Health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children aged 10-12 years old: The Zimbabwe Baseline Survey

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The Author

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DEDICATION

This dissertation is dedicated to my mother, brother and children.

DECLARATION

Professor Hans de Ridder (supervisor), Professor M.A. Monyeki (co-supervisor), and Mr Daga Makaza (assistant co-supervisor), co-authors of two articles in this dissertation, hereby give permission to the candidate Caroline Chiratidzo Mavingire to include the articles as part of her Master's dissertation.

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ABSTRACT

The future of children is being threatened to a steadily increasing extent, not least by the implications of the global obesity epidemic and ever-decreasing general levels of physical activity. Although empirical evidence has demonstrated conclusively that physical activity has numerous benefits for the health of children, many children throughout the world do not engage in the recommended 60 minutes of physical activity per day. While overall physical fitness constitutes a significant indicator of health. Anthropometric indices as indicators of body composition are also important issues to study in order to predict the health-related physical fitness of children. Regular assessments and evaluations of children in terms of these parameters are essential for making accurate assessments of their growth, development, and states of health.

This study was conducted in order to determine the health-related physical fitness, anthropometric characteristics, and levels of physical activity of Zimbabwean children between the ages of 10 and 12 years. The research sample comprised a total of 809 children, of whom 356 were boys and 453 were girls. The mean age was 11.03 years. Anthropometric measurements were made in accordance with the standard procedures of the International Society for the Advancement of Kinanthropometry (ISAK). Measurements were made of body mass, stature, triceps, biceps, subscapular, and supraspinale skinfolds, and minimum waist and gluteal girths. Nine health-related physical fitness tests were used to assess the children according to the EUROFIT and Physical Best protocols. The physical fitness tests measured were: the sit and reach test to measure flexibility in centimetres, the standing broad jump to test leg power in centimetres, the flamingo balance test over a period of 1 minute, the handgrip strength test which measured strength in kilograms, the sit-up test to measure abdominal strength over a 30-second period, the bent-arm hang test to measure upper body strength in seconds, the 10×5-metre shuttle run test to measure speed and agility in seconds, the 50-metre sprint to measure speed in seconds, and the 1.5-mile run test to measure aerobic endurance, which was scored in minutes. Levels of physical activity were assessed through the administration of the PAQ-C questionnaire and scores were recorded in hours.

The results of the study revealed that 14.8% of the children were either overweight or obese. A preponderance of underweight children was found to coexist with obesity, with 62.4% of the children classified as being thin. Grade 1 thinness was found among 5.9% of the children, while a further 5.9% exhibited grade 2 thinness. Significant gender differences ($p \leq 0.05$) were found for all of the anthropometric variables and indices, apart from waist girth. Significant gender

differences ($p \leq 0.05$ and $p \leq 0.001$) were also found in the scores for the sit and reach, standing broad jump, flamingo balance, sit-up, bent-arm hang, 10×5-metre shuttle run, 50-meter sprint, and 1.5-mile run physical fitness tests. The boys outperformed the girls in all of the physical fitness tests, apart from the sit and reach and the flamingo balance tests. The levels of physical activity in which the children engaged each day were considered to be relatively high, as a large majority of 85.2 % walked to and from school.

Both positive and negative correlations were found between measurements of body composition and scores for physical fitness tests. Measurements of body composition correlated strongly with one another ($p<0.05$). Strong positive correlations were found between BMI and scores for the standing broad jump, $r=0.08$, sit-up, $r=0.01$, 1.5-mile run, $r=0.30$, and the handgrip strength tests, $r=0.26$ right hand and $r=0.24$ left hand. Conversely, strong negative correlations were found between BMI and scores for the bent-arm hang test $r=-0.15$ and also between percentages of body fat and scores for the bent-arm hang test $r=-0.49$.

Regular measurement of Zimbabwean children is to be encouraged, as doing so would provide the information which only regular cross-sectional and longitudinal research studies are able to provide concerning trends pertaining to overweight and obese children and adolescents, which is generally lacking in sub-Saharan Africa. The continued measurement of Zimbabwean children would also significantly increase the amount of information which is available pertaining to health-related physical fitness, anthropometric characteristics, and levels of physical activity. The acquisition of a proper understanding of childhood development in the Zimbabwean context is the surest means of securing the future of the population of the country.

Key words: Children, physical fitness, anthropometry, body composition, physical activity, Zimbabwe.

OPSOMMING

Die gesondheidstatus van kinders het die afgelope jare toenemend ‘n saak van dringendheid geword, veral gesien in die lig van die epidemie wat tans rondom obesiteit bestaan, asook die toename van fisieke onaktiwiteit. Empiriese bewyse toon duidelik aan dat fisieke aktiwiteit verskeie voordele inhou vir kinders. Ten spyte hiervan, is daar baie kinders wêreldwyd wat nie die voorgeskrewe 60 minute fisieke aktiwiteit daagliks verrig nie. Fisieke fiksheid is ‘n belangrike maatstaf vir gesondheid. Antropometrie en antropometriese indekse as aanduiders van liggaamsamestelling is daarom belangrike parameters wanneer kinders bestudeer word. Gereelde antropometriese evaluerings is daarom baie belangrik aangesien dit help om groei en ontwikkeling asook gesondheidstatus by kinders beter te verstaan.

Die doel van hierdie studie was daarom om die gesondheisverwante fisieke fiksheid, antropometrie en fisieke aktiwiteitsvlakke van kinders in Zimbabwe te bepaal. Die kinders was 10-12 jaar oud. ‘n Totaal van 809 kinders waarvan 356 seuns en 453 dogters, het deel gevorm van hierdie studie. Antropometriese metings is geneem volgens die standaard prosedures soos voorgeskryf deur die “International Society for the Advancement of Kinanthropometry (ISAK)”. Die metings wat geneem is sluit in liggaamsmassa, liggaamslengte, velvoue (triseps, biseps, subskapulêre en supraspinale) en omtrekke (minimum abdomen, heup en kuit). Nege gesondheidsverwante fisieke fiksheidstoetse is afgeneem volgens die “EUROFIT” en die “Physical Best” protokolle. Die fisieke fiksheidstoetse wat gemeet is, was: die sit-en-reik toets vir soepelheid in cm, die staande verspringtoets vir eksplosiewe beenkrag in cm, die flamink balanstoets in 1 min, die handgreepsterkte toets wat gemeet is in kg, opsitte wat gebruik is om abdominale krag te meet in 30 sek, gebuigde armhangtoets om krag in die bolyf te toets in sek, die 10x50 pendel hardlooptoets vir spoed en behendigheid in sek, die 50m naellooptoets vir spoed in sek en laastens die 1.5 myl hardlooptoets om aerobiese uithouvermoë te toets in min. Fisieke aktiwiteit is gemeet met die PAQ-C vraelys en is bepunt deur tyd in ure uit te druk.

Die resultate van die studie het aangetoon dat 14.8% van die kinders oorgewig of obees was. Daar is ook gevind dat ondergewig by die kinders voorkom, met 62.4% van die kinders wat as ondergewig geklassifiseer is. By 5.9% van die kinders is graad 1 skraalheid, en by nog 5.9% van die kinders is graad 2 skraalheid bevind, wat hulle as ondergewig geklassifiseer het. Betekenisvolle geslagsverskille ($p \leq 0.05$) is gevind vir al die antropometriese veranderlikes en indekse, behalwe vir abdomenomtrek. Betekenisvolle geslagsverskille ($p \leq 0.05$ and $p \leq 0.001$) is ook gevind vir die sit-en-reik toets, die staande verspringtoets, die flamink balanstoets, opsitte, gebuigde

armhangtoets, 10X50 “shuttle” hardlooptoets, die 50m naellooptoets en laastens die 1.5 myl hardlooptoets. Die seuns was beter as die meisies in al die fisieke fiksheidstoetse behalwe in die sit-en-reik toets en die flamink balanstoets. Die vlak van daaglikse fisieke aktiwiteit van die kinders was relatief hoog aangesien die oorgrote meerderheid van die kinders (85.2 %) skooltoe geloop het.

Beide positiewe en negatiewe korrelasies is gevind tussen die liggaamsamestelling en fisieke fiksheidstoetse wat gemeet is. Metings van liggaamsamestelling het hoog gekorreleer met mekaar ($p<0.05$). Daar is ook goeie positiewe verbande gevind tussen LMI en die korrelasies vir die staande verspringtoets, r=0.08, opsitte, r=0.01, 1.5 myl hardlooptoets, r=0.30 en die handgreepsterkte toets, r=0.26 vir die regterhand and r=0.24 vir die linkerhand. Goeie omgekeerde verbande is gevind tussen die LMI en die gebuigde armhangtoets r=-0.15. Omgekeerde korrelasies is ook waargeneem tussen persentasie liggaamsvet en die gebuigde armhangtoets r=-0.49.

Die gereelde meting van kinders van Zimbabwe word baie sterk aangemoedig. Dit sal help om die gaping wat daar in die literatuur bestaan met betrekking tot oorgewig en obesiteit by kinders te oorbrug. Die deurlopende meting van die kinders van Zimbabwe, sal ook’n toename meebring van die informasie wat beskikbaar is oor die gesondheidsverwante fiksheid, antropometrie en fisieke aktiwiteitsvlakke. Dit kan ‘n groot bydrae lewer in die verstaan van die ontwikkeling van kinders in verskeie kontekste, maar veral in die Zimbabwe konteks.

Sleutelwoorde: Kinders, fisieke fiksheid, antropometrie, liggaamssamestelling, fisieke aktiwiteit, Zimbabwe

ABBREVIATIONS AND ACRONYMS

A

AAP	American Academy of Pediatrics
ACSM	American College of Sports Medicine
AEE	Activity energy expenditure

B

BMI	Body mass index
BF%	Body fat percentage
BEE	Basal Energy Expenditure

C

CDC	Centres for Disease Control and Prevention
CRC	Convention on the Rights of the Child
CRF	Cardiorespiratory fitness

D

DLW	Doubly labelled water
DXA	Dual-energy X-ray absorptiometry

E

EE	Energy expenditure
EU	European Union

F

FMI	Fat mass index

FFMI	Fat-free mass index
G	
GZCDU	Government of Zimbabwe Curriculum development unit
I	
IDEFICS	Identification and Prevention of Dietary and Lifestyle-induced Health effects in Children and InfantS
IOTF	International Obesity Task Force
M	
MET	Metabolic Equivalents
MVPA	Moderate to Vigorous Physical Activity
N	
NCD	Noncommunicable disease
NHANES	National Health and Nutrition Examination Survey
P	
PA	Physical activity
PE	Physical Education
PES	Physical Education and Sport
PF	Physical fitness
R	
REE	Resting energy expenditure
T	
TEE	Total energy expenditure

U

UN/DESA	United Nations Department of Economic and Social Affairs
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations International Children's Emergency Fund

W

WC	Waist circumference
WHO	World Health Organisation
WHO-ECHO	World Health Organisation Commission on Ending Childhood Obesity
WHO-GSHS	World Health Organisation Global School-based Student Health Survey
WHR	Waist-to-hip ratio
WHtR	Waist-to-height ratio

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Over the past few decades the health of children has become a global concern, as a result of the childhood obesity epidemic which has plagued the world since the 1980s (Ogden *et al.*, 2007: 2087). Obesity affects children in all socioe-conomic groups (Raj & Kumar, 2010:599; Montessori Model United Nations, 2014:3-4). According to the report of the Commission on Ending Childhood Obesity, the number of obese and overweight infants and children in the world rose from 32 million in 1990 to 42 million in 2013. The figures for the African continent for the same period were 4 million and 9 million, respectively (WHO ECHO Report, 2014:1). Obesity is recognised as a medical condition which results from the accumulation of excess fat in the body, to the extent that it affects health adversely (House of Commons HC23, 2004:11-12; Anderson & Butcher, 2006:20; Mahmood, 2015:6). Children with a body mass index (BMI) equal to or exceeding the 95th BMI percentile which is specific to their ages and their genders are classified as being obese. Children with a BMI equal to the 85th but below the 95th percentiles are classified as being overweight (Raj & Kumar, 2010:598-599).

The obesity epidemic also coexists with undernutrition, which still affects some regions of the world, particularly in the developing countries and the war-torn regions of Central Africa, West Africa, North Africa, Eastern Europe, and the Middle East (UN/DESA, 2013:89). According to a report of the Save the Children Fund, the growth of one (1) in every four (4) children in the world is stunted (Save the Children, 2012:1-2) and research has shown that stunting is frequently associated with undernutrition (Kruger *et al*., 2014:2, 6). At least 2.6 million children die of malnutrition each year, a statistic which accounts for a third of the number of deaths of children throughout the world (Save the Children, 2012:1-2). Both overnutrition and undernutrition severely affect the ability of children to cope with normal daily activities, which has grave implications for their quality of life (Malina *et al*., 2011:827). Nutrition and energy balance have a decisive bearing upon body composition (Heyward & Wagner, 2004:4). Body composition, which can be described as the quantification of constituents of the body in terms of fat mass and fat free mass, is a significant measure of health. It is therefore a strong measure of being either overweight or obese (Heyward & Wagner, 2004:4).

From an epidemiological perspective, the global increase in obesity has been shown to be closely associated with the corresponding global increase in physical inactivity, among other factors

(Centres for Disease Control and Prevention (CDC), 2009:5-6; Moselakgomo *et al*., 2015:731). Other factors which contribute to childhood obesity include social factors, genetics, the role played by media in the advertising of junk food and nutritional habits, which can even include the length of time for which a baby is breastfed (Consumers International, 2004:10-13; Swana & De Lange, 2015:276-278; Mahmood, 2015:6). Physical activity is very beneficial for the overall health and development of children (Strong *et al*., 2005:736). Studies have also shown that physical inactivity and the conditions of being overweight or obese during childhood and adolescence are strongly correlated with severe health problems during adulthood (Eisenmann *et al*., 2005:50-51).

1.2 Problem statement

The problem of childhood obesity has been on the agenda of many international conferences and programmes of action and interventions have been formulated and implemented to tackle it (European Union, 2014:2, 3). However, the numbers of overweight and obese people throughout the world continue to increase each year. It is estimated that if the present trends in obesity continue, the number of obese infants and children will have reached 70 million by 2025 (WHO ECHO Report, 2014:1). Scientific research has shown that body mass index (BMI) during childhood is a strong predictor of adult obesity (Dietz, 1998:522; Hills *et al.,* 2011:866; Delisle *et al*., 2014:11). As the children of today will become the parents, the workforce, and the leaders of tomorrow, it becomes increasingly imperative that the problem of childhood obesity should be confronted vigorously and overcome, in order to secure the future of the children of the world.

Research into obesity has not been equitably distributed (WHO, 2012:41; Toriola *et al*., 2012:60; WHO ECHO Report, 2014:14; Katzmarzyk, 2014:71, 74; Manyanga *et al*., 2014:2, 7). Not all countries have benefited to the same extent from in-depth investigations of their numbers of overweight people and their levels of obesity, which has resulted in the available literature not being sufficiently comprehensive and has limited the effectiveness of the interventions which have been implemented to combat the obesity epidemic (Andreasi *et al*., 2010:501; Pangani *et al.*, 2016:4; WHO, 2016:34). Annual data and other forms of regular monitoring of levels of obesity, overnutrition, undernutrition, physical activity, and noncommunicable diseases are now readily available in the developed world, where funding is available to conduct regular national surveys and research (WHO, 2010b:7). A good example of this level of commitment could be provided by the regular British House of Commons Health Committee report on obesity, whose first volume was published in 2004 (House of Commons HC23, 2004:1).

Another relevant example could be provided by the British National Child Development Study (1958 Birth Cohort Study), which endeavoured to assess the cohort of children who were born in 1958 at various ages (Power & Elliott, 2006:34-41). This longitudinal study has provided valuable data concerning physical, educational, and social development (Power & Elliott, 2006:34-41). Of particular significance in the fight against obesity is the information which this study generated with respect to non-communicable diseases (NCDs), child development, and physical activity. The many repeated measurements which have been made concerning the 1958 cohort have included measurements of height and weight, the food frequency questionnaire, exercise habits, measurements of standing and sitting height, blood pressure, pulse, blood lipids, waist and hip circumferences, and assessments of chronic, widespread pain and depression (Power & Elliot, 2006:35-36). These repeated measurements have identified a link between childhood conditions and diseases which occur during adulthood (Power & Elliott, 2006:39). The study of the year 2000, of the 1958 cohort, which was conducted by Lake and associates was able to demonstrate a strong cause and effect relationship between chronic lower back pain in early adulthood and weight gain (Lake *et al*., 2000:248-249).

By contrast, accurate and up to date data is generally difficult to find in Africa and other developing countries (Mustapha & Sanusi, 2013:206; Muthuri *et al*., 2014:5, 20; Pangani *et al*., 2016:2), largely as a result of a lack of funding for national, provincial, and district surveys and studies. Those statistics which are available tend to be based on estimates (The Economist Intelligence Unit Limited Report on NCDs, 2014:13). Large-scale studies and national surveys are particularly scarce on the African continent. South Africa is one of the few countries in Africa which has seen increased research into childhood obesity, physical activity, nutrition, and associated problems. However, the South African studies still fall far short in terms of the amount of research which is required to accumulate sufficient data for the country as a whole. The systematic review of 2015 of studies and research which have been conducted in the domain of obesity, the nutritional status of children, and physical activity attests to this fact (Monyeki *et al.*, 2015:1170). Consequently, there is therefore a gap in the relevant available descriptive literature, not only in terms of the levels of the conditions of being overweight or obese and NCDs in populations, but also concerning other health-related concerns which affect African children (Naik & Kaneda, 2015:9). As Zimbabwe is one of the developing countries in which research concerning children has not been extensive (Makaza *et al.*, 2015:16; Naik & Kaneda, 2015:6-7; Manyanga *et al*., 2016:5, 8,14), conducting a study of Zimbabwean children should serve to make a meaningful contribution to

augmenting the amount of descriptive and correlational data which is available concerning the children of southern Africa.

Increased physical activity greatly improves the health of children. The benefits range from a significantly reduced likelihood of premature death, increased cardiorespiratory fitness, stronger bones, a reduced risk of developing non-communicable diseases (NCDs), improved mental health, and improved muscular health (Pangrazi, 2000:280; Hills *et al*., 2011:867-868). The World Health Organization recommends 30 minutes of moderate exercise 3 to 5 days a week for adults to experience health benefits (WHO, 2010a:8). It is recommended that children and adolescents should have at least 60 minutes of daily exercise (WHO, 2010a:7; WHO, 2016:21). The 21st century has seen great changes in lifestyles, which are characterised by ever-increasing numbers of people living in urban areas, not only in developed countries, but also in developing countries. Motorised modes of transport (Sarmiento *et al*., 2015:S110), increased concerns for safety, and the ever-increasing availability of electronic games are among the factors which have contributed to reduced levels of physical activity among 21st century children (Raj & Kumar, 2010:598-607; Jacobs, 2013:5; Nawab *et al*., 2014:3; Olaya-Contreras *et al*., 2015:604, 605). In Zimbabwe, urban migration, globalisation, increased use of technology, and the breakdown of the traditional family unit have resulted in drastic changes in lifestyles, with severely adverse consequences for the health of those who are affected by the changes (Manyanga *et al*., 2016:5).

Physical activity levels, among other factors, influence not only, health-related physical fitness (Pangrazi, 2000:282; Moselakgomo, 2014:15), but also body composition (Andeasi, 2010:499, 501). Consequently, the combined effect of the factors which are represented by all of these constructs are therefore important in determining the degree of health which children enjoy and also the level of risk of disease to which they are exposed. It follows that the monitoring of trends cannot be performed and the prevention of the conditions of being overweight or obese among children cannot be accomplished without also performing accurate assessments of physical activity levels and health-related physical fitness (Pangrazi, 2000:283, 284; Monyeki *et al*., 2008:316; European Union, 2014:18-20). The trend in the evaluation and quantifying of physical activity is moving increasingly towards the use of pedometers and accelerometers at present, as they provide objective numerical measurements (Beighle & Pangrazi, 2006:221; Pavlidou *et al.,* 2011:26).

However, in those instances in which resources of this sort are not available, as they are generally not in the case of Zimbabwe, an evaluation of practices and levels of physical activity can nevertheless be made through self-report questionnaires, as questionnaires are still very useful for

conducting large-scale surveys of physical activity. Many studies have been conducted using self-report physical activity questionnaires (Kowalski *et al.,* 1997:174; Gidding *et al.,* 2006:2388; Mciza *et al*., 2007:121, 122; Huang *et al.,* 2009:339; Biddle *et al.,* 2011:1; Toriola & Monyeki, 2012:795; Moselakgomo, 2014:23). Studies which have been conducted in different parts of the world have demonstrated close relationships among anthropometry, body composition, physical activity levels, and health-related physical fitness (Monyeki *et al.,* 2005:879; Eisenmann, 2007:1726-1728; Ortega *et al*., 2010:259; Mamabolo *et al*., 2011:61-64; Pahkala *et al*., 2013:74, 75; Bailey *et al*., 2014:1149-1151; Toriola *et al.,* 2015:5-7). As this study has endeavoured to investigate these concerns with respect to children in Zimbabwe, it is to be hoped that it will make a meaningful contribution to the data which is available to the scientific community in this domain of children's health.

Until about 2010 there was a tendency to exclude children from discourses concerning NCDs, as chronic lifestyle diseases were generally considered, to a large extent, to affect adults only, although clinical research has revealed that large numbers of children are also presenting with risk factors for NCDs (The NCD Alliance, 2011:4), which increases the risk of premature death in adulthood. The NCDs which affect children include cardiovascular, metabolic, endocrinal, hormonal, pulmonary, skeletal, renal, gastrointestinal, and psychosocial diseases (Hills *et al*., 2011:866). The cardiovascular diseases and disorders include hypertension, left ventricular hypertrophy, and the early onset of atherosclerosis, while the metabolic and endocrinal NCDs include insulin resistance, dyslipidemia, metabolic syndrome, Type 2 Diabetes, menstrual abnormalities, and polycystic ovarian syndrome (Daniels, 2006:49; Raj & Kumar, 2010:601; Yanovski, 2015:4-5). The pulmonary NCDs which afflict children include asthma, increased bronchial hyperactivity, and obstructive sleep apnea, while the gastrointestinal and skeletal NCDs range from non-alcoholic fatty liver disease, gallstones, hepatic fibrosis, gastroesophageal reflux, tibia vara, osteoarthritis, to slipped capital femoral epiphysis (Daniels, 2006:522). Children can also suffer from renal problems, which include increased sensitivity to sodium, decreased natriuresis and proteinuria. Like adults, children are not immune to psychosocial problems, which can range from low self-esteem, and progressive withdrawal, to chronic depression (Daniels, 2006:49; Raj & Kumar, 2010:601; Yanovski, 2015:5).

An awareness of this state of affairs prompted the United Nations, through its General Assembly and its various agencies, to highlight the magnitude of the obesity epidemic and to encourage member states to adopt appropriate strategies to combat it (The NCD Alliance, 2011:4-5). The

report of the World Health Organisation of 2012 (WHO, 2012:21) provides suggested strategies which could be implemented globally in order to facilitate the prevention of childhood obesity. The report suggests 3 levels at which the global epidemic could be tackled, namely, through government structures, population-wide policies, and community-based interventions (WHO, 2012:16-21). The global action plan of the World Health Organisation for the period between 2013 and 2020 provides further guidelines for combating obesity and reducing the prevalence of NCDs (WHO, 2013:8-13). As a member of the United Nations, Zimbabwe is expected to implement the resolutions of the various UN agencies, including those of the World Health Organisation (WHO), concerning the need to combat childhood obesity (WHO, 2004:5-8; WHO, 2008:22-27; United Nations, 2008:18-21). However, financial constraints make it very difficult and, in many instances, impossible for Zimbabwe to fulfil its obligations. The extent of the lack of resources which hinders the ability of the country to make any significant progress in this respect is illustrated by a statistic from 2012, which reveals that it was estimated that 31% of the 138 000 deaths which were recorded that year were attributable to NCDs (Zimbabwe, 2013:4; Riley & Cowan, 2014:207). Against the backdrop of this alarming finding, the report of the WHO of 2014 concerning country profiles for NCDs concluded that Zimbabwe did not have fully operational, integrated, multi-sectional policies or strategies to combat alcohol abuse and tobacco consumption, or to promote healthy diets and to maintain a fully functional surveillance system (Riley & Cowan, 2014:207).

The Institute of Medicine (IOM, 2004:1) points out that children spend most of their schooldays at school. Consequently, physical education programmes can play a vital role in the fight against childhood obesity, as they constitute the cornerstone of the physical activity programme of any progressive school (American Alliance for Health Physical Education Recreation and Dance, 2013:2; Edginton *et al.*, 2014:434-435). Physical education programmes can be effectively used to promote lifelong habits with respect to activity (Active Living Research, 2007:1-3; Erwin *et al*., 2013:322, 328-331). The necessity of making regular measurements of health-related physical fitness in schools as a component of physical education programmes and studies of childhood obesity cannot be over emphasised. Making regular measurements helps to assess the effectiveness of the physical activity programmes which are followed by the school system and also helps to provide children with goals to which they may aspire, while cultivating a lifelong love for active lifestyles (Vanhees *et al*., 2005:104; Strong *et al*., 2005:736, 737; Story *et al*., 2006:143-168; Schieffer & Thomas, 2012:155-158). Comparisons can be made within groups of children whose physical fitness is measured, and to assist teachers to formulate strategies to help individual children to improve their motor ability (Rhea & Peterson, 2012:8-10, 12-13). In many developed

countries, regular assessments of the health-related physical fitness of children are integrated into the physical education programmes of schools (Cvejic *et al*., 2013:136, 138-141).

Zimbabwe has reached a point of transition in terms of both Physical Education and physical activity (Manyanga *et al*., 2016a:S341). A new curriculum for Physical Education was introduced in 2017, which is intended to remain in use until 2022. The new curriculum consists of four syllabi, which cater for the needs of learners at different levels, namely, infant school, junior school, secondary school and mass displays (Government of Zimbabwe Curriculum Development Unit (GZCDU), 2015a; GZCDU, 2015b; GZCDU, 2015c). The new curriculum makes Physical Education an examinable subject at both the primary and secondary school levels. Physical Education has been part of the Zimbabwean school curriculum since independence. It replaced the subject which was known as Physical Training (PT), which had been introduced into the curriculum of Southern Rhodesia after the Second World War (Mudekunye & Sithole, 2012:714). The subject has not always been diligently taught, as in some cases it was not accorded the same value as subjects such as English, mathematics, and science (Mudekunye & Sithole, 2012:714). At present there is no mechanism in place to ensure that Physical Education is taught during the school periods which are allocated to the subject (Manyanga *et al*., 2016b:19). The perception of Physical Education as an unimportant, non-academic subject has been witnessed in other parts of the world (Active Living Research, 2007:1; De Ridder & Coetzee, 2013:241-245; Monyeki, 2014:335).

At present Zimbabwe lags behind most other countries in many areas of research, including research into childhood obesity, as a result of a lack of funding, among other factors. The lack of funding greatly affects the availability of published research, to the extent that studies which had been conducted specifically concerning Zimbabwean children between the ages of 10 and 12 years could not be found. The unavailability of baseline data concerning Zimbabwean children necessitated the conducting of the Healthy Kids Nutrition and Physical Activity: Zimbabwe Baseline Survey of 2014 (Makaza *et al.*, 2015:9). As no earlier extensive studies had been conducted and owing to the lack of funding for conducting research into the health of the population in Zimbabwe, it was deemed to be of crucial importance to adopt a three-pronged approach to the survey, in order to maximise the benefits which could be derived from the opportunity to gather the much-needed data. The three pronged approach entailed administering a questionnaire to determine levels of nutritional knowledge and physical activity, taking anthropometric measurements, and making assessments of the physical fitness of the children. The

variety of data which was collected provided an opportunity to assess a range of different facets of the nutritional and physical fitness status of children in Zimbabwe. This research study has drawn on the data which was collected by the Healthy Kids Nutrition and Physical Activity: Zimbabwe Baseline Survey, in order to answer the following research questions:

- What are the health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children aged 10-12 years old?

- What is the relationship between body composition, physical fitness and levels of physical activity for Zimbabwean children aged 10-12 years old?

The findings of this study of Zimbabwean children should be of great significance to the scientific community, as they should alleviate the present paucity of descriptive and correlational data concerning the children in southern Africa. The study should also be significant for its ability to provide eloquent testimony to the benefits of physical education and the necessity of regular health-related physical fitness assessments of children in Zimbabwe. The evaluation of habits and practices pertaining to physical activity, through the use of both objective and subjective methods within the school system, has the potential to provide a useful basis for commencing meaningful discussions, both in the classroom and among educationists as well as those who are tasked with drafting policy, concerning the value of physical activity for children. Lifelong active healthy lifestyles would significantly reduce levels of being overweight and obese, and incidences of related NCDs, which would, in turn, reduce the great social and financial burden which is imposed by NCDs on an impoverished economy. As the study made use of data which had been collected in school settings, its findings are of great relevance to the promotion of the new physical education curriculum. They should benefit Zimbabwean schoolchildren by providing data which can be used to improve the teaching of Physical Education. The study should contribute to an increased awareness of the need to increase levels of physical activity among schoolchildren, in order to improve their health, which should provide long-term benefits for the population as a whole.

1.3 Objectives of the study

The two principal objectives of the study were:

- To determine the health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children aged 10 –12 years old.

- To determine the relationship between body composition physical fitness and levels of physical activity of Zimbabwean children aged 10 –12 years old.

1.4 Hypotheses

The research study was based upon the following hypotheses:

- Significant differences in health-related physical fitness and levels of physical activity will be found for Zimbabwean children aged 10 –12 years old.

- A significant negative relationship will be found between levels of physical activity and the body composition for Zimbabwean children aged 10 –12 years old.

1.5 Structure of the dissertation

The dissertation is submitted in an article format as approved by the North-West University senate in the following format:

CHAPTER 1: This chapter consists of the introduction, the problem statement and objectives. The NWU Harvard guidelines will be used for referencing.

CHAPTER 2: Health-related physical fitness, body composition and physical activity during childhood – a literature review. All citations and references are presented according to the NWU Harvard guidelines.

CHAPTER 3 (ARTICLE 1): Health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children aged 10 –12 years old. This article will be submitted for publication to the *International Journal of Environmental Research and Public Health.* The referencing style used will be that of the journal.

CHAPTER 4 (ARTICLE 2): The relationship between body composition, physical fitness and the levels of physical activity of Zimbabwean children aged 10 –12 years old. This article will be submitted for publication to the *African Journal for Physical Activity and Health Sciences.* The referencing style used will be that required by the journal.

CHAPTER 5: This will be the final chapter providing the summary, conclusions, limitations and recommendations of the study. All citations and references are presented according to the NWU Harvard guidelines.

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CHAPTER 2
HEALTH-RELATED PHYSICAL FITNESS, BODY COMPOSITION AND PHYSICAL ACTIVITY DURING CHILDHOOD

2.1 Introduction

The reduction and prevention of childhood obesity is currently one of the highest priorities for the world (European Union, EU, 2014:2). Overweight and obesity have been conclusively shown to exert a severely negative influence upon the lives and health of children and young people throughout the world. Prevention and reduction have become crucial imperatives. In order to achieve these objectives, it is necessary to investigate contemporary trends concerning overweight and obese children in relation to their physical activity levels and health-related physical fitness. As physical inactivity has been ranked as the fourth leading cause of premature death throughout the world (Kohl *et al*., 2012:294, 300), its eradication holds the key to improving the health and quality of life of both children and adults.

Health-related physical fitness, body composition and physical activity can be used to paint a picture of the status of the health of individual people or specific groups. An assessment of body composition, which would include the measurement of adiposity, is a significant indicator of being either overweight or obese. By contrast, physical fitness is considered to represent an equally significant marker of health (Ortega *et al*., 2008:8). Regular assessment of these parameters in populations is crucial to gaining an accurate understanding and assessment of trends pertaining to overweight and obesity. In this chapter the topic is investigated by providing a systematic overview and analysis of the literature which is available concerning overweight and obesity, health-related physical fitness, body composition, including anthropometric characteristics, as well as physical activity in childhood. The chapter also endeavours to provide a comprehensive overview of contemporary trends throughout the world concerning the prevalence, measurement and status of overweight and obesity, and also to assess and evaluate the solutions which are being sought, at present, to remedy the situation. The literature review commences by investigating the research topic from a broad perspective, before narrowing its focus to Zimbabwe.

