sal tot groot voordeel van Laerskool Roodekrans wees.

Vir enige navrae, kontak die navorser Marissa Stadler. Tel: 082 496 2772

BY VOORBAAT DANKIE VIR U SAMEWERKING
Marissa Stadler (Biokinetikus en LO-onderwyseres by Laerskool Roodekrans)

------------------------(Ouer/voog) van ---------------------(kind) gee hiermee toestemming dat my kind aan die Liggaamsopvoedingsprojek mag deelneem.

Handtekening (Ouer/Voog) --------------------------------

LIGGAAMSOPVOEDINGSPROJEK: INLIGTING RAKENDE DIE STUDIE

Geagte Ouers/Voogde

Die hedendaagse kind neem al hoe minder deel aan fisieke aktiwiteit en sit al hoe meer voor die rekenaar en die televisie. Die verlaagde hoeveelheid deelname aan fisieke aktiwiteit lei tot allerlei probleme soos obesiteit, oorgewig, swak gedrag en talle chroniese siektes. Daarom het Laerskool Kenmare ingestem om deel te neem aan 'n studie wat deur die Noordwes Universiteit (Potchefstroom-kampus) geloods word.

Inligting rakende die studie

1. Die projek word goedgekeur deur die etiese komitee van die Noordwes Universiteit.
2. Die doel van die navorsingstudie is om die invloed van 'n gestruktureerde Lewensopvoedingprogram op die fisieke fiksheid van kinders tussen die ouderdomme van 9 en 13 jaar, in Suid-Gauteng te bepaal.
3. Die deelnemers sal geweeg word en sy/haar lengte sowel as hul omtrekke en velvoue sal gemeet word sonder dat enige kind pyn sal ervaar. Elke seun en dogter sal gevra word om in hul swemklere in die privaatheid van die klaskamer vir die betrokke metings te verskyn. Die verskillende geslagte en ouderdomsgroepe sal afsonderlik gemeet word. Slegs uiters professionele biokinetici sal die metings doen en sal so te werk gaan dat geen kind in 'n verleentheid gestel word nie. Al die biokinetici is by die Mediese Raad geregistreer.
4. Die volgende komponente word tydens die navorsingstudie aangespreek: massa. lengte, velvoue, spoed, ratsheid, maagkrag, gewrigskrag, beenkrag, armkrag, balans en reaksietyd.
5. Alle inligting is vertroulik. Die inligting word anoniem gebruik om die bevindings aan ander wetenskaplikes bekend te stel.
6. Toetse sal tweemaal gedurende dieselfde jaar geskied, aan die begin van die jaar, sowel as aan die einde van die jaar.
7. U samewerking in dié verband sal hoog op prys gestel word. U sal nie spyt wees nie. Dié navorsingstudie sal tot groot voordeel van Laerskool Kenmare wees.

Vir enige navrae, kontak die navorser Marissa Stadler. Tel: 082 496 2772

BY VOORBAAT DANKIE VIR U SAMEWERKING
Marissa Stadler (Biokinetikus en LO-onderwyseres by Laerskool Roodekrans)

----------------------------(Ouer/voog) van ---------------------------(kind) gee hiermee toestemming dat my kind aan die Liggaamsopvoedingsprojek mag deelneem.

Handtekening (Ouer/Voog) --------------------------------

Appendix C

PHYSICAL ACTIVITY INTERVENTION TESTING ADMINISTRATION

C Physical Activity Intervention Testing Administration

- **Data Collection Sheet**

DATA COLLECTION SHEET

Age: .... Gender: .... Subject number: ....

School: .... Class: .... Test Date: ....

Name: .... Birth date: ....(Year; month; day)

Dominant hand: .... Sport: ....

1. ANTHROPOMETRY

Mass: ....(kg) Length: ....(cm) BMI: ....(kg/m^2)

Skinfolds:
Triceps: .... Subscapular: .... Calf: ....
....
....

2. PHYSICAL FITNESS

EUROFIT	AVERAGE	INDIVIDUAL	REMARKS
5x10m Shuttle Run (sec)			
Multi Phase Physical Fitness Test "Bleep" Test			
Standing Broad Jump (cm)			
Sit and Reach (cm)			
Sit ups (Count per 30 Sec)			
Bent arm hang (sec)			
Grip Strength (kg)			