2.2 Childhood obesity

Childhood obesity is usually defined as the accumulation of excess body fat (Anderson & Butcher, 2006:20). Childhood overweight is described as having a weight that is above the weight defined by reference standards for percentiles for a specific age and gender (Anderson & Butcher, 2006:20;

Ogden *et al*., 2010:243; Raj & Kumar, 2010:598).The reference standards which are measurements of BMI which are used to determine cut-off points for children, were arrived at through the combination of an anthropometric indicator, a reference population and the establishment of cut-points (WHO, 2006:229; Cole *et al*., 2000:1-2; De Onis & Lobstein, 2010:458-459). Children who have BMI scores which are greater than or equal to the 95th percentile for their specific genders and ages are generally defined as being obese. Those who have BMI scores which are greater than the 85th percentile and lower than the 95th percentile are classified as being overweight (Dietz & Bellizzi, 1999:123S, 125S). At present three normograms are in use for determining overweight and obesity in children and adolescents, namely, the normograms of the World Health Organisation (WHO, 2006:238, 244), the International Obesity Task Force (IOTF) (Cole *et al*., 2000:3; Cole *et al*., 2007:3-4) and the Centres for Disease Control (Kuczmarski *et al*., 2002:1-103). These normograms yield different results in terms of the levels of being overweight and obesity which they detect (Cole *et al*., 2000:4-6; Lobstein *et al*., 2004:13-15; Shields & Tremblay, 2010:267-269; De Onis & Lobstein, 2010:458). Shields and Tremblay, 2010:272 found in their study of Canadian children that although increases in obesity appeared to be more pronounced when they used the cut off-points of the IOTF, the percentage point increases were similar for the three normogorams. Despite the apparent differences in cut-points for being overweight and obesity, empirical research reveals unequivocally that the prevalences of overweight and obese children represent a grave public health concern (WHO-Europe, 2007:8; Raj & Kumar, 2010:599, 604; Shields & Tremblay, 2010:272-273; Wang *et al*., 2011:816-817; Gebremedhin, 2015:6). The high prevalences of overweight and obesity are also the cause of a myriad problems in relation to public health (Raj & Kumar, 2010:604; Yanovski, 2015:4), which are associated mainly with the costs which accompany high incidences of non-communicable chronic diseases (Finkelstein, 2012:570).

2.2.1 Children's health and obesity

The World Health Organization defines health as total well-being, a term which has physical, mental and social implications (WHO, 2014:1). The period of childhood and adolescence is a very important period, since growth events and experiences during this period will inevitably exert a profound influence upon the remainder of his or her life (Ebbeling *et al*., 2002:473). In the past, traditional wisdom in many cultures and societies tended to hold that fat children were healthy. However, research has debunked this myth and demonstrated conclusively that obesity during childhood not only exposes people to a very high risk of developing many chronic diseases in

adulthood, but also increases the likelihood of suffering from ill health during childhood itself (Ebbeling *et al*., 2002:473). Research also indicates convincingly that once both children and adults become obese, the process is very difficult to reverse or overcome (Dietz, 1998:522; De Onis & Lobstein, 2010:458). As complications which result from obesity may manifest themselves only in later life (Lee, 2009:76), it is often difficult to determine the exact point at which an overweight or obese child starts suffering the effects. Lee (2009:75-76) pointed out that children were already presenting with symptoms of chronic diseases that were previously associated only with adults. The obesity-related diseases include cardiovascular, orthopaedic, neurological, pulmonary, renal, gastrointestinal, endocrinal, and psychosocial diseases and disorders (Daniels *et al*., 2009:e490; Gupta *et al*., 2012:58-60).

Empirical studies have demonstrated the prevalence of metabolic syndrome among children and adolescents and cogent arguments have been advanced for obesity to be ranked as the most debilitating metabolic disease in the world (De Ridder & Coetzee, 2013:239). Metabolic syndrome has been described as entailing a cluster of risk factors which increase the risk of Type 2 Diabetes and cardiovascular disease. The cluster includes hypertension, glucose intolerance, abdominal obesity, and dyslipidaemia (Raj & Kumar, 2010:600; Gupta *et al*., 2012:58). In two studies (Kim *et al*., 2007:113; Park *et al*., 2009:531) it was found that there had been an increase in the prevalence of metabolic syndrome among Korean children between the ages of 2 and 19 years during the period between 1998 and 2001. The findings of the studies indicated increases in the prevalences of metabolic syndrome from 6.8% to 9.2% and 2.2% to 3.6%, respectively. Interestingly Park and associates reported a decrease in prevalence of metabolic syndrome to 1.8% among the boys and girls for the year 2005.This decrease occured although there had been a rise in the numbers of obese children during the period (Park *et al*., 2009:531). This finding could be explained by the increase in the number of children who participated in exercise during the period which had been covered by the studies (Park *et al*., 2009:232).

A strong correlation was found between hypertension and high BMI or obesity in three studies (Nielsen & Andersen, 2003:233; Agyemang *et al*., 2005:4; Salman *et al*., 2011:2-3), which served to confirm that being overweight or obese severely undermines the health of children. In addition, scientific studies of obese and non-obese children have revealed a strong link between childhood obesity generated cardiovascular disease risk factors and the development of early endothelial dysfunction and increased arterial stiffness (Zhu *et al*., 2005:339-340; Peña *et al*., 2006:4468-4469; Skilton & Celermajer, 2006:1042-1043). Evidence also suggests that obesity exerts a

negative influence upon the cognitive and motor development of children (Camargos *et al*., 2016:412-413). Close association between childhood obesity and the prevalence of other conditions and diseases has also been observed in the following studies conducted by (Papoutsakis *et al.*, 2013:91-92; Wearing *et al*., 2006:244; Minges *et al*., 2017:77), namely, in relation to asthma, musculoskeletal diseases, and psychosocial disorders, respectively.

2.2.2 Global trends in childhood obesity

According to a report of the Commission on Ending Childhood Obesity, in 2014, an estimated 41 million of the children in the world under the age of 5 years were either overweight or obese (WHO, 2016:9). Africa accounted for 10.3 million of these children, thereby accounting for 25% of the overweight or obese children under the age of five in the world (WHO, 2016:9). The global trend in obesity is pointing to a sharp rise in the numbers of overweight and obese children and adolescents (Lobstein *et al.,* 2015:2510; Neil, 2016:5; UNICEF, WHO & World Bank Group, 2017:7). In a study which was conducted by Ng *et al*. (2014:770), it was established that the worldwide rates of childhood obesity increased by 47.1% between 1980 and 2013. The number of overweight and obese children and adults increased from 857 million in 1980 to 2.1 billion in 2013 (Ng *et al*., 2014:770). In order to appreciate the implications of the trends in the rise of childhood overweight and obesity among the world's children, it is necessary to examine the data which has been provided by organisations such as the World Health Organisation (WHO), in conjunction with that which has been provided by individual studies which have been conducted in different parts of the world. **Table 2-1** represents surveys and studies of the global, regional and national trends in childhood obesity, which are discussed from sections **2.2.2** to **2.2.5** of this chapter.

Europe has been one of the regions at the forefront in the monitoring of childhood overweight and obesity. Well organised systems for surveillance at both the national and regional levels have been in place for several decades (Lifestyle Statistics Team/Health and Social Care Information Centre-hscic, 2014:19; Brug, 2007:2). By 2007, data sets for prevalence were already available for 46 of 52 countries in the European region (WHO Europe, 2007:3). An increase in the prevalence of overweight and obesity has been observed (Stratton *et al*., 2007:1175). However Rokholm *et al*. (2010:441) concluded, after evaluating the findings of 52 international studies that there appeared to be a stabilisation in rates of obesity, not only in Europe, but also in Australia, Russia, the USA and Japan. Rokholm and colleagues also observed that while a degree of stabilisation of rates appeared to be taking place, there were actually areas such as China and Vietnam where dramatic

increases in numbers of overweight and obese children were discernible (Rokholm *et al*. 2010:441).

Data from the large 2007-2010 IDEFICS (Identification and prevention of Dietary and Lifestyle-induced health Effects in Children and InfantS) study of children between the ages of 2.0 and 9.9 years, from eight European countries, generated a mean prevalence of overweight children of 21.1% for girls and 18.6% for boys (Ahrens *et al*., 2014:S103). The countries which participated in the study were Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain and Sweden (Ahrens *et al*., 2014:S100). A more recent study of European data collected between 1980 and 2013, found an increase in the prevalence of overweight and obesity of 23.8% and 22.6% over the period for boys and girls aged under 20 years old respectively. It was observed however that the means for the individual countries ranged from 15.9% in Andorra to 33.7% in Greece for the boys under 20 years (Ng *et al.*, 2014:775). The differences in the prevalence in the various European countries could be attributed to diversity in local socio-economic circumstances, including varying proportions of non-native populations (Ahrens *et al*., 2014:S104).

National health surveys to monitor rates of overweight and obesity and other health indicators have been conducted in the United States and Canada for decades. In the United States the 2012 statistical report of Ogden and associates examined trends in childhood obesity for the period 2003-2004 through 2010-2012. Their report was based upon data which had been generated from the National Health and Nutrition Examination Survey (NHANES). The study found a decrease in the rate of obesity for children aged 2-5 years from 14% in the 2003-2004 period to 8% in the 2010-2012 period (Ogden *et al*., 2014:6, 7). Using the CDC cut-off points for overweight and obesity the study by Skinner and Skelton (2014:565) established that 32.2% of the American children aged 2-19 years were overweight during the period 2011-2012. The findings of the study also indicated that 17.3% of the children were obese, while 5.9% and 2.1% fell into the Class 2 and Class 3 obesity categories, respectively. Another study conducted by Ogden *et al*., (2012:484) examined trends in childhood BMI, using United States national data for six survey periods from 1999-2010. A significant increase in rates of childhood obesity were observed among 6-11year old boys, rising from 17.9% for the 1999-2000 period to 18.3% for the 2009-2010 period (Ogden *et al*., 2012:489).

Table 2-1: Global trends pertaining to overweight and obese children and adolescents

Country or Region	Year data collected	Age/Gender: B-boys G-girls	Sample size	Overweight & obesity %	Underweight %	Overweight %	Obesity %	Standard WHO,IOTF, CDC, Cole	Source
Global (Developed)	1980	2-19 B & G		16.9 B; 16.2 G				IOTF	Ng *et al.*, 2014
	2013	2-19 B & G		23.8 B; 22.6 G					Ng *et al.*, 2014
Global (Developing)	1980	2-19 B & G		8.1 B; 8.4 G				IOTF	Ng *et al.*, 2014
	2013	2-19 B & G		12.9 B; 13.4 G					Ng *et al.*, 2014
Canada	2004/2005	3-19 B & G	9000			30.7		WHO	Rodd & Sharma, 2016
	2004	2-17	8661			34.7			Shields & Tremblay, 2010
	2009-2011	3-19 B & G	2578			28.2		WHO	Rodd & Sharma, 2016
	2012/2013	3-19 G & G	2460			27.0		WHO	Rodd & Sharma, 2016
Europe	2007-2010	2-9.9 B	9331	18.6				Cole's Ref	Ahrens *et al*., 2014
		2-9.9 G	9170	21.1				Cole's Ref	Ahrens,*et al*., 2014
E Europe & C Asia	1999-2011	15-18 G rural	4051		11.0	8.0		IOTF	Jaacks *et al*., 2015
		15-18 G	3680		13.0	9.0		IOTF	Jaacks *et al*., 2015
England	2007	5-17 B		22.7				IOTF	Wang & Lim, 2012
		5-17 G		26.6					Wang & Lim, 2012
Ireland	2012-2014	8-11 B & G	1068	25		20	5		Keane *et al*.,2014
UK (Liverpool)	1998-1999	9-11 B	1431	14.8				IOTF	Stratton *et al*., 2007
UK (Liverpool)	2003-2004	9-11B	763	26.3				IOTF	Sratton *et al*., 2007
United States	1971-1974	2-19 B					5,2		Fryar *et al.*, 2012
		2-19 G					5.0		Fryar *et al.*, 2012
	1988-1994	2-19 B					10.2		Fryar *et al.*, 2012
		2-19					9.8		Fryar *et al.*, 2012
	1999-2000	2-19 B					14.8		Fryar *et al.*, 2012
		2-19G					14.8		Fryar *et al.*, 2012
	2009-2010	2-19 B & G	4111				16.9		Ogden *et al*., 2012
	2011-2012	2-19 B & G					17.2		Ogden *et al*., 2015
	1999-2012	2-19 B & G	26 690			31.2	16.4	NHANES	Skinner & Skelton, 2014
	2013-2014	2-19 B & G					20.6		Ogden *et al*., 2016
Australia	1985	7-15 B & G				10.0	1.7		Magarey *et al*., 2001
	1995	5-17 B & G				15.0	5.2		N H S,
	2007-2008	5-14 B & G	2 788 232	23.0		17.0	6.0	Cole's Ref	Australian Ins., 2012
(Pooled population)	2008	2-18 B & G	264 905				5.3 B 5.9G	Various	Olds *et al*., 2010
	2011-2012	5-14 B & G	716000			19	7.		Australian Ins.,2014
New Zealand	1989	11-12 B & G	871			11.0		Cole's Ref	Turnbull *et al*., 2004
	2000	11-12 B & G	894			20.9		Cole's Ref	Turnbull *et al*., 2004
	2006-2007	2-14 B & G					8.0	WHO	MOH, 2012
	2011-2012	2-14 B & G	90700		4.0	21.0	10.0	WHO	MOH, 2012

Country or Region	Year data collected	Age/Gender B-boys G-girls	Sample size	Overweight & Obesity %	Underweight %	Overweight %	Obesity %	Standard WHO,IOTF, CDC, Cole	Source
China	2002	7-12 B & G	8861			4.1	2.5		Li *et al.*, 2008
	2005	7-18 B & G	226602			14.9 B &8.9 G			Ji *et al.*, 2009
	1985-2010	7-18 B & G-	1280239				0.10 (1985)	WHO	Song *et al*., 2016
		7-18 B & G-					4.3 (2010)		Song *et al*., 2016
	2013	5-14	67956	17.85			3.7		He *et al*.,2014
Japan	1979-1981	6-11 B & G	270720				5.0	Japanese	Yoshinaga *et al*., 2010
Pacific Islands	2010-2011	13-16 B& G	10424	24.3					Pengpid & Peltzer, 2015
India	2005-2006	<5	46 655				1.5	WHO	Gupta *et al.*, 2012
	2009-2010	6-15 B & G	1634			21.9	7.5	CDC	Cherian, 2012
	2013-2014	12-15 B & G	1721			26.9	8.7		Kumar & Faisal, 2015
Bangladesh	2009	6-15 B & G	10135		17.6	9.5	3.5		Balbul & Hoque, 2014
Latin America	1999-2011	15-18 G			11	24		IOTF	Jaacks *et al.*, 2015
Brazil	2004-2005	7-9 B & G	2913			15.4	7.8	IOTF	Pelegrini *et al*.,2010
	2005	7-10 B & G		22.1		16.6	5.5	IOTF	de Assis *et al*., 2005
Argentina	2012	13-15 B & G	28368			22.8	5.9	WHO	Galante *et al*.,2016
	2010	10-11 B & G	1588	27.9				IOTF	Kovalskys *et al*., 2011
Mexico	2006	2-19 B		28.4B &27.3G				CDC	Wang & Lim. 2012
Chile	2002	6 B & G		28.6B & 27.1G				IOTF	Wang & Lim. 2012
ASEAN Countries	2007-2013	13-15 B & G	30 284	9.9				Cole	Pengpid & Peltzer, 2016
Middle East-Iran	1995-1999	2-18 B & G	Pooled			10.43	5.13	Various	Kelishadi *et al*., 2014
	2000-2004	2-18 B & G	Pooled			11.25	6.14		Kelishadi *et al*., 2014
	2012-2013	6-12 B & G	2195 B & G			11.5	8.2		Karimi & Ghorbani, 2015
	2005-2010	2-18 B & G				10.88	7.25	Various	Kelishadi *et al*., 2014
Bahrain	2000	12-17 B	249				21	WHO	Al-Sendi *et al*., 2003
		12-17B	257				35	WHO	Al-Sendi *et al*., 2003
	2008	15-18 B	336	29.5		15.8	13.7		Bader *et al*., 2008
		15-18 G	396	36.8		17.4	19.4		Bader *et al*., 2008
Algeria	2010-2011	15-18 B	194			9.3	4.1	IOTF	Musaiger *et al*., 2012
		15-18 G	265			15.5	4.5		
Jordan	2010-2011	15-18 B	462			21.6	10.2	IOTF	Musaiger *et al*., 2012
		15-18 G	475			17.5	4.6		
Kuwait	1999-2000	10-14 B	7205			30.0	14.7		Al-Isa, 2004
		10-14 G	7454			31.8	13.1		
	2006	10-14 B	2657	44.2		29.3	14.9		El-Bayoumy *et al*., 2009
		10-14 G	2745	46.3		32.1	14.2		
	2010-2011	15-18 B	273			25.6	34.8	IOTF	Musaiger *et al*., 2012
		15-18 G	355			20.8	20.6		
Libya	2010-2011	15-18 B	280			16.4	9.6	IOTF	Musaiger *et al*., 2012
		15-18 G	350			26.6	10.0		

Country or Region	Year data collected	Age/Gender B-boys G-girls	Sample size	Overweight & Obesity %	Underweight %	Overweight %	Obesity %	Standard WHO, IOTF CDC, Cole	Source
Palestine	2010-2011	15-18 B	220			12.7	5.0	IOTF	Musaiger *et al*., 2012
		15-18 G	257			12.5	3.5		
Syria	2010-2011	15-18 B	549			20.3	6.7	IOTF	Musaiger *et al*., 2012
		15-18 G	513			20.1	5.3		
Saudi Arabia	1998	12-18 B	2766	20.3		14.5	5.8	Cole's Ref	El-Hazmi *et al*., 2002
		12-18 G	3076	22.5		15.6	6.9		
	2010	2-18 B & G	12852			19.0	23.0		Al-Dossary *et al*., 2010
	2010	5-18 B & G	19317			23.1	9.3		El Mouzan *et al*., 2010
United A. Emirates	2010-2011	15-18 B	262			16.8	19.1	IOTF	Musaiger *et al*., 2012
		15-18 G	243			13.6	6.6		
Sub-Saharan Africa	1999-2	15-18 G			15.0 Urban	11.0 Urban		IOTF	Jaacks *et al*., 2015
	2000	0-5 B & G	5100000			4.4		WHO	UNICEF,WHO, 2017
	1948-2013	5-17 B & G	190149	10.6			2.5	IOTF/Others	Muthuri *et al*., 2014a
	2016	0-5 B & G	6400000			3.9		WHO	UNICEF,WHO, 2017
Sudan		10-18 B & G	1138	20.5	13.9	10.8	9.7	WHO	Nagwa *et al*., 2011
Nigeria		13-18 B & G	718			0.84	1.98	WHO	Yusuf *et al*., 2013
		10-19 B & G	500			7.5	2.1	IOTF, WHO	Ani *et al*., 2014
Nigeria		10-19 B & G	2 031		16.35	5.76	1.13		Mustapha & Sanusi, 2013
Ethiopia	2012	14-22 B & G	791	5.9		10.1	1.6	CDC	Gebregergs *et al*., 2013
Ethiopia	2012-2013	15-19 B & G	800	9.4		8.6	0.8	CDC	Alemu *et al*., 2014
Southern African-R	2016	0-5 B & G	700000			11.8		WHO	UNICEF,WHO, 2017
South Africa	1999	1-9 B & G	2894			12.1	5.0	IOTF	Steyn *et al*., 2005
	2002	13-19 B & G	9522			16.4	3.5	Cole, IOTF	Reddy *et al*., 2012
	2001-2004	6-13 B & G	10 195			10.9 B	2.4 B	IOTF	Armstrong *et al*., 2006
						17.5 G	4.8 G	IOTF	Armstrong *et al*., 2006
	2005	15 B	773		20.3	5.4	2.5	WHO, Cole	Ginsburg *et al*.,2013
		15 G	840		9.6	17.5	7.5		Ginsburg *et al*.,2013
	2007	13-19.B	547	4.0				IOTF, NCHS	Kimani-Murage *et al*., 2010
	2007	13-19G	576	16.0				IOTF, NCHS	Kimani-Murage *et al*., 2010
	2008	14-19 B & G	9371			20.2	5.5	Col, IOTF	Reddy *et al*., 2012
	2010	10-16 B & G	1172		5.2	11.0	4.4	CDC, BMI	Toriola *et al*., 2012
North Africa (R)	1999-2011	15-18G rural			4.0	41.0		IOTF	Jaacks *et al*., 2015
		15-18G urban			5.0	36.0			
Algeria	2001	6-10 B & G	19263	6.8					Oulamara *et al*., 2009
Zimbabwe	2010-2011	0-5	4405	8.5		5.5	3.0	WHO	Gebremedhin, 2015
	2013	3-5	320			5.1	1.9	WHO	Mushonga *et al*., 2014

Key: Pvt Sc-private school, Pub Sc-public school, B- boy, G-girl, R-region, CDC-Centres for Disease Control, IOTF-International Obesity Task Force, WHO-World Health Organisation, E. Europe-Eastern Europe, C. Asia-Central Asia, UK-United Kingdom

A number of empirical studies have indicated that there have been significant increases in the numbers of overweight and obese children in many countries in the Middle East (Mirmiran *et al*., 2010:1024; Stott *et al*., 2013:151). The region appears to have some of the highest rates in childhood obesity in the world. Studies have found high rates of prevalence of both overweight and obesity as illustrated in **Table 2-1**. Examples of such findings include studies by Al-Sendi *et al*. (2003:473), El-Bayoumy *et al*. (2009:155), Al-Dossary *et al*. (2010:1005), and Musaiger *et al*. (2012:1924). The combined findings of these studies revealed that rates of prevalence overweight and obesity ranged from 10.43% to 46.3% among the Arabic-speaking countries. The high rates of overweight and obesity can be explained by the finding that the Middle East has the highest dietary energy surplus among developing countries (Mirmiran *et al*., 2010:1010) and has also witnessed a significant decrease in levels of physical activity (Mirmiran *et al*., 2010:1014).

A study of eight Asian countries found an average prevalence of overweight or obesity of 9.9% for children aged 13-15 years old (Pengpid & Peltzer, 2016:252). The eight countries were Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Thailand, the Philippines and Vietnam. The rates of prevalence of overweight and obesity in six of the countries were higher among boys than girls, with the exception of Cambodia and Myanmar, where rates were higher among girls. The overall rates of prevalence of overweight and obesity for the region were 11.5% for girls and 8.3% for boys (Pengpid & Peltzer, 2016:252). A particularly high rate of 36.1% was found in Brunei Darussalam (Pengpid & Peltzer, 2016:252). The strength of the study of Pengpid and Peltzer (2016) lies in its use of nationally representative data, which had been collected using the standardised global school-based student health survey protocols of the WHO, which enabled valid comparisons across the eight countries to be made (WHO-GSHS, 2013). The inherent weakness in the study however just as in the Manyanga *et al.*, (2014:6), which study discussed in section (**2.2.3**) below, was the use of self-reported data for measurements of weight and height. Self-reported data pertaining to parameters such as weight and height tends to be prone to bias (Ezzati *et al*., 2006:251, 254). It can be argued however that the WHO protocols provide a very useful module which can be applied throughout the world and provides a straight forward method of collecting useful data to track international trends pertaining to overweight and obesity (WHO-GSHS, 2013). The findings of a Vietnamese study of rural and urban preschool children in 2015, in which objective measurement was used, revealed rates of prevalence which were higher than those which were found in the study of Pengpid and Peltzer (2016:252). The Vietnamese study found a combined

rate of prevalence of 14.5% for boys and girls. The rate of prevalence among rural preschool children was 7.6%, while it was significantly higher at 21.1% among their urban counterparts (Do *et al*., 2015:7). Although for both groups the rates were higher than the national average of 5.6%, the dramatically higher rate for urban pre-schoolers is in line with results found in other studies.

Australia and New Zealand like other high income countries have been monitoring trends in overweight and obesity (Swinburn & Wood, 2013:60). A study by Olds *et al*. (2010:60) concluded after examining 41 datasets that there had been a sharp increase in obesity from 1985 to the late 1990s, which had been followed by a plateau in the rates of increase. The rates for the prevalence of obesity rose from 1% in 1985 to 5.4% in 1996 among the boys aged 2-18 years while the rates increased from 0.8% to 5.7% among the girls over the same period. The combined rates of obesity for the girls and boys were 11.2% in 2008 (Olds *et al*., 2010:60) but had dropped to 7.4% in the 2011-2012 period (Magarey, 2001:563). Although the rates of prevalence appear to have stabilised, the numbers of children who were affected in real terms remained unacceptably high. The Australian Institute of Health and Welfare estimated that one in four children aged 5-17 (translating to 1 million) were overweight or obese during the 2014-2015 period (Australian Institute of Health and Welfare, 2016:1). In New Zealand there was an estimated increase in the incidence of overweight children between the ages of 11 and 12 years, from 11.0% in 1989 to 20.9% in 2000 (Turnbull *et al*., 2004). The Ministry of Health report for 2011-2012 revealed that there appeared to be a stabilisation in the rate for overweight children, which was found to be 21% among boys and girls between the ages of 2 and 14 years. The combined rate of obesity was found to be 10% (Ministry of Health, 2012). Empirical studies in both Australia and New Zealand have shown that levels of overweight and obesity tend to be particularly high among members of indigenous populations (Obesity Working Group, 2009:6; Ministry of Health, 2012:25, 26). This finding can be explained by the tendency for indigenous populations to be relegated to the lower socio-economic groups, which research has consistently found to be particularly vulnerable to becoming overweight or obese (Rokholm *et al*., 2010:840-841; Pavela *et al*., 2016:134).

2.2.3 Prevalence of childhood obesity in Africa

On the African continent empirical research has shown that the issue of childhood overweight and obesity is no longer a problem of only the developed or First World countries, but that it also ravages developing countries (Ebbeling *et al*., 2002:478; Gupta *et al*., 2012:64). Although

the studies in many African countries have indicated that rates of prevalence of overweight and obesity that were lower than those in some developed countries, the rates of increase however appeared to be higher in the developing world (WHO, 2016:4, 9).

In a systematic review conducted by Muthuri and associates of 283 African studies from 1964-2013, it was concluded that there had been an upward rise in overweight and obesity in school-aged children in sub-Saharan Africa (Muthuri *et al*., 2014a:19). The weighted average rates for overweight and obesity for the consolidated population of boys and girls were found to be 10.6% and 2.5%, respectively (Muthuri *et al*., 2014a:14). In most of the studies which were included, the International Obesity Task Force (IOTF) standards were used, which helped to offset any possible suggestion that the use of different sets of standards would introduce an element of inconsistency to the averages which the systematic review generated (Muthuri *et al*., 2014a:5, 19). The standards are established measurements which are used to classify levels of overweight and obesity which are applicable to different populations of children (Shields & Trembley, 2010:272; Muthuri *et al*., 2014a:5, 19). Consequently, the findings of the systematic review provide a valid evaluation of trends pertaining to overweight and obesity despite the apparent limitations which could appear to be inherent in a study in which findings have been obtained by applying different sets of standards for the measurements which were taken.

The findings of individual studies which were conducted in Africa revealed significant differences in the prevalence of overweight and obesity in children and adolescents. In a comparative study of data from seven African countries, namely, Benin, Djibouti, Eygpt, Ghana, Mauritania, Malawi and Morocco, it was found that rates for overweight ranged between 8.7% and 31.4%, while those for obesity ranged from 0.6% to 9.3%. The children were aged 13-17 years (Manyanga *et al*., 2014:7). In Ethiopia, abnormally low rates of 5.4% were found for overweight and 0.5% for obesity (Gebregergs *et al*., 2013:3). In a study which was conducted by Wolde and Belachew (2014:53), the prevalance of overweight among Ethiopian children was 7.3% and 3.4% for obesity. By contrast, the findings of a study in Sudan yielded rates of 10.8% for the prevalence of overweight and 9.7% for obesity among 10-18 year old children (Nagwa *et al.*, 2011:410). A number of studies in West Africa found varying rates for overweight and obesity. One of the studies found 8.6% for overweight and 1% for obesity (Abah *et al*., 2012:54), while a study by Musa *et al.* (2012:1372) yielded rates of 12.4% and 2.3%, respectively. Mustapha and Sanusi found rates of 5.76% and 1.13%, respectively, in their research sample in 2013. The mean age was 14.28 years (Mustapha & Sanusi, 2013:208).

Prevalence rates of 12.4% and 1.9 % (Wamba *et al*., 2013:5) and 6.8% and 5.45% (Kumah *et al*., 2015:2) were reported for overweight and obesity respectively, in Cameroon. Participants were aged 8-20 years (Wamba *et al*., 2013:5; Kumah *et al*., 2015:2).

Empirical studies to assess prevalence of overweight and obesity are particularly scarce in southern Africa, apart from South Africa, where numerous studies have been conducted. In South Africa a wide range of statistics for overweight and obesity were reported. Reddy and associates found rates of 16.9% and 4%, for overweight and obesity respectively (Reddy *et al*., 2008:205-206), while Toriola *et al.* (2012:59) reported 11% for overweight and 4.4% for obesity in girls aged 10-16 years. Other South African studies found varying prevalence rates of overweight and obesity such as 10.2% and 3.2% among white boys 6-13 years (Armstrong *et al*., 2006:441) and 9% and 3.8 % for girls (Tathiah *et al*., 2013:720) respectively. Higher overweight and obesity prevalence rates of 11.2% and 4.8% among 13-18 year old learners Van Niekerk *et al*. (2014:22) and 20.2% and 5.5% among 14-19 year old boys and girls Reddy *et al*. (2012:264) were also found for South Africa. Scholars have argued that South Africa has one of the highest levels of obesity on the African continent. Gebremedhin (2015) conducted a study of rates of prevalence among children between the ages of 0 and 59 months in other Southern African countries. In his study, Gebremedhin found overweight and obesity rates that were below 10% for the different countries. Zambia had overweight and obesity rates of 5.4% and 3.4%, respectively, while those for Malawi were 8.7% and 5.8%. Even lower rates of prevalence of overweight and obesity were also found in Mozambique 7.7% and 4.2% and Namibia 3.7% and 2.3%, respectively (Gebremedhin, 2015:4). It can be asserted that since the African countries are at different stages of social, economic, and political development, the drivers of overweight and obesity affect the countries differently, hence the wide range in the prevalence of overweight and obesity across the continent (WHO, 2016:10).

Many studies which have been conducted on the African continent have established that overweight and obesity often coexist with incidences of being underweight, which is an inherent problem faced by the developing countries. This is problematic as it creates a double burden for the developing world (Amidu *et al*., 2013:32; Tzioumis & Adair, 2014:230-231,239; Monyeki *et al*., 2015:1165-1166). For example, the following studies found prevalence of underweight ranging from 5.2%-74.2% among their study samples (Reddy, 2008:205; Puckree *et al*., 2011:4; Jacobs & De Ridder, 2012:44; Toriola *et al*., 2012:59; Wamba *et al*., 2013:5; Manyanga *et al*., 2014:6; Mushonga *et al*., 2014b:8; Kumah *et al*., 2015:3; Pangani *et al*.,

2016:2). Consequently, African countries have to deal with the financial burden of ensuring food security for the under-nourished and also the immense financial burden on the health system which is created by obesity-related health problems.

2.2.4 Prevalence of childhood obesity in Zimbabwe

Reliable and accurate, nationally representative data pertaining to the prevalence of overweight and obesity are difficult to find for Zimbabwe, as a lack of funding hampers empirical research, thereby placing severe limitations upon the availability of published research. As it has already been noted, no published studies of children between the ages of 10 and 12 years could be found. Studies which were found on other age groups of children and youth in Zimbabwe will be reported here. A 2006 study focusing on the nutritional profiles of development and physical activity of diabetic children, reported an average BMI of 18.2 for both the diabetic group (42 children) and the control group (49 children) with the age of the children 6-15 years (Djarova *et al*., 2006:4-5). A study which was conducted by Gebremedhin (2015:4) found a prevalence for combined overweight and obesity among preschool children of 6.8%. The study was based upon representative data which had been generated by the Demographic and Health Survey, which had obtained data from a sample of 4405 children between the ages of 0 and 59 months (Gebremedhin, 2015:4).

The findings of a study which was conducted in order to evaluate data which had been obtained from 34 000 primary school children in sixteen suburbs of Harare in Zimbabwe, during the period between 2003 and 2011, revealed that incidences of underweight children and stunting were rising. Fluctuating rates in the prevalence of wasting among boys ranged from 3.5% to 4.8% during the period, with the highest rate being recorded in 2007. Fluctuations in rates which were observed among girls ranged between 3.5% and 6.3% (Mushonga *et al*., 2014a:8845). A more recent study of 320 preschool children found prevalence rates for overweight and obesity of 5.3% and 1.9%, respectively (Mushonga *et al*., 2014b:8). The small numbers of overweight and obese children which were found among the Zimbabwean primary schoolchildren could be attributed to generally dire economic conditions in the country at present.

Another one of the limited number of published studies (Mufunda & Makuyana, 2016:139) of young Zimbabweans focused on youth and young adults aged between 18 and 35 years. The mean age for the study was 23 years. The study found that 9% of the participants were

overweight and 15% were obese. However, the findings of the study could not be considered to be representative of the population of the country as a whole, as convenience sampling had been used to select the research population. The research sample comprised 96 participants, who were enrolled at the same university (Mufunda & Makuyana, 2016:140). The study though small demonstrated that overweight and obesity are also prevalent in Zimbabwe.

The most comprehensive study to date has been the Zimbabwe Baseline Survey of 2015, which was a cross-sectional study of 4402 children between the ages of 8 and 15 years. Results showed that the mean body mass of the measured population was below the means found in studies conducted elsewhere. For example, the mean body mass for 10-year-old girls and boys were 31.90kg and 30.61kg, respectively (Makaza *et al*., 2015:123), while in a study which was conducted outside of Zimbabwe by Lopes *et al*. (2014:894) it was found that body mass was 36.61±8.9 for girls and 37.0±9.4 for boys of the same age group. The Zimbabwean study revealed that most of the children had normal BMI scores for their ages. The CDC standards were used for the BMI classification (Makaza *et al*., 2015:128-129, 211). These findings were similar to the results found by Gebremedhin (2015:3). The lack of published studies emphasises the great need for research which is able to provide more extensive nationally representative data pertaining to the prevalence of overweight and obesity among Zimbabwean children and adolescents.

2.2.5 Children's right to health

On November 20, 1989 the United Nations General Assembly adopted Resolution 44/25, the UN Convention on the Rights of the Child (CRC), which recognises the vulnerability of children, their status as human beings in their own right, and the need for them to be accorded equal rights as citizens of the international community (UNICEF, 1989:1-2). Under this convention children are accorded in article 6, the right to receive all possible forms of assistance to enable them to attain their full potential. Furthermore, article 24 states that children have the right to health, while article 39 emphasises their right to protection from neglect, harm, or abuse (UNICEF, 1989:4, 8, 11). In view of these provisions as well as others made by the convention, scholars and other concerned stakeholders have begun viewing the issue of childhood obesity from a child human rights angle (American Academy of Pediatrics (AAP), 2010:839; Mitgang, 2011:555; Ó Cathaoir, 2016:250-251).

As it has already been noted, the obesity epidemic is rising at alarming rates (WHO, 2016:4, 11). Although some developed or First World countries appear to be experiencing slower rates of increase, to date no country has succeeded in reining in the epidemic. Consequently, some researchers have suggested that combating the epidemic within a broader agenda of upholding the rights of children could oblige individual countries to institute laws and controls to reduce their numbers of overweight and obese children significantly (AAP, 2010:840; Ó Cathaoir, 2016:252, 255, 257). In some developed countries, such as the United States, where extreme levels of obesity have been observed, some scholars have proposed intervention by the state in the interests of children who are afflicted by obesity (Mitgang, 2011:581, 585). Although researchers may not all agree upon how the epidemic may best be tackled, it does appear that one of the most effective means of combating it could be through increased commitment, on the part of the state, in countries throughout the world (Brug, 2007:3; Wang *et al*., 2007:186-187).

2.3 Health-related physical fitness

Physical fitness has been defined in many ways with some definitions combining both health-related and skill-related elements (Safrit, 1990:10; Malina, 2001:163; ACSM, 2008:2; Ortega *et al.*, 2008a:2; Cvejic *et al*., 2013:136). However, it is generally agreed that physical fitness is a construct which encompasses ten components which enable people to function and engage in physical activity in an optimal manner, without undue fatigue or discomfort, as well as to participate successfully in sport (Safrit, 1990:10; Vanhees *et al*., 2005:103, 107; ACSM, 2009:3; Cvejic *et al*., 2013:136). Health-related physical fitness has four closely related principal attributes which together promote optimal health (Ruiz *et al*., 2010a:2; Catley & Tomkinson, 2011:11; Cvejic *et al.*, 2013:143). The components are cardiorespiratory fitness, musculoskeletal fitness (strength, and endurance), flexibility, and body composition (ACSM, 2008:3). By contrast, skill-related physical fitness components include agility, power, speed, balance, coordination and reaction time, which are motor skills which are associated with enhanced sport performance (ACSM, 2008:3). Each component will now be discussed.

2.3.1 Components of health-related physical fitness

2.3.1.1 Cardiorespiratory fitness

Cardiorespiratory fitness entails the efficiency with which the cardiovascular and pulmonary systems are able to supply working muscles with sufficient oxygen for an extended period of

time (Ortega *et al*., 2008a:2). Although a balance is desirable for the five health-related components (ACSM, 2008:3), cardiorespiratory fitness is arguably the most important of the components of health-related physical fitness (Cjevic *et al*., 2013:136). Cardiorespiratory fitness provides the physiological foundation that impacts the other components and is very important for metabolic health (Cvejic *et al*., 2013:137). High levels of cardiorespiratory fitness in childhood and adolescence have been scientifically shown to greatly impact body fatness, cardiorespiratory fitness and other health outcomes in adulthood (Malina, 2001:167; Eisenmann *et al*., 2005:50; Ruiz *et al*., 2010:2; Cjevic *et al*., 2013:143).

2.3.1.2 Musculoskeletal fitness

Musculoskeletal fitness involves muscular strength and muscular endurance which constitute the healthy functioning of the system (Vanhees *et al*., 2005:108; Czejic *et al*., 2013:137). Muscular strength is the maximum force which a muscle is able to exert, while muscular endurance is the ability of a muscle to perform repeated contractions over a period of time (Ortega *et al*., 2015:535). High musculoskeletal fitness in children and adolescents ensures good posture, a healthier back, reduces risk of metabolic diseases as well as increases tolerance in relation to muscular fatigue (Artero *et al*., 2011:709; Smith *et al*., 2014:1214, 1217).

2.3.1.3 Flexibility

Flexibility is the ability of a joint to move through its full range of motion (ACSM, 2008:70; Ortega *et al*., 2015:535) involving the bones, tendons, ligaments and muscles at the joint (ACSM, 2008:70). Studies have shown that flexibility plays an important part in health through its role in posture, balance, back health and prevention of injuries in activities of daily living (ACSM, 2008:70). Too little or too much flexibility are ordinarily both undesirable, as either may increase the risk of musculoskeletal injuries (Heyward, 2010:265, 267).

2.3.1.4 Body composition

Body composition refers to the proportions of fat, muscle, bone, cartilage and water in the body (Eisenmann, 2007:1724) with fat being the most important element with regards to implications for health (ACSM, 2008:44). High percentages of body fat contribute to overweight and obesity, both of which have a negative impact on health through increased risk of disease (Yanovski, 2015:4). Body composition is therefore a very important indicator of an individual's health (Ruiz *et al*., 2010a:4).

2.4 Measuring children's physical fitness

Researchers have been interested in the measurement of the physical fitness of young people since the 1940s and 1950s (Morrow *et al*., 2009:2). Interest in empirical research in this field was generated by a number of factors. These included among others, the need to establish normative data for children, the need to determine athletic performance, the need to assess levels of physical fitness as well as the need to determine trends in children's physical fitness (Rubin & Suchomel, 1985:97; Catley & Tomkinson, 2011:7, 11). The rise of the obesity epidemic and its associated burden upon health care systems (Wang *et al*., 2011:816-817, 823; Naik & Kaneda, 2015:2) has however heightened the interest in physical fitness testing, as scholars agree that monitoring of children's physical fitness levels is crucial in the fight against the obesity epidemic (Castro-Pinero *et al*., 2011:577; Ortega *et al*., 2011:22). The physical fitness testing of children has evolved over several decades (Vanhees *et al*., 2005:107). There has been a significant move away from a focus on sport performance oriented physical fitness testing (Freedson *et al*., 2000:S78; Jackson, 2006:160; Pate *et al*., 2013:516) to a focus on more health-related physical fitness testing which has greater relevance to public health (Caspersen *et al.*, 1985:128; Malina, 2001:163; Ruiz *et al*., 2010a:1; Catley & Tomkinson, 2011:8).

The physical fitness of children and youth is best measured in the laboratory using gold standard physical fitness tests (Castro-Piñero *et al*., 2009:3; Ruiz *et al*., 2010:1). The high cost of such laboratory testing is however not practical for epidemiological studies and surveys (Catley & Tomkinson, 2011:1). Consequently, it became necessary to develop valid and reliable field tests aimed at assessing the various health-related components that describe physical fitness in children and youth (Castro-Piñero *et al*., 2009:3; Ruiz *et al*., 2010:1, 4). These simple, easy to administer field tests were criterion validated, against the gold standard laboratory tests (Freedson *et al*., 2000:S78; Bianco *et al*., 2015:453). They are combined to create highly practical test batteries which can be used in studies of large populations (Ruiz *et al*., 2010:4; Bianco *et al*., 2015:463). The validity of a test refers to its ability to measure what it is intended to measure, while its reliability refers to its ability to produce similar results if it is carried out under similar conditions (Ortega *et al*., 2008b:S50). There are more than a dozen Fitness Test batteries that are used to test the physical fitness of children and adolescents throughout the world (Castro-Piñero *et al*., 2009:4; Bianco *et al*., 2015:460). The numbers of test items which are included in the batteries range from four to ten tests (Safrit, 1990:10; Bianco *et al*., 2015:460).

2.4.1.1 Measuring cardiorespiratory fitness in children

The laboratory gold standard for measuring cardiorespiratory fitness is the maximal oxygen uptake (VO_{2max}) test, which entails exercising to exhaustion or failure (Armstrong & Welsman, 1994:435; Haff & Dumke, 2012:165). The consumption of oxygen is measured through the use of sophisticated equipment (Aadland *et al*., 2014:5). Submaximal tests, which require ending the exercise just before exhaustion such as using the multistage submaximal test on an ergometer or the Ebbeling single-stage submaximal treadmill test, are more commonly used (Haff & Dumke, 2012:175, 179). Some scholars have argued that both the maximum aerobic fitness test and laboratory-based submaximal tests are not suitable for use with most children, as the tests require them to perform to the point of near exhaustion. They argue that many children may be unwilling to perform maximally (Armstrong & Welsman, 1994:431; Rice & Howell, 2000:152) which is what ensures validity of the assessment of aerobic capacity (Voss & Sandercock, 2009:59). Rice and Howell maintain that estimation of children's peak oxygen uptake rather than maximum oxygen consumption, using validated and reliable field-based cardiorespiratory fitness tests, is more appropriate (Rice & Howell, 2000:153). However, other studies have demonstrated the ability of children and adolescents to participate successfully in studies which require near maximum levels of performance (Eiberg *et al*., 2005:726, 728; Kotte *et al*., 2016:1770). The participants in the study of Eiberg *et al*. were particularly young children, between the ages of 6 to 7 years (Eiberg *et al*., 2005:725). Moreover, criterion validated field tests also elicit that the participating children perform to near maximum (Hamlin *et al*., 2014:85). Aadland and other scholars emphasise that direct measurement of VO_{2max} is very expensive, time-consuming and requires highly skilled personnel such that it cannot be used for large studies (Aadland *et al.*, 2014:5).

Both Castro-Piñero *et al.* and Bianco *et al*. maintain that the 20-metre shuttle run test (20mSRT) is the most valid field-based test for testing cardiorespiratory fitness in children (Castro-Piñero *et al*., 2009:18; Bianco *et al*., 2015:463). Criterion validity for this test was established in studies in which it was carried out in conjunction with the use of portable gas analysers or cross-validated against the graded treadmill test (Ruiz *et al*., 2010a:3). Other commonly used cardiorespiratory field fitness tests include, the 1-mile run/walk test, the ½- mile run/walk test, the ¼-mile run/walk test and the 1.5-mile run/walk test (Castro-Piñero *et al*., 2009:6). It could be argued that the 20mSRT is popular not only because of its high validity but also because it requires little space and many children can be tested simultaneously. However, children need

to be highly motivated and strongly encouraged when performing this test, because its validity depends upon maximal levels of performance at its end (Voss & Sandercock, 2009:59).

2.4.1.2 Measuring muscular strength and endurance in children

Castro-Piñero and others comment that most assessments of musculoskeletal fitness do not have gold standard tests (Rice & Howell, 2000:153; Castro-Piñero *et al*., 2009:939). Laboratory tests for muscular strength entail the measurement of isometric, isokinetic, or isotonic contractions, using free weights, machines for the 1-repetition maximum test (1RM), isometric dynamometers and sophisticated force power racks connected to computers, which generate detailed force-time results output (Rice & Howell, 2000:153; Haff & Dumke, 2012:250, 256). The one repetition maximum test which measures the maximal amount of weight that can be bench-pressed or leg-pressed one time, is considered the gold standard for testing muscular strength (Castro-Piñero *et al*., 2009:939). Some scholars however, discourage its use to test children, for fear of possible damage to their epiphyseal plates (Faigenbaum & Myer, 2010:57). The test is also labour-intensive requiring thorough instruction of participants and very close supervision (Milliken *et al*., 2008:1345). Faigenbaum and others contend that the 1RM Test can be used safely with children, provided that the correct protocol is followed and safety precautions are taken (Faigenbaum *et al*., 2003:164). However, when large numbers of children need to be tested, the handgrip strength test is the field test of choice for assessing upper body maximal strength (Bianco *et al*., 2015:453). It is a validated and reliable test (Castro-Piñero *et al*., 2009:942) and handgrip dynamometers are affordable (Bellace *et al*., 2000:46). The standing broad jump and the vertical jump are generally recommended tests, for assessing lower body strength in children, although insufficient criterion validation studies have been conducted concerning them (Milliken *et al*., 2008:1345; Castro-Piñero *et al*., 2009:939). Local muscular endurance in children is assessed using the push-up and sit-up tests (Ganley *et al*., 2011:214; Haff & Dumke, 2012:258-259).

2.4.1.3 Measuring flexibility in children

Flexibilty is joint-specific (Heyward, 2010:266; Bianco *et al*., 2015:457). In laboratory settings flexibility is measured with a goniometer considered to be the gold standard (Haff & Dumke, 2012:81) or with the flexometer or inclinometer (Heyward, 2010:268). Inclinometers which are used in laboratories can be either mechanical or electronic. Both the goniometer and inclinometer produce valid and reliable results (Haff & Dumke, 2012:80). It can be argued that

hamstring, back and shoulder flexibility are the most important in the assessment of health-related flexibility fitness, owing to the direct bearing which they have upon ailments such as lower back pain (Smith *et al*., 2014:1214). Poor flexibility in these areas can create difficulties in the performance of activities of daily living as well as in sport participation (Heyward, 2010:265; Bianco *et al*., 2015:457).

Although direct measurement of joint flexibility can be used outside of the laboratory, the indirect measurement of flexibility is the preferred method for surveys involving children's health-related fitness (Ganley *et al*., 2011:211). The sit and reach test, which measures more hamstring than lower back flexibility is considered the most reliable field-based flexibility test (Heyward, 2010:273; Ayala *et al*., 2012:225; Bianco *et al*., 2015:458). Over the years various versions of the sit and reach test have emerged, all of which have been used in studies of children (Bianco *et al*., 2015:457-458). The modified sit and reach test has moderate validity and reliability (Safrit, 1990:22; Ruiz *et al*., 2010a:4; Ayala *et al*., 2012:220).

2.4.1.4 Measuring body composition in children

In the living, the gold standard laboratory assessment of body composition is through densitometry, performed through hydrostatic weighing or air plethysmography as well as dual-energy X-ray absorptiometry (DEXA) (Fields & Goran, 2000:619; Heyward, 2010:191). Hydro-densitometry is based upon the Archimedes principle of displacement to predict body density, lean body mass as well as body fat through the use of mathematical formulae to divide the body into fat mass and fat-free mass (Wells & Fewtrell, 2006:614; ACSM, 2009:9-10).

Fields and Goran examined the use of the 4-compartment model in body composition assessment in children using hydrostatic weighing, plethysmography, DEXA, and total body water and concluded that the 4-compartment model was superior (Fields & Goran, 2000:619). Brambilla and associates argued that magnetic resonance imaging produced superior results in studies of children as it could accurately account for regional fat distribution (Brambilla *et al*., 2006:27). In their study Talma and associates noted that although bioelectrical impedance provided a practical method for assessing body composition in children it still required an improvement in the measuring devices. They noted conflicts in criterion-validated results as well as measurement and prediction errors (Talma *et al*., 2013:903). Although many of the measuring techniques which have been discussed in this section can be safely used with

children, they are expensive to administer and are more suitable for clinical and smaller studies of children, rather than for large-scale epidemiological studies (Wells & Fewtrell, 2006:617).

Scholars observe that simpler more accessible methods of predicting body fat are more appropriate in surveys and epidemiological studies, particularly when they are used in combination (Wells & Fewtrell, 2006:615). The anthropometric method using body measurements of height and mass, skinfolds, circumferences, skeletal diameters and anthropometric indices (BMI, WHR) is the most commonly used field method (Heyward, 2010:217-221). As the measurement of skinfolds is the most technically demanding exercise in anthropometric studies, it can result in errors in the calculation of subcutaneous (Brodie *et al*., 1998:299). Anthropometric measurements are valid measures and predictors of body fat in children (Bianco *et al*., 2015:448).

2.5 Trends in children's health-related physical fitness

Over the past five decades there has been disagreement over trends in children and adolescent health-related physical fitness. Some researchers have suggested that there appears to be a steady decline in the general fitness of children (Tomkinson & Olds, 2007, cited by Mountjoy *et al*., 2011:840; Armstrong *et al*., 2011 cited by Mountjoy *et al*., 2011:840) while others have contended that there was no evidence for the claims (Harris & Cale, 2006:208). According to Harris and Cale, in 2006 little data was available to validate the claims, which had been sensationalised by the media, that the fitness of young people had declined and that methodological problems and inconsistencies at the time made the claims problematic (Harris & Cale, 2006:207).

A 2003 study of Canadian children showed that there had been a decline in the physical fitness test results of the children in the study when compared against the 1981 normative values established by the Canada Fitness Survey (Brunet *et al*., 2007:641). Stratton *et al*. (2007:1174-1175) also observed a decline in the cardiorespiratory fitness of English children aged 9 to 11 years old over the course of six assessments, which were conducted between 1998 and 2004, using the 20MSRT (Stratton *et al*., 2007:1174-1175). By contrast, Voss and Sandercock (2009) found that the 11 to 16-year-olds who participated in their study in the United Kingdom exceeded the European mean for the 20mSRT. However, the findings of several other studies have also demonstrated a decline in the aerobic power of children and adolescents (Pate *et al*., 2006:1010; Boddy *et al*., 2010:257-258; Dumith *et al*., 2010:646). It also appears that although

there has been a general decline in the aerobic performance of children and adolescents, levels of performance tend to vary significantly throughout the world. Comparative studies of the performance of children and youth in the 20mSRT using data from over 280 studies conducted in countries throughout the world, revealed great variances in performance (Olds *et al*., 2006:1032; Lang *et al*., 2016:4-5). It has been argued that the variance observed could be accounted for by the differences in levels of socioeconomic development, climate, culture as well as other factors (Olds *et al*., 2006:1033-1035; Lang *et al*., 2016:6-7).

It cannot be disputed that secular trends have also been observed in the body composition of children and adolescents (Fredriks *et al*., 2000:110; Livingstone, 2001; 111; Monyeki *et al*., 2015:1168). Secular trends have been detected not only in BMI scores, but also in waist circumferences (Must & Anderson, 2006:593). In some developed countries however there appears to be a plateauing in the levels of BMI in the children and adolescents as shown by absence of exponential rise in rates of overweight and obesity (Olds *et al*., 2010:62).

2.6 Anthropometry in children

Anthropometry refers to body dimensions or parameters which can be used to assess or describe the physique of an individual person. Body dimensions include body mass, circumferences and girths, skinfolds, bone breadths and height (Fryar *et al*., 2012:1). These basic dimensions can be combined to create derived indices, which add further detail to the description of an individual in place of using sophisticated laboratory equipment (Goon *et al.*, 2013:822). The indices include body mass index (BMI), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), fat mass index (FMI), fat-free mass index (FFMI), and percentage body fat (BF%). Anthropometric data which is obtained from children is very important in many fields of research. Tracking of childhood anthropometry is vital for assessing growth, maturity and nutritional status (Fryar *et al*., 2012:1). General health, risk factors for disease and the effectiveness of physical activity interventions can all be determined for both individual children and groups by using anthropometry. Anthropometric measurements are particularly useful when they are used in combination (Ashwell & Gibson, 2016:2).

2.6.1 Body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR) and disease

Body mass index is a simple derived anthropometric measurement which has many uses and applications. It is the most commonly used indicator of overweight and obesity (Klimek-

Piotrowska *et al*., 2015:2). Although BMI scores do not differentiate between weight due to excess fat and that due to muscle mass, the BMI is a fairly useful index for initial screening. Some researchers maintain that BMI is the best index to use in large epidemiological studies (Nihiser *et al*., 2007:652; Goon *et al*., 2013:822). On the other hand others argue that waist circumference (WC) is a more useful predictor of risks to health (Janssen *et al*., 2004:381), as central obesity is considered to represent a higher risk factor than total body fat (%BF) scores (Heyward & Wagner, 2004:185). A study by Bailey *et al*. (2013:749) established that adolescents in their research sample who had hypertriglycedemic waists were more likely to suffer from or develop metabolic syndrome than those who did not.

Many studies of children have used BMI to determine levels of overweight and obesity around the world. One such study found 45.4% overweight Caribbean adolescents by using both BMI and skinfolds, while a study of the Andibila of Nigeria revealed that the children had relatively low body mass indices, which served to confirm the usefulness of BMI as an accurate means of assessing adiposity (Nichols & Cadogan, 2009:255; Goon *et al*., 2013:826). Katzmarzyk and colleagues used the Bogalusa Heart Study to derive thresholds for BMI scores and waist circumference measurements, which could predict cardiovascular risk factors for children and adolescents between the ages of 5 and 18 years (Katzmarzyk *et al*., 2004:e201). The Ellisras longitudinal study of children between the ages of 7 and 13 years yielded a positive significant relationship among BMI, WC and systolic blood pressure. The study also found low to moderate relationship among WC, BMI and diastolic blood pressure (Monyeki *et al*., 2008:314).

Other studies which have used BMI and WHR to observe risk factors include Ng *et al*. (2006:327) among a Canadian Cree population, Juonala *et al*. (2011:1878) to link high childhood BMI with adult cardiovascular risk factors, Eisenmann, (2005:49), to determine risk factors due to truncal adiposity in Australian children and Hatipoglu *et al*. (2008:385) to determine thresholds for BMI scores and waist circumferences to predict risk factors for cardiovascular disease. Fernandez and colleagues conducted a comparative study to establish differences in levels of risks of disease among children of various ethnicities in a nationally representative sample of children in the United States (Fernandez *et al*., 2004:443). In addition, Eisenmann *et al.* (2005:49) demonstrated, through a 10-year longitudinal study, that adolescent BMI, WC, and %BF scores and measurements were inversely related to the performance of adults in treadmill tests. The researchers found that adults who performed well had lower BMI,

WC, and %BF scores and measurements than those who did not. A study of 3038 adolescents found that 412 adolescents who were obese had 3 times more cardiovascular risk clustering factors than the other participants in the study (Schwandt *et al*., 2010:668). Another study of 13 557 adolescents found a high BMI to be independently associated with a high risk of hypertension among both fit and unfit participants (Nielsen & Andersen, 2003:233).

2.6.2 Skinfolds, body fat, waist-to-height ratio (WHtR) and disease

Skinfolds and WHtR are useful surrogates for abdominal or trunk adiposity (Ashwell & Gibson, 2016:1). They can be used to evaluate levels of risk for cardiovascular and metabolic diseases (Heyward & Wagner, 2004:185). A study of adolescents in Cracow concluded that the waist-to-height ratio combined with the sum of 4 skinfolds for girls was best for assessing adiposity while the waist-to-hip ratio was best of assessing adiposity in adolescent boys (Klimek-Piotrowska *et al*., 2015:8, 10). In the Thusa Bana study, central adiposity was estimated using waist circumference, skinfolds as well as the WHtR. The study was able to establish that the growth of 29% of the children was stunted and that 3.7% of the children were overweight. This indicated high levels of retarded growth in the study population (Motswagole *et al*., 2012:65).

A study by Goon and colleagues found differences between the genders for WHtR and suggested that the differences could be accounted for by the differences in shape between boys and girls (Goon *et al*., 2009:674), alluding to the sexual dimorphism that is apparent in the human race as maturity occurs. Low central fat patterning was also found among the Andibila 7-14 year olds as indicated by the low subscapular-to-tricep ratios (Goon *et al*., 2013:827). Another study that used WHtR found statistically significant different ratios between Brazilian boys and girls (De Padua *et al*., 2014:415). Ramoshaba and associates used the neck circumference and upper arm circumference in determining the association between blood pressure and anthropometric measurements in the Ellisras study. They concluded that there was a significant relationship between the two circumferences and the blood pressure readings of the participants (Ramoshaba *et al*., 2015:6).

Some scholars strongly argue that WHtR is more useful than other measurements as a central adiposity screening tool as well as a strong predictor of cardiometabolic disease (Li *et al*., 2013:60). Two studies (Bailey *et al*., 2013:749) and (Li *et al*., 2013:60) showed that the WHtR

was highly significantly correlated with the levels of blood pressure, triglycerides, and fasting blood glucose.

2.7 Physical activity

Physical activity (PA) is defined as bodily movement which is produced by the skeletal muscles, resulting in energy expenditure (Caspersen *et al*., 1985:126; Bouchard & Shephard 1994:77). The above definition although appearing simple also points to the complexity of physical activity (Hills *et al*., 2014:11) as physical activity is influenced by a number of factors such as body mass, frequency, intensity of the bodily movement (Vanhees *et al*., 2005:104), motor skill, ground reaction forces and even the cultural context in which the activity takes place (Malina, 2001:162). Westerterp further argues that habitual PA is a function of genetic makeup accounting for much of the individual variability that is observed (Westerterp, 2009:825). The sum total of daily physical activity is accumulated through engaging in a variety of activities such as play, household chores, exercise and sport (Caspersen *et al*., 1985:127-128), all of which are important in determining the impact of such activity upon the health of the people concerned. In children PA is not accumulated as a single bout since childhood activities tend to be sporadic (Janssen & LeBlanc, 2010:12). Research has shown that the level of physical activity (low, moderate or high intensity) will have a different impact on the health or life of an individual (Caspersen *et al*., 1985:127; WHO, 2003:4).

Internationally it is recommended that children aged between 5-17 years engage in MVPA for 60 minutes daily (WHO, 2010:20; Janssen & LeBlanc, 2010:12) and that the bulk of this activity should be aerobic (Janssen & LeBlanc, 2010:13). A study of 1808 adolescents confirmed that the current recommendation for MVPA was associated with healthy CRF but that 15 minutes spent in vigorous PA daily resulted in even better CRF (Martinez-Gomez *et al*., 2010:753-754). Public health research is also concerned with the prevention of weight gain. To this end Saris and colleagues argued that much higher levels of moderate physical activity were necessary for both children and adults to prevent weight gain which is the focus of the fight against obesity (Saris *et al*., 2003:101, 103, 111). A study of 280 children aged 8-10 years established that the time spent in MVPA was associated with less adiposity than total PA, in a 12 month longitudinal study using objectively measured PA (Fisher *et al*., 2011:4). The researchers also recommend that children in this age group should engage in activities to strengthen their bones and muscles three times a week (WHO Europe, 2015:4). Alberga and colleagues were able to clearly demonstrate the different benefits of cardiorespiratory training,

resistance training, combined cardiorespiratory and resistance training against a non-exercising group. The Alberga study was of 304 adolescents (Alberga *et al*., 2016:259, 261).

2.7.1 Benefits of physical activity for children

Participating in regular physical activity (PA) of various types and intensities brings with it a myriad of health benefits for children and adolescents through its protective effect (President's Council on Fitness and Sport, 2000:2, 8). A study examining 86 research studies concluded that vigorous PA provides additional health benefits (Janssen & LeBlanc, 2010:12). The World Health Organisation points out that PA improves the health of children by reducing body fat, improving the regulation of glucose metabolism, increasing cardiovascular health, reducing the risk of various cancers, lowering blood pressure, improving musculoskeletal and mental health, and also by significantly reducing the risk of premature death (WHO, 2003:6). All the above benefits have been examined and described in many empirical studies, some of which are discussed in the sections which follow.

Lätt and colleagues established that in normal weight adolescent boys both quantity and level of physical activity were strongly negatively associated with both body composition and cardiovascular fitness. The researchers did not however find an association between PA and measures of body fatness as well as fitness in the overweight boys. The study was particularly significant in that the researchers used objectively measured PA, as well as skinfold measurements combined with DEXA scans to measure BC and a bicycle ergometer to measure VO_2 peak (Lätt *et al*., 2013:4,7). A study by Chaput and associates concluded that PA was very important for weight control (Chaput *et al*., 2011:7). Other studies also found significant associations between levels of physical activity and cardiovascular fitness (Huang & Malina, 2002:15; Hsieh *et al*., 2014:7). In addition, a study by Ortega and associates further showed that children who were more physically active exhibited higher levels of cardiovascular fitness than those who were less active, irrespective of their individual levels of adiposity (Ortega *et al*., 2008c:126-127).

Telama and associates demonstrated the long-term benefits of high levels of physical activity in a 21-year longitudinal study. They found that consistent PA between the ages of 9 and18 years significantly increased the likelihood of remaining active during adulthood (Telama *et al*., 2005:270, 272). By contrast, from a 20-year longitudinal study which tracked both PA and physical fitness (PF), it was concluded that PA had low stability coefficients largely since it is

behavioural, but that there was a relatively strong relationship between PA during childhood and PF during adulthood. This was in terms of the influence which levels of PA during childhood exerted upon the maximal aerobic power of adults, which was measured by means of a maximal treadmill test (Kemper *et al*., 2001:188-189). Based on the knowledge which has been accumulated concerning the benefits of PA during adulthood, it cannot be refuted that continuing PA during adulthood would theoretically result in a better quality of life. A comprehensive systematic review by Biddle and Asare concluded that physical activity during childhood and youth had numerous psychosocial and cognitive benefits (Biddle & Asare, 2011:9) enabling young people to be more productive and cope better with daily life.

The following studies noted a positive relationship between physical activity and an increase in bone mineral density among prepubertal girls (Courteix *et al*., 1998:156; Heinonen *et al*., 2000:1015), adolescent males and females (McKay *et al*., 2011:99), and from adolescence through to adulthood (Kemper *et al*., 2000:851). High-impact physical activity has been observed to be particularly beneficial for children (Janssen & LeBlanc, 2010:10) and was observed to generate the greatest benefit by increasing bone area in adolescent males and increasing bone density in adolescent females (McKay *et al*., 2011:100). Kruger and colleagues from a two-year longitudinal study demonstrated that physical activity positively impacted linear growth of children (Kruger *et al*., 2012:259) although as the researchers point out, the snack provided during the conducting of the study could also have contributed to the catch up-growth which was observed in the research sample (Kruger *et al*., 2012:259-260).

2.7.2 Measurement of children's physical activity

Accurate measurement of physical activity is crucial to obtaining a proper understanding of the relationship between PA and health (Westerterp, 2009:823; Hills *et al*., 2014:1). Ainsworth and colleagues further argue that assessments of PA help to identify optimal doses for the reduction of risk of disease (Ainsworth *et al*., 2015:388) which has significant implications for public health. Physical activity is a complex construct which encompasses a number of dimensions (Plasqui & Westerterp, 2007:2372), involving energy expenditure, duration, intensity, type of activity and context (Rachele *et al*., 2012:208). The measurement of PA is based on the quantification of physical activity related energy expenditure (Vanhees *et al*., 2005:103), over a specific period of time, in order to establish PA habits (Plasqui & Westerterp, 2007:2372; Westerterp, 2009:823).

It can be argued that no single instrument is available to measure all of the dimensions which are of interest to researchers who conduct studies of physical activity (Laporte *et al*., 1985:143; Kohl *et al*., 2000:S74; Hills *et al*., 2014:1). Loprinzi and Cardinal maintain that there is a need to design PA measurements specifically for children especially in view of the sporadic nature of their PA (Loprinzi & Cardinal, 2011:15). In PA research the instrument of choice would depend upon the specific parameters which are of interest for a specific study since each method comes with both strengths and weaknesses (Vanhees *et al*., 2005:104; Biddle *et al*., 2011:2; Loprinzi & Cardinal, 2011:15; Hills *et al*., 2014:1).

2.7.2.1 Objective methods

Doubly labelled water (The gold standard)

Although direct calorimetry, through the measurement of heat production, provides the gold standard for measuring PA, it is often not practical to use it (Vanhees *et al*., 2005:104). Indirect calorimetry, such as through the use of doubly labelled water (DLW), is the gold standard in the assessment of total energy expenditure in physical activity research (Vanhees *et al*., 2005:104; Armstrong & Welsman, 2006:1073; Plasqui & Westerterp, 2007:2372; Corder *et al*., 2009:862; Rachele *et al*., 2012:208; Hills *et al*., 2014:1, 3). The use of DLW entails the ingestion of the stable isotopes of hydrogen and oxygen (^{2}H ^{18}O). After they have been ingested, the isotopes distribute themselves throughout the body and are eliminated over time. The difference in the rates of elimination of the two isotopes indicates the quantity of carbon dioxide which has been produced, which, in turn, is used to measure the amount of energy which has been expended (Vanhees *et al*., 2005:104; Hills *et al*., 2014:2-3). Samples of body fluids such as saliva, blood, or urine are analysed through mass spectrometry for this purpose (Westerterp, 2009:824).

The DLW method is also used as the method of choice for the validation of field methods (Armstrong & Welsman, 2006:1073; Westerterp, 2009:823). The DLW method does not interfere with an individual's daily activity so that is good for use in the assessment of everyday total energy expenditure (Vanhees *et al*., 2005:105). Baseline energy expenditure can be calculated by use of a ventilated hood enabling the calculation of activity energy expenditure (AEE) using the formula AEE=0.9×TEE.BEE, in which TEE = total enegy expenditure and BEE = baseline energy expenditure (Westerterp, 2009:824). The use of DLW works best when combined with other methods such as accelerometers since it does not provide information

concerning the type, intensity, frequency or duration of PA (Kohl *et al*., 2000:S73; Plasqui & Westerterp, 2007:2372). The production of the isotopes is very expensive and the analysis of the results quite technical so that the use of the doubly labelled water is not usually used for large-scale studies (Sylvia *et al*., 2014:199). In addition, some children appear to be averse to ingesting the isotopes.

Motion sensors

Motion sensors are an objective method that can be used to measure PA in children. It is important to note that in spite of their benefits there is an absence of standardised procedures for calibrating objective measuring instruments (Freedson *et al*., 2012:S1). Pedometers were among the earliest inventions to objectively measure PA. The devices are relatively simple and use a spring mechanism to register human movement (Vanhees *et al*., 2005:105). Pedometers are very accurate in counting steps in running and walking but they are not able to register other non-ambulatory forms of PA, such as that involving the use of the upper body (Plasqui & Westerterp, 2007:2372; Corder *et al*., 2008:978; McClain & Tudor-Locke, 2009:528). Consequently, their range of applications and the research questions which they can be used to answer are limited. Sylvia and colleagues argue that these small devices are good for measuring moderate physical activity. Their other limitation concerns their inability to register the intensity, duration or even the frequency of activities (Sylvia *et al*., 2014:201). Corder and associates further argue that outputs from different brands of pedometers are generally not comparable (Corder *et al*., 2008:978) making comparisons between the findings of individual studies difficult.

A study of 77 boys and girls aged 10 to 12 years demonstrated that the intensity of the PA could be established in studies using pedometers by calculating the steps per minute (Graser *et al*., 2009:24). However it should be noted that the different stride lengths of the steps of children of different ages make it difficult to make comparisons across age groups (Corder *et al*., 2008:978). Butte and colleagues state that pedometers may overestimate steps at slow speed and underestimate steps at faster speeds (Butte *et al*., 2012:S8). The quality of pedometers has improved and they remain popular among researchers (McCain & Tudor-Locke, 2009:528-529), as they are convenient to use in large studies to promote PA. Studies of a large-scale that have used pedometers include, but are not limited to (Vincent & Pangrazi, 2002:432; Duncan *et al*., 2006:1406; Duncan *et al*., 2008:3; Laurson *et al*., 2008:210; Horne *et al*., 2009:194).

Accelerometers are small devices which are able to monitor motion in various planes such that they are able to record PA more accurately and comprehensively than pedometers. They are available as uniaxial, biaxial and triaxial units. A study which was conducted by Plasqui and colleagues demonstrated that the triaxial accelerometers were more efficient for assessing PA in free living conditions (Plasqui *et al*., 2005:1368) while another study concluded that most uniaxial accelerometers show little correlation with results which had been obtained from the use of DLW (Plasqui & Westerterp, 2007:2376). As they display no visual data, they do not encourage fiddling or tampering and are, consequently, convenient for using with children (McClain & Tudor-Locke, 2009:529; Hills *et al*., 2014:7). Accelerometers can provide information pertaining to the frequency, intensity as well as total amount of PA in daily life in a non-invasive manner and on a minute-by-minute basis (Westerterp, 2009:825; Hills *et al*., 2014:6). They can also be used to collect data concerning PA in free living conditions over an extended period of time. After performing a detailed analysis of 41 studies, Plasqui & Westerterp concluded that not all of the data which accelerometers had provided correlated strongly with those which had been obtained from the use of doubly labelled water (Plasqui & Westerterp, 2007:2373, 2376).

Hills and colleagues also noted that some brands may underestimate PA especially that generated by the upper body (Hills *et al*., 2014:7) since they are not able to detect such motion. Some models of accelerometers are able to detect gait abnormalities (Butte *et al*., 2012:S8). Data generated by accelerometers is however difficult and time consuming to interpret (Colley & Tremblay, 2011:783-784; Butte *et al*., 2012:S8; Freedson *et al*., 2012:S2). In addition, results are affected by the use of different epochs and cut-points (Ekelund *et al*., 2011:862) and different methods of determining the cut-points (Colley & Tremblay, 2011:783). The lack of standardisation in the manufacture of acceleromters, at present, makes it very difficult to make meaningful comparisons between the findings of different studies (Butte *et al*, 2012:S8, S10).

There has since been advancement in the accelerometers which are now available (Plasqui & Westerterp, 2007:2377) but still care needs to be taken in choosing accelerometers for empirical studies, to avoid over estimating or underestimating levels of physical activity. In their study Ekelund and colleagues reiterated the urgent need for consensus concerning the standardisation of accelerometer intensity cut-points in research pertaining to PA. Progress in this area was seen in the study by Colley and Tremblay which showed that 3 levels of activity intensity could be clearly determined in research through the use of an improved mathematical

equation, rather than the arithmetic mean (Colley & Tremblay, 2011:787). Further progress was also seen in a recent study which presented a paradata model for assessing and presenting accelerometer data. This was based on the ISCOLE study (Tudor-Locke, *et al.*, 2015:4, 6). It is to be hoped that similar studies will help to achieve an adequate degree of standardisation of data in accelerometer-based objective studies of PA.

Heart rate monitors

Heart rate monitors provide another valid and reliable objective means of measuring PA (Armstrong & Welsman, 2006:1075; Corder *et al*., 2008:982; Hills *et al*., 2014:5). Their validity is based on the assumed linear relationship between heart rate and oxygen consumption (Corder *et al*., 2008:981; Hills *et al*., 2014:5). Researchers have suggested that data which is obtained from children through monitoring their heart rates is difficult to interpret, as their physical activity tends to be sporadic and to consist of short bursts of activity. (Corder *et al*., 2008:981). The problem with using heart rate monitors to assess PA is that heart rate can be affected by other factors such as stress, fatigue, training status and food intake among others (Armstrong & Welsman, 2006:1075). Their use is also affected by interference from other monitors or equipment (Corder *et al*., 2008:981). A significant advantage of heart rate monitors stems from their ability to be individually calibrated, thereby enabling both individual and group evaluations to be carried out (Hills *et al*., 2014:5). Despite inherent limitations, Armstrong and Welsman (2006:1076) demonstrated over a period of 10 years, using specific thresholds, that heart rate monitors could be used effectively for studying PA in young people especially time which was spent in moderate to vigorous physical activity (Corder *et al*., 2008:982; Hills *et al*., 2014:5). Heart rate monitors can also be used in conjunction with accelerometers to enhance the findings of research studies (Butte *et al*., 2012:S9; Hills *et al*., 2014:8).

Armbands

Armbands have recently been added to the range of instruments and devices which can be used for making objective assessments of PA. A study of a small sample of 22 adolescents showed validity of the armbands in the measurement of PA but also concluded that the accelerometer appeared more accurate (Van Hoye *et al*., 2014:86). In an earlier study of 40 subjects it was found that the SenseWear Pro2 armband over estimated resting energy expenditure (REE) by 12.7% and the researchers concluded that more work was required to improve the instrument

(Predieri *et al*., 2013:2467, 2470). Studies which have been conducted using armbands to measure the PA of participants in a number of different age groups include, but are not limited to those of (Andreacci *et al*., 2006:S255; Andreacci *et al*., 2007:36; Calabro *et al*., 2009:1715; Soric *et al*., 2012:1184; Benito *et al*., 2012:3156 and Lee *et al*.,2016:42)**.**

Direct observation

Direct observation is the oldest objective method for measuring PA. It entails making direct observations of PA and recording data according to predetermined coded categories (Kohl *et al*., 2000:S56; Vanhees *et al*., 2005:104). Direct observation has very high validity (Kohl *et al*., 2000:S61) and is particularly useful for making evaluations of the PA of young children who are not able to complete questionnaires and are likely to tamper with pedometers (Sylvia *et al*., 2014:199). The principal disadvantage of direct observation is that it is very time-consuming and therefore not suitable for large-scale studies (Vanhees *et al*., 2005:104; Armstrong & Welsman, 2006:1074), despite its potential for providing additional information, such as the contexts in which PA occurs.

2.7.2.2 Subjective methods

Questionnaires

Questionnaires represent by far the most frequently used method of assessing physical activity (Kohl *et al*., 2000:S59, S63). They can either be administered on their own or used in conjunction with other methods (Corder *et al*., 2008:978). Questionnaires are designed to measure PA by capturing information concerning types, frequencies, and intensities of PA (Ainsworth *et al*., 2015:388) and are useful for determining compliance with recommended levels of PA. They require validation against DLW (Vanhees *et al*., 2005:106) or other criterion-based methods, such as accelerometers (Ekelund *et al*., 2011:859). Questionnaires to determine levels of PA require respondents to recall their levels of PA over periods of time, which can range from a single day, to a week, a month, a year, or even a lifetime (Rachele *et al*., 2012:208; Sylvia *et al*., 2014:200). The seven-day period is the most frequently used time frame. Physical activity questionnaires can be completed by individual participants in a study or by a proxy, as they generally are in the cases of young children or elderly people (Biddle *et al*., 2011:2). Proxy reporting can be affected by the inability of adults to remember and report the PA of children accurately (Kohl *et al*., 2000:S59; Corder *et al*., 2009:867). Interviewer-assisted questionnaires can also be used (Vanhees *et al*., 2005:106), particularly in quantitative

historically-based studies (Ainsworth *et al*., 2015:388). Baard and Mckersie used interviewer-administered questionnaires to establish the levels of PA of 713 children between the ages of 7 and10 years (Baard & Mckersie, 2014:116). Biddle and colleagues rightly point out that a number of important considerations should be made when selecting a self-report PA instrument (Biddle *et al*., 2011:2) in order for the research to effectively collect adequate and meaningful data.

The advantage of questionnaires is that they are easy to administer and cheap for use in large scale surveys. Questionnaires are useful for categorising physical activity levels and estimating energy expenditure of groups of people by applying metabolic equivalents (MET), as provided by Ainsworth *et al*., 2000:S500-S501; Westerterp, 2009:827), but are not able to accurately measure PA at a personal level (Armstrong & Welsman, 2006:1071). Questionnaires are also very useful in physical activity research as they are able to capture additional relevant information, such as the time, type and the context of the PA (Booth *et al*., 2002:1986), which objective methods are not able to capture. It should always be remembered though that the accuracy of questionnaires hinges on the memories of the participants (Ekelund *et al*., 2011:859).

Biddle and associates identified the Physical Activity Questionnaire, Youth Risk Behaviour Surveillance Survey and The Teen Health Survey as best self-report PA instruments for use in the European Project ALPHA (Biddle *et al*., 2011:3, 6). Validation studies of the most frequently used questionnaires have included the following studies and reviews Kohl *et al*., (2000:S60), Booth *et al*. (2002:1993), Corder *et al*. (2009:266, 269), and Biddle *et al*. (2011:6). In view of the low to moderate validity of questionnaires, Kohl and associates highly recommended that questionnaires be used in conjunction with other PA measuring instruments (Kohl *et al*., 2000:S72). Kahn and colleagues used questionnaires to determine a decline in physical activity among 12 812 male and female adolescents, over a three year period (Kahn *et al*., 2008:373).

Other studies that successfully used questionnaires are; Kimm and associates to establish that there was a decline in PA levels among both black and white girls (Kimm *et al*., 2002:712), Burke and colleagues to determine levels of PA in response to a lifestyle intervention among children (Burke *et al*., 2015:216), Armstrong and colleagues to report that a third of the youth in the 2001/2002 study of 22 European countries were meeting the recommended levels of PA (Armstrong & Welsman, 2006:1072) as well as, Jalali-Farahani and colleagues to establish that

boys spent 5.86 hours and girls spent 3.74 hours on sporting activities per week (Jalali-Farahani *et al*., 2016:4). Armstrong and Welsman further argue that questionnaires are useful for assessing trends in PA, including age and gender-related differences (Armstrong & Welsman, 2006:1071).

Diaries and physical activity logs

Van Hoye *et al*. (2014:83, 86) found a reasonable correlation in their study between the data pertaining to PA which was provided by diaries and that which was captured by accelerometers. From this finding they concluded that diaries represented a valid means of gathering data in large studies (Van Hoye *et al*., 2014:83, 86). Rachele and colleagues examined a number of studies and also concluded that diaries were reasonably valid instruments for assessing PA in children (Rachele *et al*., 2012:210). By contrast, Kohl and colleagues argued that diaries are not easy to use in studies of children, as they require scrupulous attention to detail in order to capture all relevant information (Kohl *et al*., 2000:S59) there by creating a high participant burden (Hills *et al*., 2014:10). PA logs provide checklists of physical activities for which participants indicate participation and the intensity of the PA by choosing from provided levels (Rachele *et al*., 2012:209). PA logs, like diaries have a high participant burden (Ainsworth *et al*., 2015:389). Diaries and PA logs are however useful instruments to provide additional information such as the setting for the physical activity and energy expenditure (EE) can be estimated by using the relevant metabolic equivalents (Hills *et al*., 2014:10; Ainsworth *et al*., 2015:389).

2.7.3 Global trends in children's physical activity

Sisson and Katzmarzyk have rightly pointed out that an understanding of the prevalence of physical activity around the world is of utmost importance. The information gathered can be used to compare different communities, countries and regions and to monitor changes over time (Sisson & Katzmarzyk, 2008:607), as well as to inform public policy (Pate *et al*., 2002:306). International trends in the levels of PA like many other trends cannot be accurately determined due to inequity in monitoring as well as the differences in the methods used in assessment of PA (Sisson & Katzmarzyk, 2008:612; Sallis *et al*., 2016:1328). In addition, most of the trends which have been identified pertaining to the PA of children and adolescents have been informed by studies which have been conducted in the developed world (Muthuri *et al*., 2014c:767). Differences in thresholds applied when objective methods are used also makes

determination of PA levels in children and adolescents difficult (Ekelund *et al*., 2011:862). The developing countries are lagging behind in data collection in this area and when data is collected, subjective methods are mainly used to do so (Sallis *et al*., 2016:1327). It has been suggested that even in the developed world, cross-country accelerometry studies are still rare (Verloigne *et al*., 2012:2; Guinhouya *et al*., 2013:305). Some countries and regions have however been conducting PA surveillance studies for several decades (Tremblay *et al*., 2016:S344, S354).

Surveys and studies suggest secular trends in levels of physical activity for children throughout the world, with many children not meeting the recommended 60 minutes of daily PA (Malina & Little, 2008:380, 382; Sallis *et al*., 2016:1327). Studies have demonstrated that there tends to be a decline in PA levels among both genders during adolescence (Armstrong & Welsman, 2006:1082). Kimm and associates found a decline in PA levels among both black and white adolescents in their study sample (Kimm *et al*., 2002:712). From an evaluation of the findings of 28 studies it was concluded that a great many children and youth do not engage in the recommended levels of physical activity. The study found that Australia, China and Ireland had the most active young people, while Tonga, Belgium and France had the least active (Sisson & Katzmarzyk, 2008:611).

Ekelund and associates argue that in view of the absence of standardisation in the assessment of PA levels in youth as well as the limited longitudinal and repeated cross-sectional studies evidence for a secular trend in children's PA is not conclusive (Ekelund *et al*., 2011:863). However a more recent study by Tremblay and colleagues while acknowledging the weaknesses in the assessment methods pointed to the fact that many children around the world did not meet the recommended quantities of PA (Tremblay *et al*., 2016:S358-S359). The study by Tremblay and colleagues was of particular significance because it included PA data for children from 38 different countries and from different continents (Tremblay *et al*., 2016:S353).

Objectively measured PA appears to provide a wide variety of PA trends. A synthesis of physical activity data for 20 000 European children generated using objective methods concluded that 71-87% of the children were meeting recommended levels of physical activity when using a cut-off of >2000cpm. The figure however drastically dropped to 3-5% when the higher cut-off of >3000cpm was used (Guinhouya *et al*., 2013:309). However an earlier study showed low levels of physical activity of 4.6% for girls and 16.8% for boys among 10-12 year

old children from five European countries (Verloigne *et al*., 2012:5). One of the earliest studies using objective methods in a large population of 5595 children aged 11 years, found that although many children were physically active smaller percentages were actually engaging in the required levels of moderate to vigorous physical activity (Riddoch *et al*., 2007:964, 967). A study by Fisher and associates established that only 1% of the children in the research sample of 8-10 year olds, were engaging in the recommended levels of PA (Fisher *et al*., 2011:5). The above studies however showed variability in PA levels in the countries of the European region and this was influenced by the various local socioeconomic and cultural differences (Verloigne *et al*., 2012:6; Guinhouya *et al*., 2013:305).

Studies from other parts of the developed world have also shown that many children do not meet the recommended levels of PA (Craig *et al*., 2010:1641; Sallis *et al*., 2016:1327).

2.7.4 Children's physical activity on the African continent

The accurate assessment of trends in the physical activity levels of African children and adolescents is hampered by the lack of time-trend studies (Muthuri *et al*., 2014b:3342). Nationally representative surveys in Africa are particularly scarce, even in South Africa, where considerable headway has been made in PA research (Draper *et al*., 2014:S99; Uys *et al*., 2016:S266). A detailed synthesis of the findings of 71 peer-reviewed research papers concerning children and adolescents in sub-Saharan Africa revealed that PA levels varied significantly among different groups (Muthuri *et al*., 2014b:3338-3341). The numbers of children who were physically active for longer than 60 minutes per day ranged from below 10% to over 88% (Muthuri *et al*., 2014b:3338-3341). The majority, 72.2% of the studies used subjective measurements, while only 27.8% used objective methods of PA assessment. The researchers concluded that there were too many differences among the studies such that specific trends in the levels of PA could not be determined (Muthuri *et al*., 2014b:3352).

The participation of increasing numbers of African countries in the Healthy Active Kids Report Card programme as well as other international research initiatives could help to generate more accurate information concerning levels of PA among African children. A study emanating from such collaborative efforts demonstrated that there were similarities in the PA profiles of Canadian and Kenyan children (Muthuri *et al*., 2014c:774). It has been suggested that since the developing African countries are going through a socioeconomic transition which includes urbanisation, a study of the physical activity of children in both rural and urban areas using

accelerometry could greatly enhance the understanding of the transition (Prista *et al*., 2009: 385).

2.7.5 Children's physical activity in Zimbabwe

Accurate levels of physical activity among Zimbabwean children are difficult to determine at present, owing to a lack of nationally representative data and published studies (Manyanga *et al*., 2016:S337). The severe paucity of published studies makes it difficult to obtain data to establish time trends, inform public health policy, or to compare Zimbabwean children with others in the region or elsewhere.

A comparative study of children and adolescents aged 6-14 years showed that the children in the healthy group spent 2.5 hrs playing sport daily, while the children who were suffering from diabetes mellitus spent only 0.8 hours playing organised sport each day (Djarova *et al*., 2006). However, a larger study using data from the Global School-based student Health Survey, of children aged 13-15 years (n-3853) reported that only 30.2% of the children were physically active (Peltzer, 2009:175). In a subsequent study, Peltzer found that only 13.7% of the adolescents were physically active (Peltzer, 2010:275). The sample for the two studies was however not nationally representative, as the subjects were drawn only from Harare, Bulawayo and parts of Manicaland province (Peltzer, 2009:175).

Mushonga and colleagues found that 67% of preschool children (n=320) in their study sample of 3-5 year olds engaged in average to high physical activity (Mushonga *et al.*, 2014b:9). The inaugural 2016 Zimbabwe Report Card on the Physical Activity for Children and Youth in Zimbabwe in 2016 revealed that more than 63% of children in the rural areas were engaging in the recommended 60 minutes of physical activity a day, while among urban children the figure was only 55% (Manyanga *et al*., 2016:S338). It is important to note that although these data were of children from the ten provinces of Zimbabwe, studies with much larger samples are required in order to have true national representation. It is therefore not surprising that Manyanga and associates concluded that there was a lack of sufficient data to inform the inaugural Zimbabwe report Card on Physical Activity for Children and Youth (Manyanga *et al*., 2016:S340).

2.8 Physical activity at school

Children spend most of their days at school (Pate *et al*., 2006:1220; Izaki, 2015:10), making schools the ideal places to influence and positively impact the lives of children and adolescents (Izaki, 2015:10), including the prevention of obesity (Gonzalez-Suarez *et al*.,2009:424). Various scholars have reported that schools can provide an ideal place and can take a leadership role in the provision of physical activity opportunities for children (Chappelle, 2001:91; Pate *et al*., 2006:1214; Active Living Research, 2007:1; Buscemi *et al*., 2014:1). Opportunities for physical activity during the course of school day can be provided for through a number of ways, including school sports, recreational intramural games or physical activity clubs, recess, physical education and physical activity breaks during non PE classes (WHO, 2000:11; Pate *et al*., 2006:1216). Figure 2-1 provides a graphic representation of the forms which encouraging physical activity could take. In this study, focus will be on the role that physical education can play in increasing the physical activity levels of children and adolescents.

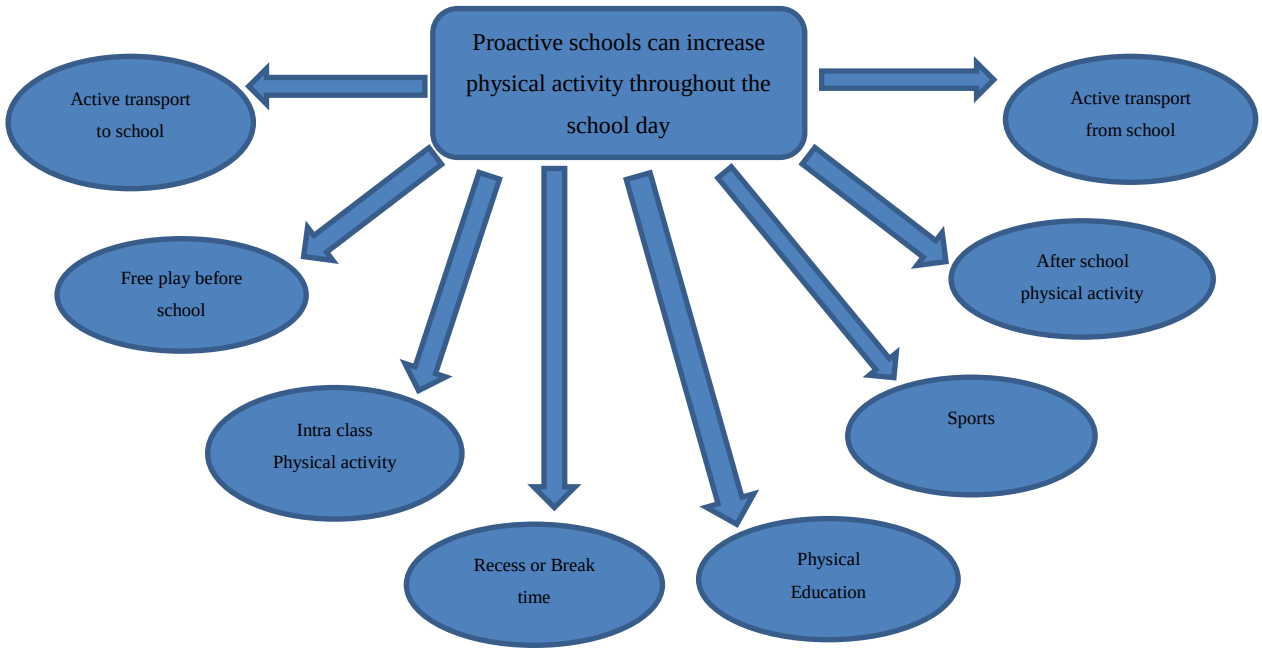

Figure 2-1: The role schools can play in increasing physical activity among children (Sources: Pate *et al*., 2006:1215-1220; Izaki, 2015:12-17)

2.8.1 Physical activity through physical education

Physical education, a pedagogical discovery of the 17th and 18th centuries (Guedes, 2007:31), holds a unique position in the school curriculum (Hardman, 2008:3). Physical education is, arguably, the only subject which has the potential and responsibility to educate the body in the knowledge and development of movement skills which enable people to engage with enjoyment in numerous physical activities (Guedes, 2007:48). Additionally, physical education goes beyond the teaching purely physical skills, as it contributes to the development of the whole person through imparting knowledge concerning the rules of games, fair play, bodily awareness, personal development, social inclusion (European Commission, 2013:7, 17; Van Deventer, 2014:193) as well as emotional, cognitive, motivational and moral concepts (Bailey, 2006:398; Mihaela & Iulian, 2015:42). It can also be argued that for many children, PE provides one of few opportunities to be physically active. In fact, the role of physical education in maintaining the health of children is so crucial that access to physical education is a fundamental human right (WHO, 2000:10; UNESCO, 2015:10). It should be noted however, that for PE to be truly beneficial, at least 50% of the lessons should be devoted to physical activities (ACS CAN, 2012:4). Sutherland and colleagues showed that there is a need to reduce time spent on administrative issues during PE lessons (Sutherland *et al*., 2016:140).

2.8.2 Global trends in physical education

Physical education (PE) or physical education and sport (PES) has evolved over the centuries, facing various crises over the period (Guedes, 2007:47). Research has revealed that there is a considerable diversity throughout the world in relation to the status which is accorded to PE and how the subject is taught (WHO, 2000:10-11; Guedes, 2007:47; Hardman, 2008:6; Mihaela & Iulian, 2015:43). Hardman however argues that in spite of the differences there is congruence that converges in the emphasis upon the physically educated person (Hardman, 2008:3). All over the world PE has faced some relegation at some point (Guedes, 2007:32), in one form or the other limiting the influence of the subject upon the health of children (WHO, 2000:10; Du Toit *et al*., 2007:244; International Platform on Sport and Development, 2009:6). The relegation has included the reduction of the time which is allocated to PE, the poor training which is received by PE teachers, reduced allocations of financial resources to PE and, in some cases, the complete removal of the subject from the curricula of schools (Le Masurier & Corbin, 2006:44; Graber *et al*., 2014, in Chin & Edginton 2014:532), usually in favour of subjects which are deemed to have greater academic significance (Nziramasanga, 1999:363). Physical

education is threatened by the emphasis which schools tend to place upon literacy and numeracy, even in countries where PE enjoys a high status, such as Australia (Georgakis & Wilson, 2014, in Chin & Edginton, 2014:19).

A study by Hardman showed that 89% of the primary schools and 87% of the secondary schools worldwide had legal requirements for the teaching of PE and that the subject was taught for a length of between 8-14 years of the child's school lives of children, with the average being 12 years (Hardman, 2008:4). The content of PE lessons varies over the period to cater for the developmental needs of the learners at the various stages. Onofre and colleagues (2012:17) also showed that PE at the nursery school level was compulsory in 63.6% of European countries in their study. Early involvement in PE is deemed very important in the development of motor skills essential for life as well as successful sport participation. Kirk argued that inequalities in this early access to PE and PA may impact levels of PA in adult lives (Kirk, 2005:240).

Hardman argued that the value which is accorded to PE varies across the globe. He found that PE was afforded low status in 30% of the countries which he surveyed for his study, while the percentages were higher elsewhere, with PE enjoying high status in 80%, 75%, and 67% of African, Asian, and Latin American countries, respectively (Hardman, 2008:6). Pate and colleagues on their part showed that PE is mandatory in schools in many states of the United States, a decline in the numbers of children who participate in it have been observed in recent decades (Pate *et al*., 2006:1215). The obesity epidemic has ignited renewed interest in improving PE for all children in Europe, America, and other countries, such as Australia. This trend is ably demonstrated by the monitoring systems which have been introduced and the budgetary provisions which have been made by national governments and non-governmental organisations.

In all European countries the progress of children in PE is monitored and assessed several times per year, using formative and summative methods (European Commission, 2013:15; Mihaela & Iulian 2015:45). In the United States most states have regular monitoring systems for PE in place (Pate *et al*., 2006:1215). The United States Congress also monitors PE through the requirements of statutes, such as the Every Student Succeeds Act (ESSA), which emphasise PE as a vital component of a well-rounded education (Cooper *et al*., 2016:134). National bodies, such as the Institute of Medicine, Centres for Disease Control and Prevention, and the

National Physical Activity Alliance all play active roles to promote PE (Cooper *et al*., 2016:135).

Many countries in Africa like in other developing countries face challenges in the teaching of PE. In many of the countries PE has a comparatively low status (Chappell, 2001:92; Wanyama & Quay, 2014:749). The low priority which is accorded to the subject is apparent from the lack of funding which is allocated to the teaching of the subject which, in turn, is evident from a dearth of facilities. In addition, teachers who are qualified to teach the subject are either non-existent or are poorly trained. Ojo reported in his study of PE in Nigeria that, not only was the teaching of the subject hampered by a lack of facilities, but also by an overloaded school curriculum (Ojo, 2015:40, 46). Middle-income countries such as India and South Africa tend to fare better, in some respects, than the low-income countries (Chappell, 2001:89). In South Africa, although the history of PE dates back to the 1800s, it faced relegation that saw it removed from the school curriculum for a time, before being subsequently reintroduced into the curriculum in recent years (De Ridder & Coetzee, 2013:240-241). The subject does not however stand alone in the South African curriculum as it is taught only as part of the subject which is known as Life Orientation. South Africa therefore needs to reintroduce PE as a subject in its own right to more effectively impact the lives of youth in the country (Shaw *et al.*, 2014 in Chin & Edginton, 2014: 441, 444, 447). Chappell argued that many governments of many developing countries wish to improve the teaching of PE but, in many cases they are overwhelmed by prevailing circumstances in their countries (Chappelle, 2001:94).

A recent emphasis in the debate pertaining to the value of PE has centred on the need for not just its inclusion in the school curriculum, but also on the quality of the PE classes (Le Masurier & Corbin, 2006:45; UNESCO, 2011:2; UNESCO, 2014:10; Van Deventer, 2014:196; Cooper *et al*., 2016:137). Quality PE is characterised by meaningful content and appropriate instruction while providing sufficient time for learning. In their study, Le Masurier and Corbin identified 10 principal reasons to encourage and fine tune the provision of quality PE (Le Masurier & Corbin, 2006:49). Van Deventer's study concludes that a holistic approach to the teaching of PE, which emphasised the 'what', 'how', 'why', 'when', and 'where' components of instruction and also the active participation of parents, represented the optimal means of instilling in learners a lifelong enjoyment of physical activity (Van Deventer, 2014:197). Chin and Edginton argue that the provision of culturally relevant best practices into high quality

physical education holds the key to making physical education effective (Chin & Edginton, 2014: 4, 6).

2.8.3 Cost-effectiveness of physical education programmes

Empirical evidence suggests that financial investment as well as time spent in physical education is not wasted (Barrett *et al*., 2015:152). The cost-effectiveness of PE can be examined from a monetary point of view as well as from a health and academic outcome point of view as well as from a societal or community impact point of view. A study by Barrett and colleagues using a simulated national cohort model which they adapted from the Australian Assessing Cost Effectiveness demonstrated that the introduction of a PE programme in primary schools could result in small saving of $60.5 million in healthcare costs due to the resulting reduction in BMI in the children. Adding extra PE time and trained teachers would result in a saving of $89.7 million and also substantially reduce the cost per BMI unit (Barrett *et al*., 2015:151). Although these projections may appear insubstantial at face value, they nevertheless demonstrate that public health benefits accrue from positive investment in effective and high quality PE programmes. Indeed, it can be argued that the benefits would be even more substantial, if we take into account the potential improvements in the physical fitness, emotional and mental well-being of the children, which would accompany the projected financial saving.

A study by Castillo and associates using objective measurements to assess the effectiveness of PE lessons, found that children were more physically active on the days on which they participated in PE. The study also demonstrated, through the use of the 20-metre shuttle run test, that the cardiorespiratory fitness of the children had improved (Castillo *et al*., 2015:754-755). Odiango and others also demonstrated that the physically impaired adolescents in their study responded well to an 8-week PE intervention. Improvements were observed in terms of reduced resting heart rates, improved cardiorespiratory fitness, reduced body weight and also increased flexibility (Odiango *et al*., 2010:1917). Sanchez-Vaznaugh and associates found that students in compliant schools were fitter than those in non-compliant schools, when they compared the physical fitness of students in Californian school districts which either complied or did not comply with the provision of 200 minutes of PE every 10 days. Their findings revealed that 60.1% of the children in compliant schools and 57.1% of those in non-compliant schools met or exceeded the cardiorespiratory fitness zone levels which were set by the Cooper Institute (Sanchez-Vaznaugh *et al.,* 2012:455). It could be argued that if PE sessions are able

to contribute to increasing the cardiorespiratory fitness of children, their academic lives would benefit accordingly. This argument is based upon empirical evidence, such as that which is provided by the study of Chaddock-Heyman and associates, which demonstrated that there was a strong correlation between the aerobic fitness of children and the microstructure of white brain matter (Chaddock-Heyman *et al.*, 2014:4). This finding demonstrates conclusively that PE benefits all learners (ACS CAN, 2012:4), irrespective of gender, socioeconomic status, location or physical ability.

Over the decades PE has been relegated because of the belief that it wasted time which could be spent in the teaching of 'academic subjects'. Empirical research has however showed that participation in PA, including that offered in PE may improve academic performance through a number of mechanisms (Bailey, 2006:399; Ruiz *et al*., 2010b:920; Donnelly *et al*., 2013:6-7; Esteban-Cornego *et al*., 2015:536, 538). **Figure 2-2** below is based upon the findings of numerous empirical studies and demonstrates the crucial role which PE plays in both the physical development and the academic performance of children and youth.

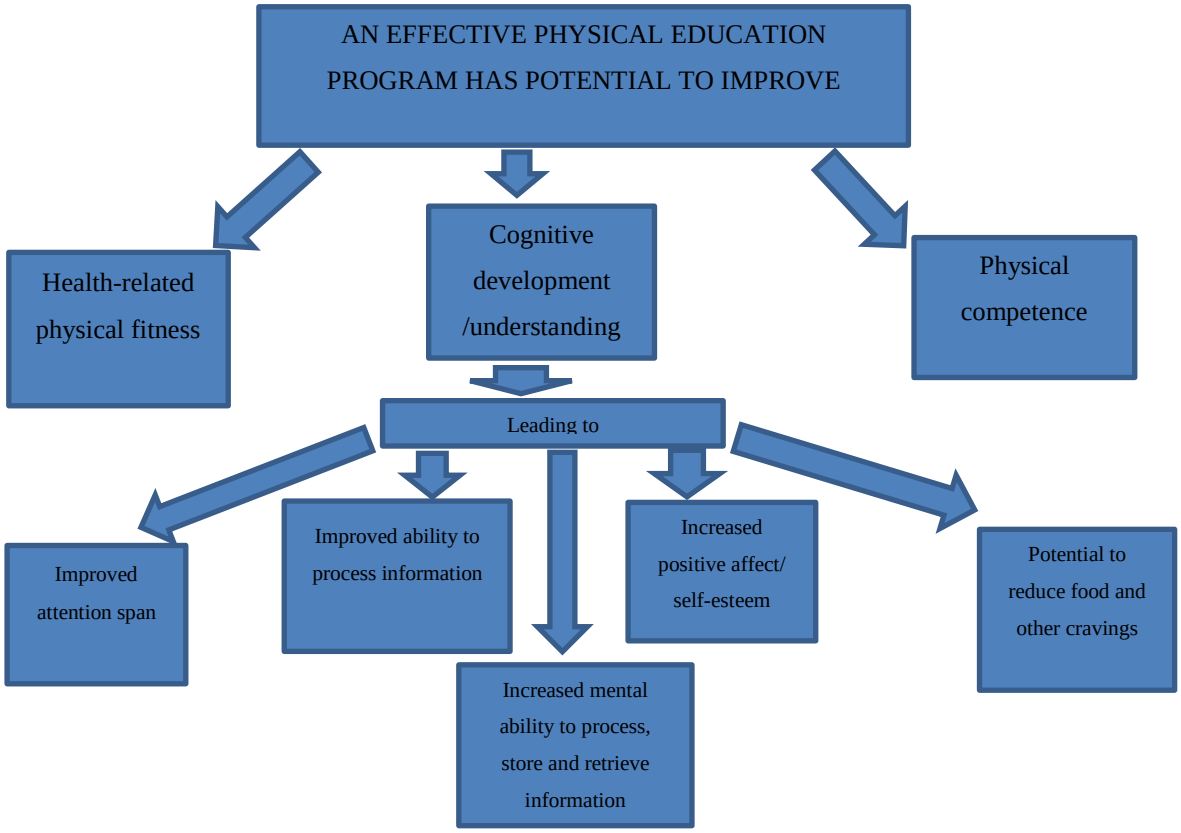

Figure 2-2: Benefits of physical education (Source: Centres for Disease Control and Prevention, 2010:9)

2.8.4 Physical education in Zimbabwe

The teaching of PE in Zimbabwe, has faced cycles and challenges just like in other parts of the world. Chinamasa and Musiyamhanje explain that the origins of the subject can be traced to the army and police during the time of the former British colony of Southern Rhodesia, while Mudekunye and Sithole trace them, more precisely, to physical training in the aftermath of the Second World War (Mudekunye & Sithole, 2012:710; Chinamasa & Musiyamhanje, 2015:31). There is agreement however that the earlier form of PE, known as physical training (PT), was teacher-centred and emphasised drills for physical development (Chinamasa & Musiyamhanje, 2015:31) no doubt for military preparedness. Chinamasa and Musiyamhanje further claim that at that point the subject was found on every school timetable with the class teachers being responsible for providing PT to their classes (Chinamasa & Musiyamhanje, 2015;31). After independence, PT took on a new identity in Zimbabwe, as PE was introduced to promote healthy life styles and also to facilitate the development of life skills (Mudekunye & Sithole, 2012:710). The syllabus required that PE have both theoretical and practical components and the subject was to be taught by fully qualified teachers (Chinamasa & Musiyamhanje, 2015:33). Although the new orientation was a laudable one, the new syllabus was seldom taught in the prescribed manner.

It appears that over the decades PE in Zimbabwe suffered relegation as happened to the subject in other parts of the world. Physical Education was offered as a subject in the teacher training colleges. Teachers who majored in PE were often students who had failed to secure places in the so-called 'more academic subjects' (Nziramasanga, 1999:363). There was a general misconception that PE as a subject was intended for dull students or those whose academic capabilities were deemed to be limited (Nhamo & Muswazi, 2014:3). The misconception has been found to be prevalent in several other countries, such as Kenya (Mwisukha *et al*., 2014, in Chin & Edginton, 2014:273). In their study Nhamo and Muswazi further argue that PE was generally considered to be an unimportant subject (Nhamo & Muswazi, 2014:4). This conclusion was confirmed in another study, whose findings revealed that the subject tended to be taught mainly by student teachers as a component of their teacher training practice requirement (Mudekunye & Sithole, 2012:714). The time which was allocated to PE classes was often considered as 'free' time in many primary schools and the subject was not included in the curricula of secondary schools (Nhamo, 2012:65). It was also found that in some instances, teachers used PE periods to teach mathematics, to complete their marking of books,

and also to enable children to attend to corrections, although some teachers used the time to allow the children to participate in traditional indoor games (Chinamasa & Musiyamhanje, 2015:36). PE was a constant feature in the scheme books of the primary teachers during this period (Nhamo, 2012:67) even though it was not being taught.

Indeed the teaching of PE has been hampered in Zimbabwe, not only by the prevalence of negative attitudes towards the subject, but also by a number of other factors. Key among these have been a shortage of equipment and facilities (Nhamo, 2012:68-69), a lack of adequate supervision (Mudekunye, 2012:714), a lack of adequate training of teachers (Nhamo, 2012:68; Nhamo & Muswazi 2014:3), a lack of status as an examinable subject (Chinamasa & Musiyamhanje, 2015:71) and the difficulties which have been encountered in interpreting the syllabus (Nhamo, 2012:69; Chinamasa & Musiyamhanje, 2015:34).

The government of Zimbabwe endorses all of the Physical Education and Physical activity declarations of the United Nations General Assembly and associated agencies. Through its Curriculum Development Unit, it has introduced new physical education syllabi for learners from preschool through to secondary school for the period between 2017 and 2022 (GZCDU 2015a; GZCDU 2015b; GZCDU 2015c). Inherent in all of the syllabi is the recognition that "Physical Education plays an important role in the total development of the learner. Through physical education learners acquire the knowledge, skills, right attitudes and values towards the pursuit of a lifelong physically active and healthy lifestyle. Physical education provides a platform and valuable opportunities to develop self-management skills" (GZCDUa 2015:1). A new feature of the syllabi is that it makes PE an examinable subject such that it can no longer be relegated, as a grade for the subject is now a requirement in the termly reports of all learners.

The new physical education syllabi are very comprehensive. They require age-appropriate coverage of theory and practical activities related to the human body, safety and health, balances, locomotion and movement, game skills, aquatics, gymnastics, and athletics and the use of a wide range of methodologies (GZCDUa, 2015:6-19; GZCDUb, 2015:6-11; GZCDUc, 2015:62-65). The teaching of PE in the Zimbabwean schools is now intended to progressively build the learner's understanding in a systematic way which theoretically should produce physically educated learners with all round health literacy. The addition of some elements of basic health-related physical fitness testing in schools would facilitate bringing Zimbabwean schools up to date with contemporary trends pertaining to PE around the world. Schools in other parts of the world require the levels of BMI and physical fitness to be assessed regularly

(Missouri Department of Elementary and Secondary Education, 2000:3; Ballard *et al*., 2005:8; NHAHPERD, 2007:18; National Association for Sport and Physical Education & American Heart Association:8, 63-66; Gee, 2015:271; Mihaela & Iulian, 2015:45). At present the new Zimbabwean syllabi for physical education do not make provision for health-related physical fitness testing in schools.

2.8.5 Increasing children's interest in physical education

Policy in relation to physical education in each school should prioritise the need to increase the amounts of PA in which children actually engage, through the formulation and implementation of appropriate motivational strategies. Appointing fully qualified specialist teachers who possess the knowledge and ability to apply a variety of teaching methods can help significantly to retain the interest of learners in the subject (Izaki, 2015:11). The effectiveness with which teachers are able to teach PE can make a very significant contribution to the physical competence of learners, and, in turn, increase their intrinsic motivation. Kirk argued that the perceived competence of teachers and coaches can influence the degree to which learners feel motivated to participate in sports (Kirk, 2005:242). A study by Erwin and colleagues showed that intrinsic motivation played a significant role in student participation in a variety of different PE settings (Erwin *et al*., 2013:329-330). The study, through the use of pedometers and accelerometers further showed that levels of PA were different in different types of PE lessons (Erwin *et al*., 2013:331), which confirmed the need for variety in the teaching of PE. In addition, learners can be significantly motivated through the provision of appropriate equipment and facilities (Izaki, 2015:13).

The interest of learners in physical activity including PE, usually declines during their adolescent years, thereby creating a challenge for schools (Pate *et al*., 2009:278). The decline in interest is often particularly prevalent among girls, who may develop misconceptions concerning PE (Ojo, 2015:48). A study which introduced an 8-month New Moves physical education intervention programme for girls only generated encouraging results. The findings revealed that 91% of the participants expressed overal satisfaction with the programme, 85% liked the physical activities which were included in it, 77% indicated that participating in the programme had increased their levels of PA, 69% reported increased self-esteem, while 92% of the parents also indicated their satisfaction with the New Moves programme (Neumark-Sztainer *et al*., 2003:47). Kirk also argues that early experiences in both PA and PE helps to reduce the rates at which learners are prone to drop out from participating in physical activities

during the later years of their adolescence (Kirk, 2005:248). It is further suggested that early experiences of PE should place less emphasis upon competitive success, but rather promote the development of motor skills and emphasise play and enjoyment (Kirk, 2005:249). The provision of a wide range of activities in PE lessons can increase participation (Izaki, 2015:15), as doing so has great potential for reducing boredom and increasing enjoyment among both genders (Izaki, 2015:12).

2.9 Conclusion

It can be concluded, that existing literature, points to an international increase in the levels of childhood obesity (Muthuri *et al*., 2014a:20; Skinner & Skelton, 2014:561, 564; Tzioumis & Adair, 2014:233. The literature also suggests that in some of the developed countries of the world there appears to be a levelling off in the numbers of overweight and obese children, although the percentages remain very high (Rodd & Sharma, 2016:8). Researchers have also concluded that the increasing numbers of children who are affected by overweight and obesity in the developing world are increasing creating a double financial burden for their countries, which are obliged to spread their limited resources to combat both undernutrition and over nutrition (Manyanga *et al*., 2014:2; Muthuri *et al*., 2014b:3328; Tzioumis & Adair, 2014:233. The result is that many developing countries confine their endeavours to attempting to eradicate poverty and undernutrition (Muthuri *et al*., 2014b:3328), as they do not consider that overnutrition represents a pressing public health concern (Kumar & Faisal, 2015:408). Left unabated overweight and obesity can easily rise to the same levels as in the developed countries (Webber *et al*., 2012:5), largely as the developing world undergoes a nutritional and socioeconomic transition which results in significantly increased levels of physical inactivity (Webber *et al*., 2012:1). Zimbabwe is one such affected developing country. Physical inactivity is the major risk factor for a wide range of noncommunicable diseases (Guinhoya *et al*., 2013:301).

Reviewed literature has clearly shown the need to monitor the trends in overweight and obesity throughout the world. Paucity in available literature for some regions and countries was noted, pointing to the need for empirical research and national surveys in the countries concerned. It was clear from the literature review that the developing world urgently requires large-scale studies in the area of overweight and obesity to accurately inform public health policy (Muthuri *et al*., 2014a:20).

Underweight, overweight and obesity all greatly affect children's growth and quality of life (Wang *et al.,* 2011:815). In view of this, the available literature shows that the regular monitoring of the health-related physical fitness including body composition and physical activity, of children everywhere can play an important role in tracking the growth and development of children throughout the world (Kumar & Faisal, 2015:409; Tzioumis & Adair, 2014:234. Literature showed that the successful implementation of programmes to combat levels of overweight and obesity require multipronged effort which include providing children with sufficient opportunities to be physically active. In view of the length of time that children spend at school, literature has identified schools as the ideal place at which children's health can be positively impacted (Cooper *et al*., 2016:133, 134). This impact is especially important in the role schools can play in increasing levels of physical activity. Although the focus in part of this literature review was on the role that physical education can play in promoting increased physical activity, **Figure 2-1** provides a concise summary to illustrate the opportunities to increase physical activity in the school settings. Schools indeed can play a key role in improving childhood and adolescent health through availing opportunities for increased physical activity.

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CHAPTER 3
HEALTH-RELATED PHYSICAL FITNESS, ANTHROPOMETRY AND PHYSICAL ACTIVITY LEVELS OF ZIMBABWEAN CHILDREN AGED 10-12 YEARS OLD

Chapter 3 is a research article which will be submitted to a peer-reviewed journal, the International Journal of Environmental Research and Public Health. Accordingly, the chapter is presented in the format which is required by the journal.

Health-Related Physical Fitness, Anthropometry and Physical Activity Levels of Zimbabwean Children Aged 10-12 Years Old

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3.1 Abstract

Background: Health-related physical fitness and physical activity levels are significant determinants of the health status of children. Research studies pertaining to these variables are limited in sub-Saharan African countries, particularly in Zimbabwe. The purpose of this study therefore was to describe and evaluate the health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children aged 10-12 years old.

Methods: A cross-sectional study design on a total of 809 (356 boys and 451 girls) aged 10 to 12 years existing data collected by the Zimbabwe Baseline Survey was analysed. Anthropometric variables and indices of height, weight, skinfolds, gluteal girth, waist girth, BMI, SSKF, %BF, WHR and WHtR were analysed for the whole group, by gender and by age group. Nine physical fitness test items were assessed, namely, the sit and reach, standing broad jump, flamingo balance, hand grip strength, sit up, bent-arm hang, 10×5m shuttle run, 50m sprint, and 1.5-mile run tests. Physical activity levels were assessed by administering the PAQ-C questionnaire.

Results: Combined overweight and obesity was found to be 14.8%. Grade 1 and grade 2 thinness were each exhibited by 5.9% of the children. Significant gender differences were found for all of the anthropometrical variables and indices (≤ 0.05 and ≤ 0.001), apart from waist girth. Significant gender differences were found in performance in the standing broad jump, sit up, bent-arm hang, 10×5m shuttle run, 50m sprint and 1.5-mile run tests ($p \leq 0.001$). Only 43% of the children played outside for more than 1 hour after school.

Conclusion: Both thinness and combined overweight and obesity exists in the sampled Zimbabwean children. It was apparent that Zimbabwean children use walking as a mode of transport and spent an hour watching TV or using electronic games. Zimbabwean children performed poorly in strength fitness tests. Given the public health implications these findings, strategic intervention geared towards the reduction of thinness and overweight as well as promotion of physical activity among Zimbabwean children are urgently needed.

Key words: Children; health; anthropometry; physical fitness; physical activity; obesity; Zimbabwe

3.2 INTRODUCTION

Both underweight and obesity are serious public health problems among children in sub-Saharan Africa [1]. In 2010, the World Health Organisation estimated that 81% of the world's children aged between 11 and 17 years were insufficiently physically active [2]. The findings of studies have revealed that a subcutaneous fatness rebound, which results from nutritional recovery, is associated with over fatness or obesity in later life [3, 4]. Evidence shows that obesity has a multifactorial nature resulting from genetic, epigenetic, behavioural, physiological, environmental and sociocultural factors leading to an imbalance between energy intake and expenditure over an extended time period [5]. Emerging empirical evidence has confirmed that excessive fatness is closely related to the metabolic complications of obesity, cardiovascular disease, inactivity, poor physical fitness and psychosocial problems [6, 7, 8, 9].

It has been conclusively established that both physical activity and physical fitness have a significant bearing upon the health and development of children [10, 11, 12]. Both physical activity and physical fitness require regular monitoring worldwide [1, 13]. Regular surveillance studies can provide meaningful evidence-based data which can be used to inform health and socioeconomic policies [1].

Although data abound on the relationship of obesity and physical activity among children and adults in developed countries [1], limited data are available for developing countries [14]. There appears to be inadequate investigated data on sub-Saharan children [15], with South Africa being the exception. Numerous studies of health-related physical fitness, anthropometry and physical activity are available on South Africa [16, 17, 18, 19, 20, 21]. Additionally, Monyeki and colleagues [22] reported a high prevalence of thinness among rural pre-primary and primary school children. In this study, it was apparent that thinness represented a much greater public health problem than overweight [22]. Findings of a study of rural South African children showed that the children had high levels of physical activity [16]. Studies by Monyeki *et al*. [16] and Amusa *et al*. [17] showed that boys performed better than girls in the physical fitness tests for strength and power. The findings of a study of Namibian children revealed significantly low levels of physical activity, accompanied by equally significantly high incidences of overweight and obesity among the 16 to 18 year old girls in the research sample [23].

Hardly, any studies on the health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children exist [24]. There is a great need to collect data and create databases to facilitate making standardised international comparisons [1, 13, 14]. The purpose of this study therefore was to describe and evaluate the health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children aged 10-12 years old.

3.3 METHODS AND MEASUREMENTS

Study design

The study used a cross-sectional design on existing data from Healthy Kids Nutrition and Physical Activity: Zimbabwe Baseline Survey, collected from primary school children who were purposively selected in 15 primary schools in Zimbabwe [25]. The schools included urban, rural, mine and boarding schools. Children who were enrolled in Grades 4, 5, and 6 were invited to participate in the study. The initial research sample comprised 4402 children, aged between 8 and 15 years. The main objective of the Zimbabwe Baseline Survey was to obtain baseline data for Zimbabwean children concerning their nutritional and physical fitness status, nutritional knowledge, attitudes towards nutrition, anthropometric characteristics and levels of physical activity. The purpose of the survey was to provide Nestlé Zimbabwe with information which could be used to make an objective evaluation of the nutritional programmes and other related programmes which were being implemented in the various provinces at the time and also to design strategies and programmes for the future. Ethical clearance and permission were sought from the Medical Research Council of Zimbabwe (MRCZ) and the appropriate certificate was issued (Study Number: A/1900). Permission was also sought from and granted by the Ministry of Primary and Secondary Education. North-West University granted permission to perform the analyses of the secondary data (Ethics number: NWU-00067-17-S1.).

Participants

For the current study, a total of 809 children (356 boys and 453 girls), aged 10 to 12 years, was extracted from the initial sample of 4402 children who participated in the main Zimbabwe Baseline Survey of 2015 [25]. The criteria for inclusion in this study were that the children should be between 10 and 12 years of age and have provided complete data in the form of the questionnaire, anthropometric measurements and scores for health-related physical fitness.

Equipment and data collection

Training and Pilot Study

Planning and training sessions for researchers and research assistants were conducted in preparation for collecting the data. To ensure that the protocols which had been adopted were appropriate and to give the researchers an adequate amount of practice in gathering the data, a pilot study was conducted at a school in Bulawayo in Zimbabwe.

Questionnaires

The questionnaire which was employed in the Zimbabwe Baseline survey comprised three sections. The first covered ***demographic information***: date of birth, gender, grade, height and weight. The second covered ***nutritional knowledge, nutritional attitudes, the foods and meals*** which had been consumed on the previous day and also those which had been consumed during the previous seven days [25]. The last section dealt with the physical activities in which learners participated on a regular basis and also those which had been performed on the previous day [26]. The physical activity section was based on the questions which are asked in the ***Physical Activity*** Questionnaire for Children (PAQ-C**)** [26]. Each of the 9 (PAQ-C) questionnaire items was scored between 1 (low) and 5 (high physical activity), and a mean score of all items constitutes the overall PAQ score [26]. Percentages of time in hours spent in the various physical activities were then calculated for the total group and sub-groups. This physical activity measuring instrument has 'r' values ranging from r=0.45 to r=0.82 across the various areas examined [26]. The questionnaires were available in English, Shona and Ndebele.

Anthropometric measurements

The anthropometric measurements for the Zimbabwe Baseline Survey were made according to the standard procedures which have been developed by the International Society for the Advancement of Kinanthropometry (ISAK) [27]. The measurements were made by qualified Level 2 and Level 3 anthropometrists. The learners wore minimal clothing and were barefoot. The measurements included body mass, stature, arm span, skinfolds (i.e. triceps, biceps, subscapular, supraspinale and medial calf measurements), and gluteal girth [27]. Skinfolds were measured to the nearest 0.1mm. Stature was measured to the nearest 0.1cm. Breadths were measured to the nearest 0.1mm. All measurements of skinfolds and breadths were taken on the right side of the body. To ensure the reliability and quality of the data which was

collected, the researchers and research assistants were assigned to measuring only specific anthropometric variables throughout the survey. The anthropometric measurements were taken twice. The Seca Alpha Model 770 Digital weighing scale was used to measure body mass, while the Lufkin metal anthropometric tape measure was used to measure girths, circumferences and arm spans. The Harpenden Skinfold Caliper was used to measure skinfolds and a Seca stadiometer was used to measure stature.

BMI was calculated as weight divided by height squared (weight/height^2), waist-to-hip ratio calculated as weight divided by gluteal girth (WHR), and waist-to-height ratio (WHtR) calculated as waist divided by height. BMI cut-off of Cole *et al.* [28] were used to classify children into normal weight (BMI between the 18.5 and <16), overweight (BMI = 25 to <30) and obesity (BMI ≥30) as +1 and +2 standard deviation, respectively, and thinness grades 1 (−1 standard deviation = (BMI between 17 to <18.5), 2 (−2 standard deviation; BMI between 16 to <17), and 3 (−3 standard deviation = (BMI = <16).

Percentage body fat (%BF) was calculated from the sum of triceps and subscapular skinfolds using the Slaughter equation, which has been recommended for use in children from different settings [29].

Health-related fitness tests

The Health-related fitness tests for motor performance were conducted in accordance with the Eurofit and Physical best protocols [30, 31]. These field tests have been used successfully in other studies [31]. The health-related fitness tests were conducted both indoors and outdoors. The testing commenced with the least fatiguing tests and concluded with the most fatiguing tests of physical fitness. The learners were cheered on during the performance of the fitness tests to encourage optimal levels of performance.

The children first participated in a warm-up session, which was led by one of the researchers or research assistants.

Cardiorespiratory fitness was assessed using the 1.5-mile run test. Time taken to complete the run was recorded as the score. To ensure standardisation in this test, a standard perimeter of 400 metres was measured out in the rural schools, using a surveyor’s wheel.

Muscular fitness was assessed in terms of both strength and endurance. The standing broad jump test was used to measure leg power in cm. Learners attempted the test twice, aiming to attain the greatest horizontal distance. Upper body static strength was measured using the handgrip test. A hand dynamometer was used to measure maximal force exerted by both arms, one at a time. The flexed-arm hang test was used to test upper body muscular endurance, which was measured in seconds. Abdominal muscular endurance was measured using the sit-up test, which measured the maximum number of sit-ups which the learners could perform in 30 seconds.

Flexibility was measured by using the sit and reach test, with flexibility being measured in cm. In this test the learners bent their trunks and reached over as far as possible on the sit and reach box. Two trials were performed and the better distance was considered as the final score.

Agility and speed were measured using the 10×5-metre sprint shuttle test and the 50-metre dash. Scores for both tests were measured in seconds. The flamingo balance test was used to assess balance. The test measured balance by the number of times the children failed to retain their balance during a 1-minute period.

Analysis of data

The data which was analysed in this study was obtained from the original Zimbabwe Healthy Kids Baseline Survey data set, and the analyses were performed by using the IBM SPSS Statistics version 24 software. All variables were checked for normality by means of the Kolmogorov-Smirnov test. Descriptive statistics of frequencies, modes, ranges, means and standard deviations were used to analyse the various variables pertaining to the health-related physical fitness, anthropometry and levels of physical activity of the children. Differences between the means were analysed by means of an independent *t*-test and the Mann–Whitney U test was used to analyse categorical values. The level of significance was set at $p \leq 0.05$.

3.4 RESULTS

Tables 3-1 and 3-2 show the descriptive characteristics of the research sample of 809 children, for the total group and by gender, respectively. The mean age of the children in the sample was 11.03±.79 years. An average height 142.86±8.60 cm was calculated while the range of 114.70 cm to 171.40 cm was observed. The results show that 14.8% of the children were overweight while 62.4% were thin (cf. Figure 3-1). Higher proportions of girls tended to be overweight

than boys, who were generally thinner. Overweight increases with age, with high percentage of overweight in older children on the one side while on the other hand thinness decreases with age.

Table 3-1Descriptive characteristics (mean, min, max and standard deviation) for the total group (N=809)

	Mean	SD	Minimum	Maximum
Anthropometric measurements and body composition				
Age (years)	11.03	.79	10	12
Height (cm)	142.86	8.60	114.70	171.40
Body mass (kg)	33.71	7.55	19.5	69.1
Triceps skinfold (mm)	7.82	3.51	2.0	28.3
Biceps skinfold (mm)	3.92	1.70	1.5	15.5
Subscapular skinfold (mm)	6.08	2.45	2.0	22.3
Supraspinale skinfold (mm)	5.11	2.96	2.0	26.5
WC (cm)	58.17	4.86	20.8	83.5
WHR	.82	.07	.29	2.14
BMI (Kg/m^2)	16.36	2.27	11.41	32.74
SSKF (mm)	13.89	5.57	4.00	50.60
%BF	14.00	8.22	.81	64.14
WHtR	.41	.03	.15	.72
Health-related physical fitness				
Sit and reach (cm)	10.90	8.32	-20.0	35.0
Standing broad jump (cm)	131.63	19.62	81.5	215.0
Flamingo balance test (x/sec.)	9.32	5.70	.0	36.0
Handgrip strength (R) (kg)	14.92	6.42	.0	36.0
Handgrip strength (L) (kg)	13.56	6.26	.0	34.0
Sit-ups maximum (x/sec.)	12.53	5.17	.0	31.0
Bent-arm hang (sec.)	10.24	9.51	.0	60.0
10 x 5m shuttle run (x/sec.)	15.57	1.36	10.3	21.4
50m sprint (sec.)	9.15	1.15	7.1	19.7
1.5-mile run (min.)	14.01	3.51	.0	24.2
BMI Categories				
Category	**Frequency**		**Percentage**	
Grade 1 thinness	48		5.9	
Grade 2 thinness	48		5.9	
Thinness	505		62.4	
Normal weight	88		10.9	
Overweight/Obesity	120		14.8	

Key:WC-Waist circumference, WHR-Waist to hip ratio, BMI-Body mass index, SSKF-Sum of Skinfold, %BF-Percentage body fat, WHtR-Waist to height ratio, SD-Standard deviation

No significant ($p>0.05$) gender differences were found for age and waist girth, while significant gender differences were found for gluteal girth, SSKF and % BF ($p\leq0.001$. The girls were significantly ($p\leq0.05$) taller and heavier than the boys (Table 2). In terms of WHR and WHtR, the boys had significantly ($p\leq0.05$) higher mean values than the girls.

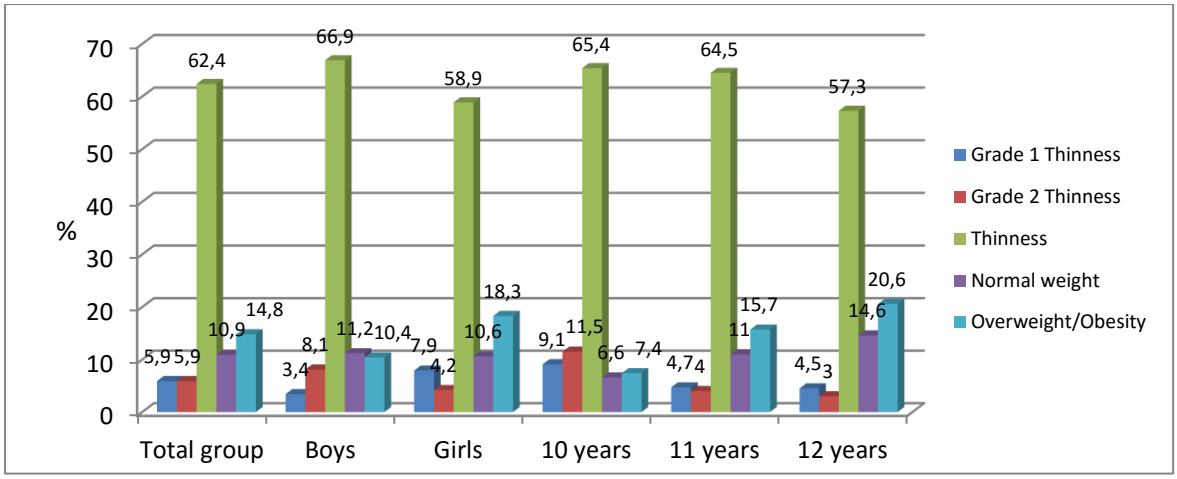

Figure 3-1 BMI categories for the total group, gender and age groups

No significant gender difference was found for handgrip strength (cf. Table 3-2). The boys ($p \leq 0.001$) performed significantly better than the girls in the standing broad jump (136.53 vs 124.76), sit-ups (14.41 vs 11.04), bent-arm hang (13.69 vs 7.57), 10x 5-m shuttle run (15.05 vs 15.96), 50 m sprint (8.82 vs 9.41) and 1.5-mile run (12.60 vs 15.16) physical fitness tests.

Table 3-3 shows the anthropometric, body composition characteristics, as well as the performance in the health-related physical fitness tests of the children by age and gender. The anthropometric and body composition means increased by age for both boys and girls for most of the parameters. The mean score for height increased by 5.34 cm between the 11-year-old and the 12-year-old boys. A greater increase of 7.73 cm in mean height was found between the 10-year-old boys and the older 12-year-old boys. Among the girls the mean height increased by 10.7 cm between the 10- and the 12-year-olds. The weight, skinfolds, waist circumference BMI and % body fat scores all increased by age group, among both the boys and the girls. For example, the mean weight among the boys increased by 5.52kg from the youngest age group to the oldest age group.

Table 3-2Gender differences for the health-related physical fitness and anthropometry

	Gender	N	Mean	SD	P-value of the differences
Age (years)	Boy	356	11.04	0.82	
	Girl	451	11.02	0.78	0.83
Height	Boy	356	140.99	8.16	≤0.001
	Girl	451	144.33	8.673	
Weight	Boy	356	32.23	6.27	≤0.001
	Girl	451	34.87	8.26	
Triceps skinfold	Boy	356	6.72	2.94	≤0.001
	Girl	451	8.68	3.69	
Subscapular skinfold	Boy	356	5.33	1.76	≤0.001
	Girl	451	6.67	2.75	
Waist girth	Boy	356	58.03	4.54	0.45
	Girl	451	58.29	5.10	
Gluteal girth	Boy	356	69.04	5.69	≤0.001
	Girl	451	73.23	8.19	
BMI	Boy	356	16.08	1.77	0.002
	Girl	451	16.57	2.59	
Waist/Hip Ratio	Boy	356	.84	.06	≤0.001
	Girl	451	.80	.08	
SSKF	Boy	356	12.05	4.52	≤0.001
	Girl	451	15.32	6.20	
%BF	Boy	356	9.31	5.44	≤0.001
	Girl	451	17.67	8.16	
WHtR	Boy	356	.41	.04	≤0.001
	Girl	451	.40	.03	
Health-related physical fitness					
Sit and reach	Boy	356	9.82	8.34	0.003
	Girl	451	11.78	8.21	
Standing broad jump	Boy	356	136.53	23.62	≤0.001
	Girl	451	124.76	20.60	
Flamingo balance test	Boy	356	8.85	5.62	0.04
	Girl	451	9.75	5.73	
Handgrip strength (R)	Boy	356	14.74	6.62	0.46
	Girl	451	15.08	6.27	
Handgrip strength (L)	Boy	356	13.24	6.27	0.23
	Girl	451	13.81	6.26	
Sit-ups maximum	Boy	356	14.41	4.94	≤0.001
	Girl	451	11.04	4.86	
Bent-arm hang	Boy	356	13.69	10.31	≤0.001
	Girl	451	7.57	7.86	
10 x 5m shuttle run	Boy	356	15.05	1.26	≤0.001
	Girl	451	15.96	1.30	
50m sprint	Boy	356	8.82	.971	≤0.001
	Girl	451	9.41	1.22	
1.5-mile run	Boy	356	12.60	2.76	≤0.001
	Girl	451	15.16	3.62	

Key:WC-Waist circumference, WHR-Waist to hip ratio, BMI-Body mass index, SSKF-Sum of Skinfold, %BF-Percentage body fat, WHtR-Waist to height ratio, SD-Standard deviation, $p \leq 0.05$

The mean scores for the WHR were similar, with only very slight differences in the standard deviation among the boys. Among the girls a greater variation in WHR was observed with a difference of 0.04 in the mean scores of the 10- and 11-year-old girls. A similar trend was evident in the results for WHtR.

The results for the performance of the children in the health-related fitness tests were varied across the different age groups of both boys and girls. The mean scores increased with age in some tests, while they decreased in others. In the sit and reach test a difference of 1.48cm was found between the mean scores of the 10- and 11-year-old boys (10.55±8.23 vs 9.07±7.35 cm), while a difference of 0.77 cm was found between the mean scores of the 11-and 12-year-old

boys. A similar trend was found in the mean scores for the flamingo balance test, in which the 11-year-old boys outperformed the 10 year-olds by 0.84 seconds, while the 11-year-olds outperformed the 12-year-olds by 0.41 seconds.

Table 3-3 Anthropometry and health-related physical fitness by age

		Age 10	Age 11	Age 12
		Mean±SD	Mean±SD	Mean±SD
Anthropometry and body composition	**Gender**			
Height	Boy	136.49±7.06	141.83±7.66	144.22±7.78
	Girl	138.54±7.57	144.70±7.54	149.24±7.75
Weight	Boy	28.87±4.76	33.13±6.47	34.39±6.06
	Girl	30.67±6.37	35.18±7.63	38.70±8.51
Triceps skinfold	Boy	6.36±2.74	6.81±2.98	6.96±3.06
	Girl	7.94±3.45	8.74±3.58	9.30±3.92
Subscapular skinfold	Boy	5.17±1.75	5.37±1.58	5.44±1.93
	Girl	6.03±2.49	6.63±2.49	7.28±3.15
Waist girth	Boy	56.39±4.39	58.26±5.13	59.27±3.65
	Girl	56.39±4.82	58.18±4.74	60.21±5.13
Gluteal girth	Boy	66.74±5.23	69.73±5.57	70.71±5.43
	Girl	69.26±6.96	73.67±7.55	76.35±8.50
Waist/Hip Ratio	Boy	.85±.06	.84±.07	.84±.05
	Girl	.82±.13	.78±.05	.79±.06
BMI	Boy	15.44±1.75	16.32±1.63	16.44±1.77
	Girl	15.63±1.98	16.67±2.61	17.32±2.79
SSKF	Boy	11.54±4.30	12.18±4.40	12.39±4.83
	Girl	13.91±5.76	15.37±5.83	16.58±6.77
%BF	Boy	8.74±5.16	9.44±5.30	9.70±5.80
	Girl	15.81±7.59	17.74±7.67	19.34±8.91
WHtR	Boy	.42±.04	.41±.04	.41±.03
	Girl	.41±.03	.40±.03	.41±.03
Health-related physical fitness				
Sit and reach	Boy	10.55±8.23	9.07±7.35	9.84±9.24
	Girl	9.71±7.30	12.56±8.92	12.91±7.67
Standing broad jump	Boy	131.19±23.30	133.25±24.52	144.46±20.95
	Girl	118.99±19.71	127.65±19.61	126.32±21.68
Flamingo balance test	Boy	9.24±6.01	8.41±4.66	8.92±6.07
	Girl	9.20±5.99	9.42±5.63	10.87±5.51
Handgrip strength (R)	Boy	11.83±5.71	14.96±6.49	16.14±6.79
	Girl	13.44±5.97	14.37±5.98	17.51±6.22
Handgrip strength (L)	Boy	11.83±5.71	13.39±6.17	14.37±6.69
	Girl	11.98±5.84	13.44±6.01	15.95±6.37
Sit-ups maximum	Boy	13.14±4 56	14.46±5.11	15 50±4.90
	Girl	9.77±4.35	11.24±4.96	11.97±4.93
Bent-arm hang	Boy	12.76±9.9	14.43±10.79	13.79±10.21
	Girl	8.44±9.34	6.90±6.99	7.57±7.40
10 x 5m Shuttle Run	Boy	15.25±1.18	14.96±1.08	14.98±1.46
	Girl	16.28±1.45	16.00±1.22	15.66±1.22
50m sprint	Boy	9.12±0.83	8.70±0.71	8.68±1.22
	Girl	9.84±1.52	9.36±1.15	9.10±0.86
1.5-mile run	Boy	12.76±2.72	12.82±3.01	12.26±2.50
	Girl	13.84±3.58	15.18±3.88	15.82±3.20

Key:WC-Waist circumference, WHR-Waist to hip ratio, BMI-Body mass index, SSKF-Sum of Skinfold, %BF-Percentage body fat, WHtR-Waist to height ratio, SD-Standard deviation.

The mean scores for the standing broad jump, handgrip strength, and sit-up tests all improved with age among the boys.

The older boys outperformed the younger boys in one of the running physical fitness tests. The 12 year old boys did better than the 10 year old boys in the 50m sprint by 0.44 seconds (8.68±1.22 vs 9.12±0.83 seconds) respectively. The performances of the 11-and 12-year-old boys were similar for the 50m sprint (8.70±0.71 vs 8.68±1.22 seconds) respectively. A decrease and increase in time taken was observed in the results of the 10×5m shuttle run and 1.5-mile run. The 11-year-old boys were the fastest (14.96±1.08) and there was a difference of 2.29 seconds between their mean score and that of the 10-year-old boys (15.25±1.18 seconds). In the 1.5-mile run test there was a difference of 0.56 minutes between the fastest age group who were the 12-year-olds and the slowest, age group who were the 10-year-olds (12.26±2.50 vs 12.82±3.01 minutes).

The results for the girls were varied. The older girls outperformed the younger girls in the sit and reach test, the flamingo balance test, the handgrip strength test, the sit-up test, the 10×5 metre shuttle run, and the 50m sprint. The younger girls however outperformed the older girls in the 1.5-mile run. A 3.2 cm difference was found between the mean scores of the 12-year-old and 10-year-old girls for the sit and reach test. Performance of the 11-and 12-year-old girls was similar in the sit and reach test with a difference of only 0.35 cm in the mean scores. There was an increase of 8.66 cm between the mean scores of the 10-year-olds and the 11-year-olds for the standing broad jump test (118.99±19.71 vs127.65±19.61 cm). There was a very small decrease of 1.33 cm between the mean scores for the 11-year-olds and 12-year-olds. A small difference of 1.67 seconds between the mean score of the 10-year-old girls and 12-year-olds (9.20±5.99 vs 10.87±5.51) in the flamingo balance test was observed. The mean for the 10-year-olds in the 50m sprint was greater by 0.48 seconds than that of the 11-year-olds, whose mean score, in turn was 0.26 greater than that of the 12-year-olds. In the 1.5-mile run the younger 10-year-old girls outperformed the older 12-year-olds by 1.98 minutes (13.84±3.58 vs 15.82±3.20) minutes, while a difference in performance of 0.64 minutes was found between the 11year old year old and 12 year old girls.

Table 3-4 presents data on physical activity scores for the total group, by gender and p-values of the gender differences. Less than half of the children in the study (43%) reported being involved in PA for longer than 1 hour after school, with boys (45%) outperforming the girls (40%). Thirty percent (30%) of the participant reported spending more than 1 hour playing outside after school. Nineteen percent (19%) of the participants spent one hour watching television and 12.5% reported spending 1 hour playing electronic games, with the respective

percentages being higher for boys than girls for both activities (21.5% vs 14.1%; 16.6% vs 11.0%). A small minority of 5.7% of the total group watched television for more than 5 hours a day, with the percentages for boys and girls being almost the same.

A minority of 24.2% of the participants reported not having spent time watching television on the previous day, while 43.1% had not played any electronic games. By contrast, 2.3% reported having spent more than 5 hours playing electronic games. Although a large majority of 85.2% reported that they walked to and from school, only 24.2% of the children chose walking as their preferred mode of transport. Most appeared to have strong preferences for commuting to and from school either by bicycle or motor car. More than half of the children (63.7% and 58.3%) reported having participated in exercise or sporting activities that made their hearts pump fast and breathing hard. There were significant gender differences for preferred modes of transport ($p \leq 0.001$) and also for the time which was spent playing or participating in vigorous sporting activities ($p \leq 0.001$).

The results for the physical activity levels for different age groups are shown in Table 3-5. Across the ages, the results show that 47% of the 10-year-old children spend less than one hour outside playing after school, with staggering decreases in ages 11 (41.9%) and 12 (39.4%). Less than 50% of the children across the three age groups spend more than 1 hour playing outside after school. The percentage of time spent in watching TV and playing electronic games was high in the category of one hour. Higher percentages of the 11-year-olds spent time watching television (7.1%) or playing electronic games (3.8%), by comparison with the 10-year-olds (3.6% and 3.6%, respectively) and 12-year-olds (3.3% and 4.5%, respectively). More than 80% of the children across the age groups walk to school. Of the 10-year-olds, 31.6% indicated that they would prefer to go to school by bicycle, while for the 11-year-olds the percentage was 7.3% and for the 12-year-olds it was 30.9%. Travelling to school by car was preferred by 33.7% of the 10-year-olds, 34% of the 11-year-olds, and 27.6% of the 12-year-old.

Table 3-4 Physical activity scores for the total group, by gender and p-values of the gender differences

		Total		Boys		Girls		Total	Boys	Girls	Sig
Physical activity variables	**Scale**	**N**	**%**	**N**	**%**	**N**	**%**	**Median**	**Median**		
How many hours do you spend outside playing after school?	None	105	18.4	48	17.5	57	19.3	2.00	2.00	2.00	.559
	Less than one hour	246	43.1	126	45.8	119	40				
	More than one hour	185	32.4	88	32.0	98	33.1				
	Don't know	36	6.2	13	4.7	21	7.1				
	Total	572	100.0	275	100.0	295	100.0				
How many hours did you spend watching videos or TV yesterday?	Less than half an hour	64	11.3	26	9.5	38	13.1	6.00	6.00	7.00	.921
	Half an hour	22	3.9	12	4.4	10	3.4				
	One hour	107	18.9	59	21.5	48	16.6				
	One and a half hours	36	6.4	19	6.9	17	5.9				
	Two hours	42	7.4	21	7.6	21	7.2				
	Two and a half hours	12	2.1	5	1.8	7	2.4				
	Three hours	27	4.8	7	2.5	20	6.9				
	Three and a half hours	7	1.2	5	1.8	2	.7				
	Four hours	17	3.0	9	3.3	8	2.8				
	Four and a half hours	6	1.1	2	.7	4	1.4				
	Five hours	30	5.3	12	4.4	18	6.2				
	More than five hours	32	5.7	15	5.5	17	5.9				
	Don't know	26	4.6	14	5.1	12	4.1				
	None	137	24.2	69	25.1	68	23.4				
	Total	565	100.0	275	100	290	100				
How many hours did you spend playing electronic games?	Less than half an hour	47	8.3	23	8.3	24	8.3	10.00	8.00	12.00	.162
	Half an hour	62	11.0	30	10.9	32	11.0				
	One hour	71	12.5	39	14.1	32	11.0				
	One and a half hours	15	2.7	9	3.3	6	2.1				
	Two hours	35	6.2	19	6.9	16	5.5				
	Two and a half hours	8	1.4	4	1.4	4	1.4				
	Three hours	24	4.2	13	4.7	11	3.8				
	Three and a half hours	4	.7	-	-	4	1.4				
	Four hours	14	2.5	8	2.9	6	2.1				
	Four and a half hours	10	1.8	6	2.2	4	1.4				
	Five hours	8	1.4	2	.7	6	2.1				
	More than five hours	13	2.3	6	2.2	7	2.4				
	Don't know	11	1.9	7	2.5	4	1.4				
	None	244	43.1	110	39.9	134	46.2				
	Total	566	100.0	276	100	290	100				
What method of travel did you use to and from school yesterday?	Walking	484	85.2	226	82.2	258	88.1	1.00	1.00	1.00	.334
	Bicycle	22	3.9	18	6.5	4	1.4				
	Motorcycle	2	.4	1	.4	1	.3				
	Bus/Kombi	28	4.9	15	5.5	13	4.4				
	Car	31	5.5	14	5.1	17	5.8				
	Total	568	100.0	275	100.0	293	100.0				
What is your preferred method of getting to and from school?	Walking	136	24.2	64	23.4	64	23.4	2.00	2.00	4.00	.000
	Bicycle	167	29.8	110	40.1	110	40.1				
	Motorcycle	18	3.2	12	4.4	12	4.4				
	Bus/Kombi	49	8.7	24	8.8	24	8.8				
	Train	10	1.8	5	1.8	5	1.8				
	Car	181	32.3	59	21.5	59	21.5				
	Total	561	100.0	274	100.0	274	100.0				
Yesterday, did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes?	Yes	365	63.7	201	72.3	164	55.6	1.00	1.00	1.00	.000
	No	194	33.9	70	25.2	124	42.0				
	Don't now	14	2.4	7	2.5	7	2.4				
	Total	573	100.0	278	100.0	295	100.0				
Yesterday, did you exercise or participate in physical activities that made your heart beat fast and made you breathe hard for at least 20 minutes?	Yes	336	58.3	201	72.3	164	55.6	1.00	1.00	1.00	.166
	No	227	39.4	70	25.2	124	42.0				
	Don't know	13	2.3	7	2.5	7	2.4				
	Total	576	100.0	278	100.0	295	100.0				

Table 3-5 Physical Activity by age group

		10 years		11 year		12 years	
Physical activity variables	**Scale**	**N**	**%**	**N**	**%**	**N**	**%**
How many hours do you spend outside playing after school?	None	46	22.9	32	14.9	27	17.4
	Less than one hour	95	47.1	90	41.9	61	39.4
	More than one hour	48	23.9	80	37.2	58	37.4
	Don't know	12	6.0	13	6	9	5.8
	Total	201	100	215	100	155	100
How many hours did you spend watching videos or TV yesterday?	Less than half an hour	28	14.2	22	10.4	13	8.6
	Half an hour	2	1.0	12	5.7	8	5.3
	One hour	43	21.8	39	18.4	25	16.6
	One and a half hours	7	3.6	13	6.1	16	10.6
	Two hours	13	6.6	18	8.5	11	7.3
	Two and a half hours	3	1.5	5	2.4	3	2.0
	Three hours	7	3.6	15	7.1	5	3.3
	Three and a half hours	1	.5	3	1.4	3	2.0
	Four hours	6	3.0	4	1.9	7	4.6
	Four and a half hours	-	-	3	1.4	3	2.0
	Five hours	15	7.6	13	6.1	-	-
	More than five hours	11	5.6	12	5.7	9	6.0
	Don't know	9	4.6	8	3.8	3	25.8
	None	52	26.4	45	21.2	39	25.8
	Total	197	100	212	100	151	100
How many hours did you spend playing electronic games?	Less than half an hour	18	9.3	18	8.5	11	7.1
	Half an hour	17	8.8	27	12.7	16	10.4
	One hour	25	12.9	30	14.1	16	10.4
	One and a half hours	5	2.6	9	4.2	1	.6
	Two hours	13	6.7	10	4.7	12	7.8
	Two and a half hours	3	1.5	4	.5	1	.6
	Three hours	7	3.6	10	3.8	7	4.5
	Three and a half hours	2	1.0	1	2.8	1	.6
	Four hours	4	2.1	8	.5	2	1.3
	Four and a half hours	-	-	6	1.9	2	1.3
	Five hours	5	2.6	1	.5	2	1.3
	More than five hours	5	2.6	4	1.9	4	2.6
	Don't know	3	1.5	3	1.4	5	3.2
	None	87	44.8	82	38.5	74	48.1
	Total	194	100	213	100	154	100
What method of travel did you use to and from school yesterday?	Walking	173	89.17	176	83.4	133	86.9
	Bicycle	6	3.09	10	4.7	5	3.3
	Motorcycle	1	.5	1	.5	-	-
	Bus/Kombi	7	4.1	16	7.6	5	3.3
	Car	13	6.7	8	3.8	10	6.5
	Total	200	100	211	100	153	100
What is your preferred method of getting to and from school?	Walking	37	18.9	51	24.4	47	30.9
	Bicycle	62	31.6	57	27.3	47	30.9
	Motorcycle	7	3.6	8	3.8	3	2.0
	Bus/Kombi	20	10.2	19	9.1	10	6.6
	Train	4	2.0	3	1.4	3	2.0
	Car	66	33.7	71	34	42	27.6
	Total	196	100	209	100	152	100
Yesterday, did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes?	Yes	127	63.5	133	62.1	101	65.6
	No	68	34	74	34.6	51	33.1
	Don't know	5	2.5	7	3.3	2	1.3
	Total	200	100	214	100	154	100
Yesterday, did you exercise or participate in physical activities that made your heart beat fast and made you breathe hard for at least 20 minutes?	Yes	105	52.2	129	60.0	98	63.2
	No	90	44.8	82	38.1	55	35.5
	Don't know	6	3.0	4	1.9	2	1.3
	Total	200	100	215	100	155	100

3.5 DISCUSSION

The purpose of this study was to evaluate and describe the health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children aged 10 to 12 years. The results of this study should help to augment the descriptive data which is available concerning children in Southern Africa which has been provided by studies such as conducted by [8, 16, 17, 18, 19, 20, 21, 22, 23, 24, 32, 33] It also provides a glimpse into the status of children in Zimbabwe with regards to their anthropometry, health-related physical fitness and physical activity. The main findings of the study shows both thinness and overweight among the 10 to 12 years old Zimbabwean children, with more (62.4%) children presenting with thinness compared to overweight (14.8%). Physical fitness varied by age and gender, with boys performing better than girls in almost all fitness tests. Overall, the Zimbabwean children walk to school and spend at least 1 hour a day watching television or playing electronic games.

Differences as well as similarities were found in the anthropometric results obtained for the Zimbabwean sample when compared with the results of other groups of 10-to 12-year-old children measured in different parts of the world. The 10-year-old boys in the Zimbabwe study were shorter than the 10 year old boys from Mpumalanga, province of South Africa while the Zimbabwean 10-year-old girls were however taller [19]. Both 10-year-old Zimbabwean boys and girls were significantly taller than the 10-year-old Andibila from Nigeria [34]. By contrast, the Zimbabwean 11-year-olds were found to be significantly shorter than their counterparts in a European study [35]. The result for the mean height of the 12-year- old boys in this study was similar to that found among the 12-year-old Limpopo boys by [19], while the boys in the study by [36] were shorter. The results of this study revealed that the mean body mass of the Zimbabwean children was less than those which had been found among children of the same age groups in other studies [19, 34, 35].

The BMI rates for the Zimbabwean boys were generally lower than those for children measured in the Limpopo province of South Africa as well as those measured in Europe studies [19, 34, 35] but were higher than the BMI rate for 11 year old boys found by Jacobs and De Ridder [23], among rural black children in the North West province of South Africa. The BMI rates of the Zimbabwean girl children were lower than those of findings of other studies, but were higher than those which were found among the Andibila of Nigeria and the girls from Limpopo, South Africa [19, 34]. The differences in the mean BMI scores between the Zimbabwean girls

and the Andibila of Nigeria could be explained by the fact that the Andibila study subjects live a very commercially isolated traditional life which would most likely limit their exposure to calorie dense foods. The Andibila also live a very active lifestyle characterised by manual labour and walking everywhere [34]. The sum of skinfolds and % BF were also lower among the Zimbabwean boys and girls although not all of the studies had provided data for these parameters. The findings of the WHtR were similar to those of children in the African studies, except for the 10-year-old girls from Mpumalanga, South Africa but were significantly lower than that found for the European children [19, 34, 35]. The waist circumferences found among the Zimbabwean children in this study were similar to those found among the other African children but were significantly lower than the results found among the European children [34, 35]. Waist circumference, BMI and % BF are strong indicators of nutritional status [36]. It could be argued that the European children coming from the developed world have greater access to food than the children from Zimbabwe, South Africa and Nigeria hence influencing their body composition.

The increased prevalence of childhood overweight and obesity witnessed in different parts of the world is the result of a complex interaction between the environment and genes [37]. The level of overweight and obesity in the present study sample was found to be 14.8%. The observed combined overweight and obesity are somewhat comparable to other African studies [15]. The combined overweight and obesity rates in Malawi 14.5%, Sierra Leone 16.9% and Comoros 15.9% [38], were reported. These African country overweight and obesity rates were however much lower than those reported by Ng *et al*., who reported rates of 33% and 38% for overweight and obesity respectively in 9-12 year old Cree children of Canada [39]. A recent study of Brazilian children also found high rates of overweight and obesity of 26.2% and 28.4% among the boys and girls respectively [6]. The joint 2017, UNICEF/WHO/World Bank Group world report on child malnutrition estimates the levels of combined overweight and obesity to be 5.2% for the African continent and 10.1% for southern Africa, respectively [38].

In this study of Zimbabwean children, prevalence of 5.9% and 5.9% for grade 1 and 2 thinness respectively. This finding is similar to findings of other studies in Africa where both overweight and thinness were observed [15, 21, 22, 34]. The results of this study reflect the double burden of undernutrition and overnutrition that characterises many developing countries [1]. The lower BMI, WHtR and WC mean values found among the Zimbabwean children can possibly be explained by the current low standard of living in Zimbabwe which greatly influences the

nutritional levels of the children. Zimbabwe is currently classified as one of the poorest countries in Africa facing many socioeconomic challenges [40].

The health-related physical fitness of children is dependent upon the time which they spend in physical activity [13], the levels of physical activity in which they engage, and genetics [11, 41]. There is growing concern over the declining levels of physical fitness among young people [6, 15]. The comparisons of the performance of the 10-12 year old Zimbabwean children in the health-related fitness tests with that of children elsewhere was made difficult by the fact that published results with the same tests for the age group were hard to find and also owing to the use of different protocols and norms in the published studies which were available. The varied reporting of results among studies also makes comparisons difficult. The findings of this study showed that the performance of the Zimbabwean children was lower than that of children in other studies for the sit and reach test, the standing broad jump, the bent-arm hang and sit-up tests [17, 19, 33, 35, 36, 40]. A study by Andreasi *et al.* [42] also reported poor levels of physical fitness in Brazilian children especially among girls.

Cardiorespiratory fitness is an important measure of health in children and adolescents, further influencing cardiorespiratory fitness later in life [42]. Adequate comparison of this measured dimension was hampered by the use of the 1.5-mile run in this study when most other studies utilised tests run over shorter distances. The Zimbabwean boys and girls however performed better in the 10×5m shuttle run test and the 50m sprint test than children of similar ages in other studies [17, 33]. Their performance in the 50m sprint was comparable with results found by Monyeki *et al*. in 2005 [16]. A study by Ng *et al* in 2006 [39] also found poor aerobic fitness in their study population. The lower performance of the Zimbabwean children in a number of the health-related physical fitness tests could be explained by the lack of participation in school-based physical activities that could help develop mastery of the elements that were tested. Physical Education is not considered a serious subject in most primary schools [43], and this is a worrying situation. The better performance of the children in the 10×5m shuttle run and the 50m sprint could be explained by the fact that 85% of the children walk to and from school. It is possible that the children get enough practise of take-off speed especially if they have to run to and from school when late and from playing games such as “tag”, which are common among Zimbabwean children. The findings of consistently better performance among the boys than the girls in most of the physical fitness tests are consistent with the findings of other studies [39].

A high level of physical activity is desirable in children, as it is associated with reduced risk of cardiovascular disease as well as increased life expectancy [37]. Physical inactivity has been identified as one of the top five risk factors for global mortality [2]. Continued participation in adequate levels of physical activity is crucial as it has been shown that the benefits of physical activity for health are not preserved indefinitely, but are determined by current physical activity [41]. This study found that most of the children did not play outside after school with only 32.4% reporting playing outside for more than 1 hour a day. These results are consistent with findings in other studies that have found that children are spending less time outside [44] and many do not engage in recommended levels of physical activity [39, 44]. This is a cause for concern as physical activity is an important factor in the human energy balance [2]. The results of the HELENA study of adolescents from 10 European countries however found very high self-reported levels of physical activity [45]. The HELENA study found that the adolescents were spending 165 minutes per day in physical activity with 32 minutes being spent in vigorous physical activity [45]. The findings of the study upon which this research article has been based indicated that the girls in the sample were generally less physically active than the boys, which tended to confirm the findings of several other studies [18]. This study found that the oldest age group of 12-year-olds spent more time playing outside and were generally more physically active. This is not consistent with other studies, which have shown that children tend to become less active as they grow older [18, 41, 46]. Interestingly, our study also found that the youngest age group of 10-year-olds spent the most time watching television, while the middle group of 11-year-olds spent the most time playing electronic games. A study by Diouf *et al.* found that the children in their study spent 65% of their time in sedentary behaviours [47] while it is generally recommended that children should spend a maximum of 2 hours a day watching television [19]. Excessive time spent in physical inactivity by children increases, the risk of overweight and obesity [19, 46, 47], which in turn, increases the risk of developing many debilitating chronic diseases during adulthood [37].

Strengths and Limitations

A major strength of this study is that it used data collected from children in primary schools from all the 10 provinces of Zimbabwe. This makes the findings fairly representative of the average school children in Zimbabwe, although caution must be taken when interpreting the results since children from the wealthier private schools were not part of the schools covered. The cross-sectional nature of the study design, measuring health-related parameters at a specific point in time represents a weakness. Repeated cross-sectional measurements or a

longitudinal study would provide a more comprehensive picture of the health-related physical fitness, anthropometry and physical activity levels of the 10 to 12 year old Zimbabwean children. Even though resources are scarce in Zimbabwe, another strength of the study is that the study analysed a wide range of health-related physical fitness parameters, which should serve to improve descriptive data which is available concerning children in southern Africa. The use of data from the 1.5-mile test although giving a picture of the cardiorespiratory fitness level of the Zimbabwean children made comparisons with other studies difficult since most studies on children tend to use aerobic fitness tests which are run over shorter distances with the 20mSRT being the most popular test. Another weakness of this study is that the data for physical activity levels was collected using subjective methods. The cross-sectional nature of the study may have limited the study one way or the other, given the fact that in a longitudinal study development of the problem can be easily identified.

3.6 CONCLUSIONS

Despite the limitations which have been enumerated, the study nevertheless provides a descriptive baseline picture of the health-related physical fitness, anthropometry and physical activity of 10-12 year old children in Zimbabwe. The study established that the children in the research sample did not spend sufficient time playing outdoors indicating a need to promote increased physical activity among primary school children. This is essential to improve the present and future health of the children of Zimbabwe. The study also established that the children had low physical fitness in the muscular endurance and muscular strength tests. Zimbabwean children use walking as a mode of transport. The findings concerning the level of underweight and overweight has shown that Zimbabwe, like other African countries going through socioeconomic transition faces the danger of continued undernutrition juxtaposed over increased overweight in children such that appropriate public policy needs to be put in place to deal with both elements. This may ensure that the levels of childhood overweight and obesity do not rise to the high levels already faced by some high-income countries namely the United States, Canada, and New Zealand, some medium-income countries such as Brazil, South Africa, and Saudi Arabia, and low-income countries such as Djibouti and Sudan. This is especially so since most African countries do not have effective obesity monitoring programmes in place as they focus more on childhood infectious diseases. The regular measurement of BMI in nationally representative samples of primary school children is highly

recommended. Future research in Zimbabwe could further expand the measurement of physical activity and health-related physical fitness to include those children enrolled in private primary schools. The future studies should however use aerobic fitness tests such as the 20mSRT that are commonly used in studies of children throughout the world to make for easier comparisons. It is recommended that future studies be conducted using objective methods to measure levels of physical activity, such as pedometers and accelerometers.

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Author Ccontributions

C.C.M. designed the study. J.H.D. oversaw the study process. D.M. was the principal investigator of the Zimbabwe Baseline survey which collected the data used in this study. D.M. and C.C.M participated in the original data collection process. M.A.M analysed the data for the study and made valuable suggestions concerning the style in which it was written. C.C.M. interpreted the results. J.H.D., M.A.M., and D.M. critically reviewed drafts of the manuscript and approved the final manuscript as submitted.

Conflicts of Interest

The authors declare that there were no conflicts of interest, as Nestlé Zimbabwe did not influence the conducting of the study in any way

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CHAPTER 4

THE RELATIONSHIP BETWEEN BODY COMPOSITION, PHYSICAL FITNESS AND LEVELS OF PHYSICAL ACTIVITY OF ZIMBABWEAN CHILDREN AGED 10-12 YEARS

Chapter 4 is a research article which will be submitted to a reputable peer-reviewed journal, the African Journal for Physical Activity and Health Sciences. Accordingly, the chapter is presented in the format which is required by the journal.

THE RELATIONSHIP BETWEEN BODY COMPOSITION, PHYSICAL FITNESS AND LEVELS OF PHYSICAL ACTIVITY OF ZIMBABWEAN CHILDREN AGED 10-12 YEARS

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4.1 Abstract

Objectives: The objective of this study was to determine the relationship between body composition, physical fitness and levels of physical activity of Zimbabwean children aged 10-12 years old.

Methods: Body composition was determined using skinfolds, BMI, sum of skinfolds, %Body fat and waist circumference. Nine physical fitness tests were used to measure health-related physical fitness. The Physical Activity Questionnaire for Children (PAQ-C) was used to assess levels of physical activity. Spearman's correlation coefficient was used to determine the relationships between variables.

Results: The results were varied. Measures of body composition, namely, BMI, waist circumference, %BF and Sum of skinfolds were strongly correlated ($r=51$ to $r=83$; $P<0.05$) with one another. Strong positive correlations were found between BMI and scores for the standing broad jump, sit-up, 1.5-mile run and handgrip strength tests ($p<0.05$). Negative correlations were found between BMI and scores for the bent-arm hang test ($r=-0.15$, $p<0.05$) and also between %BF and scores for the bent-arm hang test ($r=-0.49$, $p<0.05$).

Conclusions: Both positive and negative correlations were found between the measures of body composition and the scores for the various physical fitness tests. The correlations between the variables appear to have been influenced by the generally low BMI of the research sample.

Key words: Body composition, physical fitness, physical activity, correlation, Zimbabwe.

4.2 Introduction

The health of children and adolescents has become a cause for international concern.This is caused the ever-increasing global childhood and adolescent overweight and obesity, increased prevalence of NCDs (Patton *et al*., 2012; Sawyer *et al*., 2012), and the ever-increasing physical inactivity among young people (Bauman *et al*., 2012; Kohl *et al*., 2012). Increased physical activity is very important in the prevention of overweight and obesity in children and adolescents (Ekelund *et al*., 2004), contributing significantly to improved health and the reduced risk of NCDs throughout the life course (Oja *et al*., 2010). Physical fitness, which is described as a set of attributes enabling one to participate in physical activity (Caspersen *et al*., 1985), is an important marker of health (Ortega *et al*., 2008). Empirical evidence indicates that both physical activity level and intensity have an influence upon physical fitness (Ruiz *et al*., 2006; Hussey *et al*., 2007; Hsieh *et al*., 2014).

Scholars are particularly interested in the relationships which exist between body composition, physical fitness and physical activity because a comprehensive understanding of these three parameters can shade light on childhood and adolescent growth (Andreasi *et al*., 2010; Dumith *et al*., 2010) and health status (Esmaelzadeh & Siahkouhian, 2011). Association between physical activity and body composition during adolescence is however complicated by the physical developmental changes which take place during this period, particularly in girls (Reichert *et al*., 2015). From their study of Canadian children, Brunet and associates (2007) concluded that there had been a general decline in the physical fitness of Canadian children during the period between 1981 and 2003, which had been accompanied by a strong negative correlation with body composition. The children were measured at the ages of 7, 8 and 10. The findings of other empirical studies have demonstrated a strong inverse correlation between physical activity and overweight (Bovet *et al*., 2007), among physical activity, adiposity and BMI (Brunet *et al*., 2007; Dumith *et al*., 2010; Marques *et al*., 2016), between physical fitness and blood pressure (Brunet *et al*., 2007) and also between physical activity and screen time (Bai *et al*., 2016). Research has also revealed strong associations among physical activity, weight and physical fitness (Artero *et al*., 2010; Dencker & Anderson, 2011). Aboshkair *et al*. (2012), argue that while the associations between BMI and cardiorespiratory fitness, are well researched less research has been done concerning the combined relationships among body fat, BMI and cardiorespiratory fitness. Their study also established a positive impact of increased or higher physical activity on health-related physical fitness (Aboshkair *et al*., 2012).

Although published studies and data are now available concerning the association among body composition, physical fitness and levels of physical activity for both children and adults in the developed countries, relatively little similar data is available concerning the developing world, particularly sub-Saharan Africa. In the developing countries, research into adolescent health tends to focus on health problems, rather than developmental issues, reducing the attention which is given to issues of prevention and association (Fatusi & Hindin, 2010). The purpose of this study was therefore to determine the association between body composition, health-related physical fitness and the levels of physical activity of Zimbabwean children aged 10-12 years old.

4.3 Methodology

The research followed a cross-sectional study design on the data collected during the conducting of the Healthy Kids Nutrition and Physical Activity: Zimbabwe Baseline Survey. Data for 809 children (356 boys and 453 girls) aged 10 and 12 years was used. The study consisted of children from Grades 4 to 6 who were enrolled in 15 purposively selected primary schools from all ten provinces of Zimbabwe (Makaza *et al*., 2015). The Zimbabwe Baseline Survey was approved by the Medical Research Council of Zimbabwe (MRCZ) and the certificate number was A/1900. Written informed consent was given by parents, guardians and children and written assent was also given by all participating children. The Ministry of Education also gave permission for the survey to be conducted. Permission to conduct this study was granted by both the Medical Research Council of Zimbabwe (MRCZ) and the Health Research Ethics Committee (HREC) of the North-West University. The approval numbers are MRCZ/B/1091 and NWU-00067-17-S1, respectively.

Data were collected during October and November of 2014. The Baseline Survey involved a questionnaire which collected information on nutritional knowledge, their attitudes, the foods and meals which they had consumed during the previous 7 days, the types of physical activity in which they engaged on a regular basis as well as that engaged in, on the previous day. The questionnaire as well as the consent and assent forms were made available in English, Shona and Ndebele. All children enrolled in Grades 4 to 6 and present on the day on which the data was collected had equal opportunity to participate in the study if their parents and they themselves individually indicated that they consented to do so. A total of 1062 children were randomly selected to participate in tests of health-related physical fitness. For the purposes of this study, data which had been obtained from 809 children was analysed. The anthropometric measurements were made according to standard ISAK specifications. Children were in minimal clothing (Stewart *et al*., 2011). The fitness

tests were conducted according to the standardised Eurofit (1988) and American Alliance for Health, Physical Education, Recreation and Dance (2013) protocols. The health-related physical fitness tests conducted were sit and reach, standing broad jump, flamingo balance test, handgrip strength, sit-ups, bent-arm hang, 10×5m shuttle run, 50m sprint and the 1.5-mile run.

Demographic questionnaire

The questionnaire captured demographic information concerning ages, genders, and the grades of the children.

Anthropometric measurements

The height of the children was measured by means of a stadiometer. The height of the children was measured while the children had no shoes and recorded to the nearest 0.1cm. The weight was measured while the children wore minimal clothing and recorded to the nearest 0.1kg. A Harpenden skinfold calliper was used to measure skinfolds. The triceps and subscapular skinfolds were measured to the nearest 0.1mm. Percentage of body fat was calculated from the sum of the triceps and subscapular skinfolds using the equation which was developed by Slaughter *et al*., (1988), which has been approved for use with children from different settings. The waist circumference was measured to the nearest 0.1cm with a Lufkin flexible steel anthropometric tape measure.

Physical Fitness

Nine physical fitness tests were part of this study. The flamingo balance test was used to determine the ability of the children to balance on one leg. The children were required to stand barefoot, with one leg flexed and held at the back, on a beam which was 3cm wide, 5cm high and 50cm long. The number of times which the children lost their balance in a 60-second period were counted and recorded. A score of zero was awarded if a child lost balance 15 times during the first 30 seconds of the test. The children were required to hold onto a horizontal bar with their chins above the bar for the flexed-arm hang test, which measured upper body strength. Their scores were recorded in seconds. The handgrip strength test also measured upper body strength. The children were required to squeeze a dynamometer forcefully and continuously, for at least 2 seconds, with each hand. The scores were recorded to the nearest 0.1kg. A standardised sit and reach box was used for the sit and reach test to measure the flexibility of the back and the hamstrings of the children. Scores were measured to the nearest 0.1cm. The sit-up test, to measure abdominal strength, was performed for

30 seconds with the knees bent at 90 degrees. The children were required to raise their trunks to touch their knees with their elbows, with their arms crossed in front of their chests. Their scores comprised the number of sit-ups which they were able to perform successfully in 30 seconds. The standing broad jump test measured lower body strength and the children were required to jump as far as they could from a stationery position. The distance jumped was measured to the nearest 0.1cm. The 10×5m shuttle run was used to measure speed and agility. The children were required to run as fast as they could between two lines, which had been drawn 10 metres apart and to pivot at each end, in order to repeat the run five times. The test was scored in seconds. The 50-metre sprint test was also used to assess speed and agility and required the children to run as fast as they could over a distance of 50 metres. Running commenced from a standing position and the results were scored in seconds. The 1.5-mile run tested their aerobic fitness, with the scores being recorded in the form of the time which was taken to complete the run in minutes.

4.4 Data analysis

Descriptive statistics of frequencies, means and standard deviations were used to analyse body composition, health-related physical fitness and levels of physical activity. The Mann-Whitney U-test was used to determine differences between genders. Spearman's correlation coefficient was used to determine correlations among the variables of body composition, health-related physical fitness, and levels of physical activity. Correlations were determined for the whole group and also for both genders. The statistical analyses were performed by making use of Version 25 of the Statistical Package for the Social Sciences (SPSS) software. The level of significance was set at $p<0.05$

4.5 Results

Table 4-1: Characteristics of sample population

	C- MEAN	SD	B- MEAN	SD	G-MEAN	SD
Anthropometric measurements and body composition						
Age (years)	11.03	.79	11.04	0.82	11.02	0.78
Height (cm)	142.86	8.60	140.99	8.16	144.33	8.67
Body mass (kg)	33.71	7.55	32.23	6.27	34.87	8.26
Triceps skinfold (mm)	7.82	3.51	6.72	2.94	8.68	3.69
Subscapular skinfold (mm)	6.08	2.45	5.33	1.76	6.67	2.75
Waist girth (cm)	58.17	4.86	58.03	4.54	58.29	5.69
Waist-to-hip ratio	.82	.07	.84	.06	.80	.08
Body mass index	16.36	2.27	16.08	1.77	16.57	2.59
Sum of skinfolds (mm)	13.89	5.57	12.05	4.52	15.32	6.20
% Body fat	14.00	8.22	9.31	5.44	17.67	8.16
Waist-to-height-ratio	.41	.03	.41	.04	.40	.03
Health-related physical fitness						
Sit and reach (cm)	10.90	8.32	9.82	8.34	11.78	8.21
Standing broad jump (cm)	131.63	19.62	136.53	23.62	124.76	20.60
Flamingo balance test (×/sec)	9.32	5.70	8.85	5.62	9.75	5.73
Handgrip strength (R)(kg)	14.92	6.42	14.74	6.62	15.08	6.27
Handgrip strength (L)(kg)	13.56	6.26	13.24	6.27	13.81	6.26
Sit-ups Maximum (×/sec)	12.53	5.17	14.41	4.94	11.04	4.86
Bent-arm hang (sec)	10.24	9.51	13.69	10.31	7.57	7.86
10×5m shuttle run (×/sec)	15.57	1.36	15.05	1.26	15.96	1.30
50m sprint (sec)	9.15	1.15	8.82	.97	9.41	1.22
1.5-mile run (sec)	14.01	3.51	12.60	2.76	15.16	3.62
KEY:						
C-MEAN=COMBINED MEAN, B-MEAN=BOYS MEAN, G-MEAN=GIRLS MEAN, SD-STANDARD DEVIATION						
cm=centimetres, kg=kilograms, sec=seconds, ×=times, R=Right, L=Left, BMI=Body mass index						
mm=millimetres						

Table 4-1 and Figure 4-1 summarise the anthropometric characteristics of the research sample. The mean height was142.86cm and the mean weight was 33.71kg. The girls were heavier than the boys and had a higher mean percentage of body fat, while 14.83% of the children were classified as being overweight. A large portion of the children were classified as being thin or underweight. The boys outperformed the girls in all of the physical fitness tests except the flamingo balance, the sit and reach and the handgrip strength tests, in which the girls outperformed the boys.

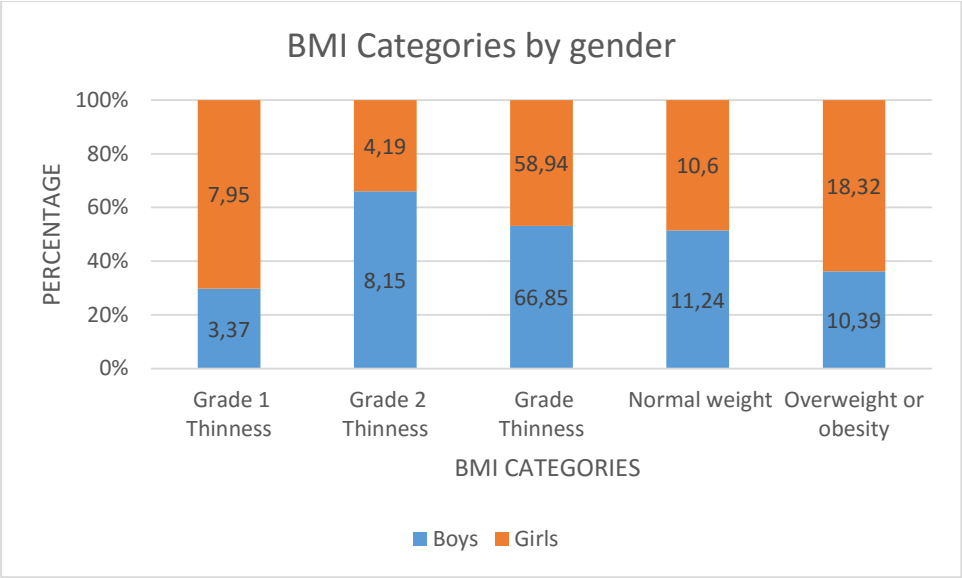

Figure 4-1: BMI categories by gender

Physical Activity

The physical activity of the children was captured by the (PAQ-C) Physical Activity Questionnaire for Children (Kowalski *et al*., 2004). The children provided information on the physical activities they engaged in regularly as well as those engaged in on the previous day. Responses to the questions were given according to categories. These responses were added up and percentages were calculated for the group of children. Table 4-2 shows the physical activity by age group. Only 23.9% of the 10 year olds spent more than one hour playing outside compared to 37.2% of the 11 year olds and 37.4% of the 12 year olds. Most of the children walked to school. The percentages of children who walked to school were as follows; 89.17% of the 10 year olds, 83.4% of the 11 year olds and 86.9% of the 12 years. A considerable percentage of the children preferred to go to school by bicycle. The highest percentage of 31.6% was among the 10 year olds followed by 30.9% among the 12 year olds and then 27.3% among the 11year olds. Many of the children reported having participated in vigorous physical activity on the previous day. The percentages were as follows; 52.2% of the 10 year olds, 60.0% of the 11 year olds and 63.2% of the 12 year olds.

Table 4-2: Physical Activity by age group.

		10 years		11 year		12 years	
Physical activity variables	**Scale**	**N**	**%**	**N**	**%**	**N**	**%**
How many hours do you spend outside playing after school?	None	46	22.9	32	14.9	27	17.4
	Less than one hour	95	47.1	90	41.9	61	39.4
	More than one hour	48	23.9	80	37.2	58	37.4
	Don't know	12	6.0	13	6	9	5.8
	Total	201	100	215	100	155	100
How many hours did you spend watching videos or TV yesterday?	Less than half an hour	28	14.2	22	10.4	13	8.6
	Half an hour	2	1.0	12	5.7	8	5.3
	One hour	43	21.8	39	18.4	25	16.6
	One and a half hours	7	3.6	13	6.1	16	10.6
	Two hours	13	6.6	18	8.5	11	7.3
	Two and a half hours	3	1.5	5	2.4	3	2.0
	Three hours	7	3.6	15	7.1	5	3.3
	Three and a half hours	1	.5	3	1.4	3	2.0
	Four hours	6	3.0	4	1.9	7	4.6
	Four and a half hours	-	-	3	1.4	3	2.0
	Five hours	15	7.6	13	6.1	-	-
	More than five hours	11	5.6	12	5.7	9	6.0
	Don't know	9	4.6	8	3.8	3	25.8
	None	52	26.4	45	21.2	39	25.8
	Total	197	100	212	100	151	100
How many hours did you spend playing electronic games?	Less than half an hour	18	9.3	18	8.5	11	7.1
	Half an hour	17	8.8	27	12.7	16	10.4
	One hour	25	12.9	30	14.1	16	10.4
	One and a half hours	5	2.6	9	4.2	1	.6
	Two hours	13	6.7	10	4.7	12	7.8
	Two and a half hours	3	1.5	4	.5	1	.6
	Three hours	7	3.6	10	3.8	7	4.5
	Three and a half hours	2	1.0	1	2.8	1	.6
	Four hours	4	2.1	8	.5	2	1.3
	Four and a half hours	-	-	6	1.9	2	1.3
	Five hours	5	2.6	1	.5	2	1.3
	More than five hours	5	2.6	4	1.9	4	2.6
	Don't know	3	1.5	3	1.4	5	3.2
	None	87	44.8	82	38.5	74	48.1
	Total	194	100	213	100	154	100
What method of travel did you use to and from school yesterday?	Walking	173	89.17	176	83.4	133	86.9
	Bicycle	6	3.09	10	4.7	5	3.3
	Motorcycle	1	.5	1	.5	-	-
	Bus/Kombi	7	4.1	16	7.6	5	3.3
	Car	13	6.7	8	3.8	10	6.5
	Total	200	100	211	100	153	100
What is your preferred method of getting to and from school?	Walking	37	18.9	51	24.4	47	30.9
	Bicycle	62	31.6	57	27.3	47	30.9
	Motorcycle	7	3.6	8	3.8	3	2.0
	Bus/Kombi	20	10.2	19	9.1	10	6.6
	Train	4	2.0	3	1.4	3	2.0
	Car	66	33.7	71	34	42	27.6
	Total	196	100	209	100	152	100
Yesterday, did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes?	Yes	127	63.5	133	62.1	101	65.6
	No	68	34	74	34.6	51	33.1
	Don't know	5	2.5	7	3.3	2	1.3
	Total	200	100	214	100	154	100
Yesterday, did you exercise or participate in physical activities that made your heart beat fast and made you breathe hard for at least 20 minutes?	Yes	105	52.2	129	60.0	98	63.2
	No	90	44.8	82	38.1	55	35.5
	Don't know	6	3.0	4	1.9	2	1.3
	Total	200	100	215	100	155	100

Table taken from Mavingire *et al*., 2018 page 123

Table 4.3 demonstrates the associations between the various variables pertaining to body composition, health-related physical fitness and levels of physical activity for both boys and girls. Significant positive associations were observed weight and subscapular skinfold, waist girth, BMI,

sum of skinfolds, fat % and waist-to-height ratio at a level of $p<0.01$. Weight was significantly negatively associated with waist-to-hip ratio. Weight was positively significantly associated with the following fitness tests: sit and reach, flamingo balance, 10×5-metre shuttle run, and the 50-metre sprint at a level of $p<0.01$. BMI was significantly positively associated with all skinfolds, fat %, and waist girth. BMI was also significantly positively associated with some fitness tests, namely, the sit and reach, standing broad jump, handgrip strength, and 1.5-mile run tests, although but was significantly negatively associated with the bent-arm hang at $p<0.01$.

In addition, significant associations were observed between fat % and other body composition variables as well as between fat % and fitness tests. Significant positive associations at $p<0.01$ were found between waist girth and the anthropometric variables of height, weight, triceps skinfold, subscapular skinfold, BMI, sum of skinfolds and fat %. Significant positive associations at $p<0.05$ and $p<0.01$ were observed between waist girth and the fitness tests of flamingo balance, handgrip strength and the anthropometric index of waist-to-height ratio. Positive associations were found between the sit and reach test and the anthropometric variables. The standing broad jump and the bent-arm hang tests were inversely associated with the anthropometric variables with the associations being stronger for the bent-arm hang.

Table 4-3: Correlation coefficients for boys and girls

	Height	Wght	Tri	SSc	Wst	WHR	BMI	SS	F %	WHtR	S R	SBJ	FB	HGR	HGL	SU	BAH	10×5	50m	1.5m
Height		.84**	.37**	.44**	.48**	-.43**	.43**	.41**	.40**	-.32**	.15**	.14**	.13**	.34**	.31**	.09**	-.18**	-.07**	-.14**	.28**
Weight	.84**		.51**	.57**	.66**	-.38**	.83**	.55**	.51**	-.01	.18**	.14**	.17**	.36**	.34**	.06**	-.20**	-.06**	-.08**	.33**
Triceps	.37**	.51**		.83**	.49**	-.49**	.51**	.98**	.91**	.21**	.21**	-.12**	.16**	.00**	.02**	-.06	-.42**	.23**	.18**	.39**
Subscapular	.44**	.57**	.83**		.57**	-44**	.54**	.93**	.87**	.24**	.20**	-.08**	.13**	.02**	.01**	-.09**	-.41**	.22**	.17**	.34**
Waist girth	.48**	.66**	.49**	.57**		.02**	.64**	.54**	.45**	.62**	.10*	.07*	.16**	.28**	.26**	.02	-.16**	-.04	-.03	.13**
Waist/Hip ratio	-.43**	-.38**	-.49**	-44**	.01		-.23**	-.49**	-55**	.39**	-.17**	.05**	-.06	-.17**	-.20**	-.00	.30**	-.14**	-.02	-.34**
BMI	.43**	.83**	.51**	.54**	.64**	-.23**		.54**	.46**	.31**	.16**	.08*	.16**	.26**	.24**	.01	-.15**	-.05	-.01	.30**
Sum of SKF	.41**	.55**	.98**	.93**	.54**	-.49**	.54**		.94**	.23**	.22**	-.11**	.16**	.01	.02	-.07*	-.43**	.24**	.18**	.38**
Fat %	.40**	.51**	.91**	.87**	.45**	-.55**	.46**	-.94**		.14**	.23**	-.20**	.17**	.01	.03	-.18**	-.49**	,33**	.26**	.43**
Waist/HeightR	-.32**	-.01	.21**	.24**	.62**	.39**	.31**	.23**	.14**		-.00	-.06	.06	-.01	-.01	-.07*	-.03	.0.3	.13**	-.10*
Sit and reach	.15**	.18**	.21**	.20**	.10*	-.17**	.16**	.22**	.23**	-.00		.09*	-.04	-.07	-.07	.01	-.14**	-.01	.03	.26**
Standing b j	.14**	.14**	-.12**	-.08*	.07*	.05	.08*	-.11**	-.20**	-.06	.09*		-.12**	.13**	.15**	.28**	.31**	-.42**	-.41**	-.08
Flamingo b	.13**	.17**	.16**	.13**	.16**	-.06	.16**	.16**	.17**	.06	-.04	-.12**		-.03	-.07	-.10*	-.15**	.14**	.11**	.25**
Handgrip R	.34**	.36**	.00	.02	.28**	-.17**	.26**	.01	.01	-.01	-.07	.13**	-.03		.90**	.11**	.16**	-.33**	-20**	.02
Handgrip L	.31**	.34**	.02	.01	.26**	-.20**	.24**	.02	.03	-.01	-.07	.15**	-.07	.90**		.10*	.15**	-.31**	-19**	.03
Sit-ups	.09**	.06	-.06	-.09**	.02	-.00	.01	-.07*	-.18**	-.07*	.01	.28**	-.10*	.11**	.10*		.19**	-.31**	-.35**	-.16**
Bent-arm hang	-.18**	-.20**	-.41**	-.41**	-.16**	.30**	-.15**	-.43**	-.49**	.31**	-.14**	.31**	-.15**	.16**	.15**	.19**		-.45**	-.29**	-.26**
10×5m shuttle	-.07	-.06	.23**	.22**	-.04	-.14**	-.05	.24**	.33**	.03	-.01	-.42**	.14**	-.33**	-.31**	-.31**	-.45**		.50**	.29**
50m sprint	-.14**	-.08*	.18**	.17**	-.03	-.02	-.01	.18**	.26**	.13**	.03	-.41**	.11**	-.20**	-.19**	-.35**	-.29**	.50**		.19**
1.5-mile run	.28**	.33**	.39**	.34**	.13**	-.34**	.30**	.38**	.43**	-.10*	.26**	-.08	.25**	.02	.03	-.16**	-.26**	.29**	.19**	

KEY	Height=Height of subject	Wst=Waist	F %=Fat percentage	F B=Flamingo balance	BAH=Bent-arm hang
	Wght=Weight of subject	WHR=Waist-to-hip ratio	WhtR=Waist-to-height ratio	HGR=Handgrip right	10×5=10×5m shuttle run
	Tri=Triceps skinfold	BMI=Body mass index	S R=Sit and reach	HGL=Handgrip left	50m=50-metre sprint
	SSc=Subscapular skinfold	SS=Sum of skinfolds	S B J=Standing broad jump	SU=Sit-ups	1.5m=1.5-mile run
***= Correlation is significant at 0.05 level**		**= Correlation is significant at 0.01 level			

Table 4-4: Correlation coefficients for boys

	Height	Weight	Triceps	SSc	Waist G	WHR	BMI	SS	Fat %	WhtR	S & R	SBJ	FB	HGR	HGL	Sit Up	BAH	10×5	50m	1.5m
Height		.81**	.25**	.25**	.40**	-.33**	.33**	.26**	.26**	-.41**	.07	.20**	.06	.26**	.24**	.26**	-.11*	-.19**	-.28**	-.03
Weight	.81**		.46**	.45**	.59**	-.31**	.79**	.48**	.47**	-.09	.04	.24**	.12*	.32**	.31**	.26**	-.11*	-.23**	-.31**	.05
Triceps	.25**	.46**		.78**	.43**	-.30**	.52**	.97**	.97**	.21**	.12*	-.02	.14*	-.10	-.07	.11*	-.27**	.09	.08	.20**
Subscapular	.25**	.45**	.78**		.45**	-.21**	.50**	.90**	.90**	.24**	.10	.00	.10	-.15**	-.18**	.02	-.27**	.10	.08	.10
Waist girth	.40**	.59**	.43**	.45**		.14**	.57**	.45**	.45**	.62**	-.01	.16**	.11	.29	.28**	.10	-.15**	-.13*	-.14*	.04
Waist/Height R	-.33**	-.31**	-.30**	-.21**	.14**		-.19**	-.28**	-.29**	.41**	-.10	-.13*	.04	-.18**	-.24**	-.20**	.03	.17**	.17**	-.06
BMI	.33**	.79**	.52**	.50**	.57**	-.19**		.53**	.53**	.27**	.01	.20**	.20**	.13*	.24**	.24**	.18**	-.06	-.20**	.12
Sum of SKF	.26**	.48**	.97**	.90**	.45**	-.28**	.53**		1.0**	.22**	.12*	-.01	.13*	-.13*	-.11*	.07	-.28**	.10	.08	.18**
Fat %	.26**	.47**	.97**	.90**	.45**	-.29**	.53**	1.0**		.22**	.13**	-.02	.12*	-.13*	-.12*	.07	-.29**	.11*	.08	.18**
Waist/Height R	-.42**	-.09	.21**	.24**	.62**	.41**	.27**	.22**	.22**		-.04	-.03	.08	.03	.04	-.12*	-.05	.07	.11*	.03
Sit and reach	.07	.04	.12*	.10	.01	.10	.01	.12*	.13*	-.04		.15*	-.09	-.18**	-.17**	.12*	-.08	.04	.08	.22**
Standing b	.20**	.24**	-.02	.00	.16**	-.13*	.20**	-.01	-.02	-.03	.15*		-.18**	.19**	.22**	.30**	.24**	-42**	-44**	.05
Flamingo b	.06	.12*	.14*	.10	.11	.04	.13*	.13*	.12*	.08	-.09	-.18**		-.07	-.11	-.13*	-20**	.15*	.14*	.11
Handgrip R	.26**	.32**	-.10	-.15**	.29**	-.18**	.24**	-.13*	-.13*	.03	-.18**	.19**	-.07		.91**	.22**	.22**	-.42**	-.34**	-.10
Handgrip L	.24**	.31**	-.07	-.18**	.28**	-.24**	.24**	-.11*	-.12*	.04	-.17**	.22**	-.11	.91**		.20**	.21**	-.36**	-.33**	-.08
Sit-ups	.26**	.26**	.11*	.02	.10	-.20**	.18**	.07	.07	-.12*	.12*	.30**	-.13*	.22**	.20**		.14*	-.35**	-.37**	-.11
Bent-arm h	-.11*	-.11*	-.27**	-.27**	-.15**	.03	-.06	-.28**	-.29**	-.05	-.08	.24**	-.20**	.22**	.21**	.14 *		-.43**	-.25**	-.10
10×5m	-.19**	-.23**	.09	.10	-.13*	.17**	-.20**	.10	.11*	.07	.04	-.42**	.15*	-.42**	-.36**	-.35**	-43**		.50**	.05
50m sprint	-.28**	-.31**	.08	.08	-.14*	.17**	-.23**	.08	.08	.11*	.08	-.44**	.14*	-.34**	-.32**	-.37**	-.25**	.50**		.17*
1.5-mile run	-.03	.05	.20**	.10	.04	-.06	.12	.18**	.18**	.03	.22**	.05	.11	-.10	-.08	-.11	-.10	.05	.17*	

KEY	Height=Height of subject	Waist G=Waist girth	Fat %=Fat Percentage	F B=Flamingo balance	BAH=Bent-arm hang
	Weight=Weight of subject	WhR=Waist-to-hip ratio	WhtR=Waist-to-height ratio	HGR=Handgrip right	10×5=10×5m shuttle run
	Triceps=Triceps skinfold	BMI=Body mass index	S & R=Sit and reach	HGL=Handgrip left	50m=50-metre sprint
	SSc=Subscapular skinfold	SS=Sum of skinfolds	S B J=Standing broad jump	Sit Up=Sit-ups	1.5m=1.5-mile run
***= Correlation is significant at 0.05 level**		**= Correlation is significant at 0.01 level			

Among the boys, weight and waist girth were positively associated with anthropometric variables of height, skinfolds, BMI and fat %. The association for weight with BMI were particularly strong, with a correlation coefficient of 0.79. The fat percentage was negatively associated with most fitness tests at a significance of $p<0.05$. Both negative and positive associations were observed among the results for the girls. Height was significantly associated with most of the variables, particularly when the p-value was set at $p<0.01$ level. Waist girth and BMI were significantly positively associated with the majority of the anthropometric variables. The level of significance was at the $p<0.01$ level. BMI was positively associated with the sit and reach, flamingo balance and handgrip tests, but was negatively associated with performance in the bent-arm hang and the 10×5-metre shuttle run.

Table 4-5: Correlation coefficients for girls

	Height	Weight	Triceps	SSc	Waist	WhR	BMI	SS	F %	WHtR	S & R	SBJ	F B	HGR	HGL	S U	BAH	10×5	50m	1.5mile
Height		.84**	.38**	.49**	.56**	-.43**	.49**	.44**	.44**	-.21**	.17**	.22**	.15**	.42**	.38**	.11*	-.09	-.14**	-.19**	.31**
Weight	.84**		.53**	.63**	.73**	-.39**	.87**	.59**	.59**	.11*	.24**	.15**	.18**	.40**	.36**	.03	-.16**	-.06	-.02	.39**
Triceps skinfold	.38**	.53**		.82**	.58**	-.47**	.53**	.97**	.97**	.34**	.22**	-.04	.13*	.08	.08	.01	-.37**	.15**	.11*	.40**
Subscapular SF	.49**	.63**	.82**		.71**	-.42**	.59**	.92**	.92**	.38**	.22**	.01	.11*	.14**	.13*	.00	-.37**	.13**	.10*	.34**
Waist girth	.56**	.73**	.58**	.71**		-.06	.69**	.66**	.66**	.64**	.19**	.02	.19**	.27**	.25**	-.04	-.19**	-.01	.06	.17**
Waist/Hip ratio	-.43**	-.39**	-.47**	-.42**	-.06		-.24**	-.46**	-.46**	.32**	-.13*	-.06	-.05	-.21**	-.20**	-17**	.22**	-.08	.10*	-.33**
BMI	.49**	.87**	.53**	.59**	.69**	-.24**		.58**	.58**	.38**	.25**	.04	.17**	.28**	.25**	-.05	-.16**	-.00	.10*	.36**
Sum of skinfolds	.44**	.59**	.97**	.92**	.66**	-.46**	.58**		1.00**	.38**	.23**	-.02	.14*	.10*	.10	.01	-.39**	.14**	.11*	.38**
Fat %	.44**	.59**	.97**	.92**	.66**	-.46**	.58**	1.00**		.38**	.23**	-.02	.14**	.10*	.10	.01	-.39**	.14**	.11*	.38**
Waist/Height R	-21**	.11*	.34**	.38**	.64**	.32**	.38**	.38**	.38**		.09	-.17**	.06	-.06	-.04	-.15**	-.14**	.10*	.25**	-.10
Sit and reach	.17**	.24**	.22**	.22**	.19**	-.13*	.25**	.23**	.23**	.09		.12*	.01	.03	.01	.01	-.10	-.16**	-.08	.19**
Standing b jump	.22**	.15**	-.04	.01	.02	-.06	.04	-.02	-.02	.17**	.12*		-.04	.09	.11*	.15**	.27**	-.28**	-.28**	.02
Flamingo b	.15**	.18**	.13*	.11*	.19**	-.05	.17**	.14*	.14*	.06	.01	-.04		.01	-.04	-.04	-.08	.07	.05	.31**
Handgrip R	.42**	.40**	.08	.14**	.27**	-.21**	.28**	.10*	.10*	-.06	.03	.09	.01		.90**	.06	.16**	-.31**	-.10*	.07
Handgrip L	.38**	.36**	.08	.13*	.25**	-.20**	.25**	.10	.10	-.04	.01	.11*	-.04	.90**		.05	.17**	-.34**	-.12*	.04
Sit-ups	.11*	.03	.01	.00	-.04	-.17**	-.05	.01	.01	-.15**	.01	.15**	-.04	.06	.05		.10*	-.10*	-.21**	.01
Bent-arm hang	-.09	-.16**	-.37**	-.37**	-.19**	.22**	-.16**	-.39**	-.39**	-14**	-.10	.27**	-.08	.16**	.17**	.10		-.32**	-.21**	-.17**
10×5m shuttle	-.14**	-.06	.15**	.13**	-.01	-.08	-.00	.14**	.14**	.10*	-.16**	-.28**	.07	-.31**	-.34**	-.10*	-.32**		.38**	.27**
50m sprint	-.19**	-.02	.11*	.10*	.06	.10*	.11*	.11*	.11*	.25**	-.08	-.28**	.05	-.10*	-.12*	-.21**	-21**	.38**		.02
1.5-mile run	.31**	.39**	.40**	.34**	.17**	-.17**	-.33**	.36**	.38**	.38**	-.10	.19**	.02	.31**	.07	.04	.01	-.17**	.27**	

KEY	Height=Height of subject	Waist=Waist girth	F %=Fat percentage	F B=Flamingo balance	BAH=Bent-arm hang
	Weight=Weight of subject	WhR=Waist-to-hip ratio	WhtR=Waist-to-height ratio	HGR=Handgrip right	10×5=10×5m shuttle run
	Triceps=Triceps skinfold	BMI=Body mass index	S & R=Sit and reach	HGL=Handgrip left	50m=50-metre sprint
	SSc=Subscapular skinfold	SS=Sum of skinfolds	S B J=Standing broad jump	S U=Sit-ups	1.5mile=1.5-mile run
***=Correlation is significant at 0.05 level**		**=Correlation is significant at 0.01 level			

4.6 Discussion

The combined prevalence of overweight and obesity in the research sample of children was 14.8%, which is higher than the UNICEF/WHO/World Bank Group estimated levels for Africa and Southern Africa for 2017, of 5.2% and 11.8% respectively (UNICEF/WHO/World Bank Group, 2017). According to research, obesity and poor cardiorespiratory fitness greatly contribute to the increased prevalence of cardiovascular disease (Hsieh *et al*., 2014). It has been shown that children and adolescents with higher levels of cardiorespiratory fitness have healthier cardiovascular profiles than those whose levels of cardiovascular fitness are lower (Ortega *et al*., 2008). Increased physical activity is highly recommended in the prevention of childhood and adolescent obesity (Reichert *et al*., 2015). The study of the associations among body composition, physical fitness and physical activity in young people in different settings is therefore key to understanding the dynamics of the fight against the obesity epidemic. Bovet *et al*. (2007) found strong inverse associations between physical fitness and overweight in over 4000 adolescents in the Seychelles (Bovet *et al*., 2007).

Moderate and strong associations found for this study will be discussed. Strong associations were found between measures of adiposity and body weight. The positive correlations with weight ranged from r=0.51 for association with the triceps skinfold to r=0.83 for association with BMI showing reasonable agreement between the various measures of adiposity. These results are in agreement with findings of Brunet *et al.* (2007), who found significantly higher correlations of r=0.90 and r=0.86 between BMI and waist circumference among Canadian boys and girls, respectively (Brunet *et al*., 2007). The fact that percentages of body fat was strongly positively correlated with the skinfolds and sum of skinfolds shows that skinfolds are a good indicator of adiposity in the study population.

Inverse associations are usually expected between BMI and tests that require the body to be projected through space (Kim *et al*., 2005; Monyeki *et al*., 2005; Bovet *et al*., 2007). However a positive association was found between BMI and the standing broad jump for the children in our study. This could be explained by the fact that a large portion of the sample was underweight. This was similar to the findings of Monyeki and colleagues in an undernourished population. In the study by Monyeki and colleagues, the result was ascribed to the possibility that the BMI was a result of more muscle mass, rather that fat (Monyeki *et al*., 2005).

The positive association between BMI and handgrip strength, r=0.26 and r=0.24 for the combined genders for the right and left hand respectively is similar to the findings of Bovet *et al*. (2007). On the other hand, the percentages of body fat and the sum of skinfolds were inversely associated with the handgrip strength test. The reasons for this observation are not clear since it would have been expected that underweight children would perform poorly in the handgrip test since they would be expected to also have less absolute muscle mass required for good performance in this test (Artero *et al*., 2010). Stature correlated positively with the right and left handgrip strength tests. This finding was similar to that of Muhumbe & Van Gent among rural and urban boys in the Eastern Cape province of South Africa (Muhumbe & Van Gent, 20114).

Inverse correlations are usually observed between BMI and percentage body fat with physical fitness tests requiring speed and agility as well as in lifting of the body (Bovet *et al*., 2007; Brunet *et al*., 2007). In this study however, only weak insignificant negative correlations were found between BMI and scores for the 10×5-metre shuttle run and the 50-metre sprint in the combined sample. The finding could possibly be explained by the fact that the majority of the children were thin. It has been argued that both being underweight and overweight will affect physical performance (Monyeki *et al*., 2005; Artero *et al*., 2010). Expected significant negative correlations were however observed among the boys. Unexpected positive correlations found between the sum of skinfolds measurements and percentages of body fat with the 1.5-mile run test for aerobic fitness in the combined group and among the girls differed from the findings of other research studies. Ostojic *et al*. (2011) found strong negative correlations between aerobic fitness and percentages of body fat among Serbian school children aged 6 to 14 years.

In the bent-arm hang test, the correlations of r=-0.15 with BMI and r=-0.49 with percentages of body fat confirmed previous findings that underweight children tend to perform better in the test (Artero *et al*., 2010). Andreasi and colleagues point out that significant negative correlations are usually observed between BMI and waist circumference and abdominal strength (Andreasi *et al*., 2010). By contrast, it was found in this study that scores for the sit-up test were positively correlated with the BMI scores. The finding was an unexpected one, as it is normally assumed that the thin children would find it easy to lift their trunks. The most plausible conclusion could be that the poor performance of the thin children in the test could be attributed to the negative influence which being underweight exerts upon muscular fitness (Bovet *et al*., 2007; Artero *et al*., 2010; Aboshkair *et al*., 2012).

As it has been reiterated throughout the article, physical activity is crucial to developing and maintaining cardiorespiratory fitness (Hsieh *et al*., 2014). Increased mechanisation, not only in work but also in modes of transport and leisure activities, has led to a drastic decrease in physical activity, making inactivity a major public health problem of both young and old (Blair & Morris, 2009). No gold standard method exists for the measurement of daily physical activity (Denker & Andersen, 2011). Although physical activity is recommended for the prevention and treatment of obesity (Reichert *et al.*, 2015), alarmingly large numbers of children and adolescents throughout the world do not engage in the recommended daily 60 minutes of moderate to vigorous physical activity (WHO, 2016). This is of concern since daily physical activity has a bearing on the levels of aerobic and muscular physical fitness as well as body composition, both of which affect children's cardiovascular health quite early in life (Ortega *et al*., 2008).

The majority of children in this study (85%) use active transport to and from school. This it can be argued contributes considerable time to their daily physical activity. This should be interpreted with a measure of caution though since the children were not asked about how long the daily commuting to school, took in order to estimate the distances which they covered. In the rural schools it was observed that the children had to travel in groups suggesting that the distances which they covered may have been considerable, necessitating the organising of groups to ensure their safety. Although most of the children walked to and from school, only 30% reported playing outside for more than an hour after school. It is possible that the children may have engaged in the performance of household chores after school, particularly the girls as is the case in many African communities (Prista *et al*., 2003). A considerable number of children (63.7% of the boys and 58.3% of the girls) reported participating in exercise that elevated the heart rate while a small minority of 5.3% reported having watched television for more than 5 hours on the previous day. Although the levels of physical activity of the children were not computed to metabolic equivalents, it would appear that the use of active transport benefits the children considering the levels of overweight in the study population. Sarmiento and associates in their study of 12 countries found that children who used active school transport were less likely to be overweight or to have high percentages of body fat than those who used forms of automotive transport. The countries in the study were Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, the United Kingdom and the United States of America (Sarmiento *et al*., 2015). The interpretation in this case should be taken with caution however since other factors may contribute to the low weight of many of the study subjects.

Limitations

The study had several inherent limitations. Body composition was assessed by means of field research methods. The physical activity was measured using a questionnaire which is subject to bias. In addition, the amount of physical activity in which the children egaged by walking to and from school could not be determined, as the distances were not established.

4.7 Conclusion

One of the significant findings of the study was that a majority of the children in the study fell into the thinness categories in relation to BMI. This had a bearing on the outcome of the results of the fitness tests. Both positive and negative correlations especially between BMI and health-related fitness tests were found. Active transportation contributed to the levels of physical activity in which the children engaged. Future studies should however aim to quantify the time which is spent commuting in order to estimate the distances which are covered and to arrive at accurate assessments of daily physical activity.

Conflict of interest

The authors of this research article declare no conflict of interest.

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CHAPTER 5
SUMMARY, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

5.1 SUMMARY

Childhood health has become a topical issue in 21st century international affairs and public health (Alberga *et al*., 2012:261; European Association for the Study of Obesity EASO & C3 Collaborating for Health, 2014:5, 7; Güngör, 2014:129). Indeed, the future of the desired world trends in obesity rests upon the successful navigation of childhood and adolescence by every child (Alberga *et al*., 2012:268; Güngör, 2014:140; WHO, 2016:10, 40). Physical activity is an important element in the growth of children contributing much to their overall health (WHO, 2012:4). This study looked at various issues concerning childhood and adolescent health. It was observed that childhood overweight and obesity having reached epidemic levels continue to grow worldwide (Lobstein *et al.*, 2015:2510; WHO, 2017a:6), alongside the ever-increasing levels of physical inactivity (Muth, 2015:34, 39). In 2016 it was estimated that more than 124 million of the children and adolescents of the world aged between 5-19 years were obese (WHO, 2017b:1).

Childhood obesity usually leads to adult obesity and its accompanying comorbidities (Biro & Wien, 2010:1503S; WHO, 2017a:6). Childhood obesity however also leads to serious childhood health problems which impact quality of life. Key among these health problems are Type 2 Diabetes mellitus, asthma, hypertension, polycystic ovarian syndrome, early puberty, sleep apnea, dyslipidemia, as well as a range of musculoskeletal and psychosocial problems (Lakshman *et al.*, 2012:1771; Güngör, 2014:133). The monitoring of trends of childhood overweight and obesity, physical activity and physical fitness is key in the global effort to reduce and prevent obesity (WHO, 2016:38; WHO, 2017a:9). An examination of the relevant available literature revealed that a gap exists in the information available concerning childhood obesity, physical activity and related health issues for some parts of the world, including Zimbabwe. The aim of this study was therefore to determine:

> **The health-related physical fitness, anthropometry and physical activity levels of Zimbabwean children aged 10-12 years**.

The study is presented in article format with Chapters 3 and 4 taking the form of research articles which are to be submitted for publication in accredited peer-reviewed journals. The first chapter was devoted to an elucidation of the problem statement, the objectives and hypotheses of the study.

It was apparent that there is a gap in the literature concerning health-related physical fitness anthropometry and physical activity levels of 10-12 year old children in Zimbabwe.

Chapter 2 took the form of a review of the relevant available literature pertaining to the health-related physical fitness, body composition and physical activity during childhood. Particular emphasis was placed upon assessing contemporary trends in the prevalence of overweight and obesity. It was abundantly evident from the literature that childhood overweight and obesity are a matter of public health (Jaacks *et al*., 2015:434). It was observed from literature that increased physical activity has numerous benefits for children and adolescents. The benefits include optimal growth and development, healthy body composition, reduced risk of NCDs and increased self-esteem among others (Monyeki, 2014:332-333). The literature also confirmed that regular monitoring and measuring of health-related physical fitness, body composition and physical activity are key in the fight against childhood overweight and obesity (Ontario Agency for Health Protection and Promotion, 2013:12).

Reliable test batteries involving field tests have been designed for the assessment of childhood health-related physical fitness and body composition (Ortega *et al*., 2008:S55). Childhood physical activity can be determined by using either subjective or objective methods. The current trend in assessing physical activity is moving towards more use of objective methods (Freedson *et al*., 2012:S1; Ainsworth *et al*., 2015:390). The literature tended to suggest that the limited numbers of studies which had been conducted in the developing world could be attributed, to a large extent, to the unaffordability of using objective methods for many developing countries. Subjective methods, particularly those which entail the use of variants of the physical activity questionnaire, are still useful and practical for large-scale epidemiological studies.

Many children do not meet the recommended 60 minutes per day of physical activity. Literature confirmed that children spend most of their waking hours at school. This makes schools key centres for the promotion of physical activity among school-age children (New Zealand Ministry of Education, 2007:13; Story *et al*., 2009:72). The provision of quality PE in schools has great potential for contribute meaningful physical activity for all school children. In Zimbabwe PE has faced mixed fortunes over the years as has occurred in other parts of the world. Literature revealed that Zimbabwe introduced new PE syllabi in 2017 which make PE an examinable subject at the primary and secondary school levels. Chapter 2 concluded with a summary of the types of strategies which could be adopted in order to promote a diverse range of physical activities in schools.

Chapter 3 is a research article investigating, 'Health-related physical fitness, anthropometry, and physical activity levels of Zimbabwean children aged 10-12 years old'. **Chapter 4** takes the form of another research article investigating, 'The relationship between body composition, physical fitness, and levels of physical activity of Zimbabwean children aged 10-12 years.' Both articles comprise detailed discussions of the research designs which were developed to conduct the respective studies, the research methods which were employed, the results which were generated, and discussions of their findings and conclusions.

5.2 CONCLUSIONS

The conclusions of the study are in accordance with the objectives and hypotheses which were articulated in Chapter 1.

5.2.1 Hypothesis 1: Significant differences in health-related physical fitness and levels of physical activity will be found for Zimbabwean children aged 10-12 years.

Significant gender differences were found in the results for the performance of eight physical fitness tests, $p \leq 0.05$. Significant gender differences were observed for the sit and reach, standing broad jump, flamingo balance, sit-ups, bent arm hang, 10×5m shuttle run, 50m sprint and 1.5 mile run physical fitness tests. The boys performed better than the girls in six of the eight tests, in which statistically significant gender differences were found. In terms of levels of physical activity, the boys were found to be significantly more active than the girls. Among the boys, 45% reported spending more than an hour playing outside after school, compared with 40% of the girls. Less than half of the children (43.1%) reported that they played with electronic games. Accordingly, hypothesis 1 is accepted.

5.2.2 Hypothesis 2: A significant negative relationship will be found between levels of physical activity and body composition for Zimbabwean children aged 10-12 years.

The results of the study showed that the majority of the children who participated in the study were underweight. Children with grade 1 and grade 2 thinness, were 5.9% each while 62.4% of the children were classified as generally thin. The children had considerable levels of physical activity indicated by the fact that 85.2% of the children reported walking to and from school. The time taken to commute and the distances which they covered during the commuting were however not determined. Scores for physical activity were calculated according to time, specifically hours. Metabolic equivalents were not used to score physical activity. Significant positive correlations

were found between body composition and scores for the sit and reach, handgrip strength, and flamingo balance physical fitness tests. Significant negative correlations were found between the body composition and the standing broad jump and the bent arm hang physical fitness tests. A similar statistical correlation between body composition and physical activity could not be established, owing to the method which was used to score physical activity. Owing to the high contribution of walking to the overall levels of physical activity of the children, hypothesis 2 is partially accepted.

5.3 LIMITATIONS OF THE STUDY

The study was not without limitations. Interpretation of the results should be made in the light of a number of inherent weaknesses. One limitation lies in the sample selection. Although the study sample was drawn from primary schools located in the ten provinces of Zimbabwe, the fact that these schools had to have been part of the group of schools involved with Nestlé, introduced some form of bias in the selection. Although the participating primary schools represented average schools in Zimbabwe, there was no representation of the children from the affluent primary schools. The cross-sectional nature of the research design was also a weakness, as repeated measurements in a longitudinal study would have provided a more comprehensive picture of the health-related physical fitness, anthropometry, and physical activity of the Zimbabwean children aged 10-12 years. Another weakness of the study was that the physical activity was assessed using a subjective method, namely, the administration of a physical activity questionnaire. The fact that body composition was assessed using field methods rather than laboratory methods was also a weakness.

5.4 RECOMMENDATIONS

From the findings of this study, it is evident that there is a need to conduct further research concerning Zimbabwean children in the following respects:

- More cross-sectional studies of nationally representative samples are needed to determine the prevalence of overweight and obesity among Zimbabwean children between the ages of 6 and 18 years.
- More cross-sectional studies with larger nationally representative samples are needed to measure health-related physical fitness, anthropometry, and physical activity among 10- to 12-year-old Zimbabwean children.

- Longitudinal studies are needed to provide a more comprehensive appraisal of health-related physical fitness, body composition, and physical activity of Zimbabwean primary school children.
- Studies are needed in which laboratory methods are used to assess health-related physical fitness and body composition, and objective methods are used to assess physical activity among children.
- Cross-sectional and longitudinal studies are needed to determine health-related physical fitness, body composition, and physical activity among secondary school children in Zimbabwe.

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APPENDIX A:

About *International Journal of Environmental Research and Public Health*

Aims and Scope

International Journal of Environmental Research and Public Health (IJERPH) (ISSN 1660-4601) is a peer-reviewed scientific journal that publishes original articles, critical reviews, research notes, and short communications in the interdisciplinary area of environmental health sciences and public health. It links several scientific disciplines including biology, biochemistry, biotechnology, cellular and molecular biology, chemistry, computer science, ecology, engineering, epidemiology, genetics, immunology, microbiology, oncology, pathology, pharmacology, and toxicology, in an integrated fashion, to address critical issues related to environmental quality and public health. Therefore, *IJERPH* focuses on the publication of scientific and technical information on the impacts of natural phenomena and anthropogenic factors on the quality of our environment, the interrelationships between environmental health and the quality of life, as well as the socio-cultural, political, economic, and legal considerations related to environmental stewardship and public health. The primary areas of research interests to the *IJERPH* include:

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- Health risk assessment and management
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- Environmental chemistry and computational modeling
- Environmental policy and management
- Environmental engineering and biotechnology
- Emerging issues in environmental health and diseases
- Environmental education and public health

Therefore this international journal covers a broad spectrum of important topics which are relevant to environmental health sciences and public health protection. It provides comprehensive and unique information with a worldwide readership. Emphasizing holistic approach, the journal serves as a comprehensive and multidisciplinary platform, addressing important public health issues associated with environmental pollution and degradation. A large number of eminent professors and scientists from all over the world serve as guest reviewers for the journal.

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the manuscript, or in the decision to publish the results must be declared in this section. If there is no role, please state "The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results".

- **References:** References must be numbered in order of appearance in the text (including table captions and figure legends) and listed individually at the end of the manuscript. We recommend preparing the references with a bibliography software package, such as EndNote, ReferenceManager or Zotero to avoid typing mistakes and duplicated references. We encourage citations to data, computer code and other citable research material. Include the digital object identifier (DOI) for all references where available. If available online, you may use reference style 9. below.
- Citations and References in Supplementary files are permitted provided that they also appear in the main text and in the reference list.

In the text, reference numbers should be placed in square brackets [ ], and placed before the punctuation; for example [1], [1–3] or [1,3]. For embedded citations in the text with pagination, use both parentheses and brackets to indicate the reference number and page numbers; for example [5] (p. 10). or [6] (pp. 101–105).

The Reference list should include the full title as recommended by the ACS style guide. The style file for endnote, MDPI.ens, can be found at http://endnote.com/downloads/style/mdpi References should be described as follows, depending on the type of work:

- Journal Articles:

1. Author 1, A.B.; Author 2, C.D. Title of the article. *Abbreviated Journal Name* **Year**, *Volume*, page range, DOI. Available online: URL (accessed on Day Month Year).

- Books and Book Chapters:

2. Author 1, A.; Author 2, B. *Book Title*, 3rd ed.; Publisher: Publisher Location, Country, Year; pp. 154–196; ISBN.
3. Author 1, A.; Author 2, B. Title of the chapter. In *Book Title*, 2nd ed.; Editor 1, A.; Editor 2, B., Eds.; Publisher: Publisher Location, Country, Year; Volume 3, pp. 154–196; ISBN.

- Unpublished work, submitted work, personal communication:

4. Author 1, A.B.; Author 2, C. Title of Unpublished Work. status (unpublished; manuscript in preparation).
5.Author 1, A.B.; Author 2, C. Title of Unpublished Work. *Abbreviated Journal Name* stage of publication (under review; accepted; in press).
6.Author 1, A.B. (University, City, State, Country); Author 2, C. (Institute, City, State, Country). Personal communication, Year.

- Conference Proceedings:

7. Author 1, A.B.; Author 2, C.D.; Author 3, E.F. Title of Presentation. In *Title of the Collected Work* (if available), Proceedings of the Name of the Conference, Location of Conference, Country, Date of Conference; Editor 1, Editor 2, Eds. (if available); Publisher: City, Country, Year (if available); Abstract Number (optional), Pagination (optional).

- Thesis:

8. Author 1, A.B. Title of Thesis. Level of Thesis, Degree-Granting University, Location of University, Date of Completion.

- Websites:

9.Title of Site. Available online: URL (accessed on Day Month Year).
Unlike published works, websites may change over time or disappear, so we encourage you create an archive of the cited website using a service such as WebCite. Archived websites should be cited

using the link provided as follows: 10. Title of Site. URL (archived on Day Month Year). See the Reference List and Citations Guide for more detailed information.

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Preparing Figures, Schemes and Tables

- File for Figures and schemes must be provided during submission in a single zip archive and at a sufficiently high resolution (minimum 1000 pixels width/height, or a resolution of 300 dpi or higher). Common formats are accepted, however, TIFF, JPEG, EPS and PDF are preferred.
- *IJERPH* can publish multimedia files in articles or as supplementary materials. Please contact the editorial office for further information.
- All Figures, Schemes and Tables should be inserted into the main text close to their first citation and must be numbered following their number of appearance (Figure 1, Scheme I, Figure 2, Scheme II, Table 1, *etc.*).
- All Figures, Schemes and Tables should have a short explanatory title and caption.
- All table columns should have an explanatory heading. To facilitate the copy-editing of larger tables, smaller fonts may be used, but no less than 8 pt. in size. Authors should use the Table option of Microsoft Word to create tables.
- Authors are encouraged to prepare figures and schemes in color (RGB at 8-bit per channel). There is no additional cost for publishing full color graphics.

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Supplementary Materials, Data Deposit and Software Source Code

Data Availability

In order to maintain the integrity, transparency and reproducibility of research records, authors must make their experimental and research data openly available either by depositing into data repositories or by publishing the data and files as supplementary information in this journal.

Computer Code and Software

For work where novel computer code was developed, authors should release the code either by depositing in a recognized, public repository or uploading as supplementary information to the publication. The name and version of all software used should be clearly indicated.

Supplementary Material

Additional data and files can be uploaded as "Supplementary Files" during the manuscript submission process. The supplementary files will also be available to the referees as part of the peer-review process. Any file format is acceptable, however we recommend that common, non-proprietary formats are used where possible.

Unpublished Data

Restrictions on data availability should be noted during submission and in the manuscript. "Data not shown" should be avoided: authors are encouraged to publish all observations related to the submitted manuscript as Supplementary Material. "Unpublished data" intended for publication in a manuscript that is either planned, "in preparation" or "submitted" but not yet accepted, should be cited in the text and a reference should be added in the References section. "Personal Communication" should also be cited in the text and reference added in the References section. (see also the MDPI reference list and citations style guide).

Remote Hosting and Large Data Sets

Data may be deposited with specialized service providers or institutional/subject repositories, preferably those that use the DataCite mechanism. Large data sets and files greater than 60 MB must be deposited in this way. For a list of repositories specialized in scientific and experimental data, please consult databib.org or re3data.org. The data repository name, link to the data set (URL) and accession number, doi or handle number of the data set must be provided in the paper. The journal Data also accepts submissions of data set papers.

Deposition of Sequences and of Expression Data

New sequence information must be deposited to the appropriate database prior to submission of the manuscript. Accession numbers provided by the database should be included in the submitted manuscript. Manuscripts will not be published until the accession number is provided.

- *New nucleic acid sequences* must be deposited in one of the following databases: GenBank, EMBL, or DDBJ. Sequences should be submitted to only one database.
- *New high throughput sequencing (HTS) datasets* (RNA-seq, ChIP-Seq, degradome analysis, …) must be deposited either in the GEO database or in the NCBI's Sequence Read Archive.
- *New microarray data* must be deposited either in the GEO or the ArrayExpress databases.The "Minimal Information About a Microarray Experiment" (MIAME) guidelines published by the Microarray Gene Expression Data Society must be followed.
- *New protein sequences* obtained by protein sequencing must be submitted to UniProt (submission tool SPIN).

All sequence names and the accession numbers provided by the databases should be provided in the Materials and Methods section of the article.

References in Supplementary Files

Citations and References in Supplementary files are permitted provided that they also appear in the reference list of the main text.

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Research Ethics

Research Involving Human Subjects

When reporting on research that involves human subjects, human material, human tissues or human data, authors must declare that the investigations were carried out following the rules of the Declaration of Helsinki of 1975 (https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/), revised in 2008. According to point 23 of this declaration, an approval from an ethics committee should have been obtained before undertaking the research. As a minimum, a statement including the project identification code, date of approval and name of the ethics committee or institutional review board should be cited in the Methods Section of the article. Data relating to individual participants must be described in detail, but private information identifying participants need not be included unless the identifiable materials are of relevance to the research (for example, photographs of participants' faces that show a particular symptom). A written informed consent for publication must be obtained from participating patients in this case.

Editors reserve the rights to reject any submission that does not meet these requirements.

Example of Ethical Statements:

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of XXX (Project identification code).

Ethical Guidelines for the Use of Animals in Research

The editors will require that the benefits potentially derived from any research causing harm to animals are significant in relation to any cost endured by animals, and that procedures followed are unlikely to cause offense to the majority of readers. Authors should particularly ensure that their research complies with the commonly-accepted '3Rs':

- Replacement of animals by alternatives wherever possible,
- Reduction in number of animals used, and
- Refinement of experimental conditions and procedures to minimize the harm to animals.

Any experimental work must also have been conducted in accordance with relevant national legislation on the use of animals for research. For further guidance authors should refer to the Code of Practice for the Housing and Care of Animals Used in Scientific Procedures [1].

Manuscripts containing original descriptions of research conducted in experimental animals must contain details of approval by a properly constituted research ethics committee. As a minimum, the project identification code, date of approval and name of the ethics committee or institutional review board should be cited in the Methods section.

IJERPH endorses the ARRIVE guidelines (www.nc3rs.org.uk/ARRIVE) for reporting experiments using live animals. Authors and reviewers can use the ARRIVE guidelines as a checklist, which can be found at www.nc3rs.org.uk/ARRIVEchecklist.

1. Home Office. Animals (Scientific Procedures) Act 1986. Code of Practice for the Housing and Care of Animals Used in Scientific Procedures. Available online: http://www.official-documents.gov.uk/document/hc8889/hc01/0107/0107.pdf.

Research Involving Plants

Experimental research on plants (either cultivated or wild) including collection of plant material, must comply with institutional, national, or international guidelines. We recommend that authors comply with the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

For each submitted manuscript supporting genetic information and origin must be provided. For research manuscripts involving rare and non-model plants (other than, e.g., *Arabidopsis thaliana*, *Nicotiana benthamiana, Oriza sativa*, or many other typical model plants), voucher specimens must be deposited in an accessible herbarium or museum. Vouchers may be requested for review by future investigators to verify the identity of the material used in the study (especially if taxonomic rearrangements occur in the future). They should include details of the populations sampled on the site of collection (GPS coordinates), date of collection, and document the part(s) used in the study where appropriate. For rare, threatened or endangered species this can be waived but it is necessary for the author to describe this in the cover letter.

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An example of Ethical Statements:

Torenia fournieri plants were used in this study. White-flowered Crown White (CrW) and violet-flowered Crown Violet (CrV) cultivars selected from 'Crown Mix' (XXX Company, City, Country) were kindly provided by Dr. XXX (XXX Institute, City, Country).

Arabidopis mutant lines (SALKxxxx, SAILxxxx,…) were kindly provided by Dr. XXX , institute, city, country).

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Suggesting Reviewers

During the submission process, please suggest three potential reviewers with the appropriate expertise to review the manuscript. The editors will not necessarily approach these referees. Please provide detailed contact information (address, homepage, phone, e-mail address). The proposed referees should neither be current collaborators of the co-authors nor have published with any of the co-authors of the manuscript within the last five years. Proposed reviewers should be from different institutions to the authors. You may identify appropriate Editorial Board members of the journal as potential reviewers. You may suggest reviewers from among the authors that you frequently cite in your paper.

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English Corrections

To facilitate proper peer-reviewing of your manuscript, it is essential that it is submitted in grammatically correct English. Advice on some specific language points can be found here.

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Qualification for Authorship

Authorship must include and be strictly limited to researchers who substantially contributed to the design of the study, the production, analysis, or interpretation of the results, and/or preparation of the manuscript. Those who contributed to the work but do not qualify for authorship should be listed in the acknowledgments. More detailed guidance on authorship is given by the International Council of Medical Journal Editors (ICMJE). The journal also adheres to the standards of the Committee on Publication Ethics (COPE) that "all authors should agree to be listed and should approve the submitted and accepted versions of the publication. Any change to the author list should be approved by all authors including any who have been removed from the list. The corresponding author should act as a point of contact between the editor and the other authors and should keep co-authors informed and involve them in major decisions about the publication (e.g. answering reviewers' comments)." [1]

1. Wager, E.; Kleinert, S. Responsible research publication: international standards for authors. A position statement developed at the 2nd World Conference on Research Integrity, Singapore, July 22-24, 2010. In Promoting Research Integrity in a Global Environment; Mayer, T., Steneck, N., eds.; Imperial College Press / World Scientific Publishing: Singapore; Chapter 50, pp. 309-16.

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Editorial Procedures and Peer-Review

Initial Checks

All submitted manuscripts received by the Editorial Office will be checked by a professional in-house *Managing Editor* to determine whether it is properly prepared and whether the manuscript follows the ethical policies of the journal, including those for human and animal experimentation. Manuscripts that do not fit the journals ethical policy will be rejected before peer-review. Manuscripts that are not properly prepared will be returned to the authors for revision and resubmission. After these checks, the *Managing Editor* will consult the journals' *Editor-in-Chief* or the *Guest Editor* (or an *Editorial Board member* in case of a conflict of interest) to determine

whether the manuscript fits the scope of the journal and whether it is scientifically sound. No judgment on the significance or potential impact of the work will be made at this stage. Reject decisions at this stage will be verified by the *Editor-in-Chief*.

Peer-Review

Once a manuscript passes the initial checks, it will be assigned to at least two independent experts for peer-review. A single-blind review is applied, where authors' identities are known to reviewers. Peer review comments are confidential and will only be disclosed with the express agreement of the reviewer.

In the case of regular submissions, in-house assistant editors will invite experts, including recommendations by an academic editor. These experts may also include *Editorial Board members* and Guest Editors of the journal. In the case of a special issue, the *Guest Editor* will advise on the selection of reviewers.
Potential reviewers suggested by the authors may also be considered. Reviewers should not have published with any of the co-authors during the past five years and should not currently work or collaborate with one of the institutes of the co-authors of the submitted manuscript.

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All the articles, reviews and communications published in MDPI journals go through the peer-review process and receive at least two reviews. The in-house editor will communicate the decision of the academic editor, which will be one of the following:

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  The paper is in principle accepted after revision based on the reviewer's comments. Authors are given five days for minor revisions.
- *Reconsider after Major Revisions*:
  The acceptance of the manuscript would depend on the revisions. The author needs to provide a point by point response or provide a rebuttal if some of the reviewer's comments cannot be revised. Usually, only one round of major revisions is allowed. Authors will be asked to resubmit the revised paper within ten days and the revised version will be returned to the reviewer for further comments.
- *Reject and Encourage Resubmission*:
  An article where additional experiments are needed to support the conclusions will be rejected and the authors will be encouraged to re-submit the paper once further experiments have been conducted.
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  The article has serious flaws, makes no original contribution, and the paper is rejected with no offer of resubmission to the journal.

All reviewer comments should be responded to in a point-by-point fashion. Where the authors disagree with a reviewer, they must provide a clear response.

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Authors may appeal a rejection by sending an e-mail to the Editorial Office of the journal. The appeal must provide a detailed justification, including point-by-point responses to the reviewers' and/or Editor's comments. The *Managing Editor* of the journal will forward the manuscript and

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Production and Publication

Once accepted, the manuscript will undergo professional copy-editing, English editing, proofreading by the authors, final corrections, pagination, and, publication on the www.mdpi.com website.

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Clinical Trials Registration

Registration

Authors are strongly encouraged to pre-register clinical trials with an international clinical trials register or and to cite a reference to the registration in the Methods section. Suitable databases include clinicaltrials.gov, the EU Clinical Trials Register and those listed by the World Health Organisation International Clinical Trials Registry Platform.

CONSORT Statement

IJERPH requires a completed CONSORT 2010 checklist and flow diagram as a condition of submission when reporting the results of a randomized trial. Templates for these can be found here or on the CONSORT website (http://www.consort-statement.org) which also describes several CONSORT checklist extensions for different designs and types of data beyond two group parallel trials. At minimum, your article should report the content addressed by each item of the checklist. Meeting these basic reporting requirements will greatly improve the value of your trial report and may enhance its chances for eventual publication.

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The editors of this journal enforce a rigorous peer-review process together with strict ethical policies and standards to ensure to add high quality scientific works to the field of scholarly publication. Unfortunately, cases of plagiarism, data falsification, image manipulation,

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- Any facts that might be perceived as a possible conflict of interest of the author(s) must be disclosed in the paper prior to submission.
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- Data and methods used in the research need to be presented in sufficient detail in the paper, so that other researchers can replicate the work.
- Raw data should preferably be publicly deposited by the authors before submission of their manuscript. Authors need to at least have the raw data readily available for presentation to the referees and the editors of the journal, if requested. Authors need to ensure appropriate measures are taken so that raw data is retained in full for a reasonable time after publication.
- Simultaneous submission of manuscripts to more than one journal is not tolerated.
- Republishing content that is not novel is not tolerated (for example, an English translation of a paper that is already published in another language will not be accepted).
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      If plagiarism is detected during the peer review process, the manuscript may be rejected. If plagiarism is detected after publication, we may publish a correction or retract the paper.

    - **Image files must not be manipulated or adjusted in any way** that could lead to misinterpretation of the information provided by the original image.

      Irregular manipulation includes: 1) introduction, enhancement, moving, or removing features from the original image; 2) grouping of images that should obviously be presented separately (e.g., from different parts of the same gel, or from different gels); or 3) modifying the contrast, brightness or color balance to obscure, eliminate or enhance some information.

If irregular image manipulation is identified and confirmed during the peer review process, we may reject the manuscript. If irregular image manipulation is identified and confirmed after publication, we may correct or retract the paper.

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Guidelines for Authors the African Journal for Physical Activity and Health Sciences

AIM

The African Journal for Physical Activity and Health Sciences (AJPHES) is a peer-reviewed journal established to:

i) provide a forum for health specialists, researchers in physical activity, professionals in human movement studies 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. Research-related contributions by specialists in physical activity and health sciences from other continents are also welcome.

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

AJPHES 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 AJPHES 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 AJPHES 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 the acknowledgement section of the manuscript.

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Original manuscript and all correspondence should be addressed to the Editor-In-Chief:

Editor-in-Chief: Prof. Abel L. Toriola

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Tshwane University of Technology P. Bag X680, Pretoria 0001, South Africa
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Articles should be submitted electronically, i.e. via e-mail attachment. However, the corresponding author should ensure that such articles are virus free. AJPHES 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.

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Manuscripts should be type written in fluent English (using 12-point Times New Roman font and 1½ line-spacing) on one side of whiteA4-sized paper justified fully with 3cm margin on all sides. In preparing manuscripts, MS-Word, Office 2007 for Windows should be used. Length of manuscripts should not normally exceed 12 printed pages (including tables, figures, references, etc.). For articles exceeding 12 typed pages US$ 10.0 is charged per every extra page. Authors will be requested to pay a publication fee to defray the very high cost of publication. The pages of manuscripts must be numbered sequentially beginning with the title page. The presentation format should be consistent with the guidelines in the publication format of the American Psychological Association (APA) (6th edition).

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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 keywords 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 also using single line spacing: 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 it 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.

Methodology

This section should provide sufficient and relevant information regarding study participants, ethics/informed consent, 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 locations 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 internationale (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).

References

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 the 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 the 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(s) and other specific information provided in the third example below:

For authored references:

For edited references:

For chapter references in a book:

Amusa, L.O. & Toriola, A.L. (2003). *Foundations of Sport Science* (2nd ed.) (pp. 39-45). Makhado, South Africa: Leach Printers.

Amusa, L.O. & Toriola, A.L. (Eds.) (2003). *Contemporary Issues in Physical Education and Sports* (2nd ed.) (pp. 20-24). Makhado, South Africa: Leach Printers.

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

Example 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 Marketing (online*), October, 1(4), at http://www.cad.gu.au/cjsm/wilson.html. February 1997.

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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 electronically within one week of receipt. It will be assumed that the publication should go ahead if no response is received from the corresponding author within one week. Minor editorial corrections are handled by AJPHES.

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APPENDIX B:

Healthy Kids Nutrition and Physical Activity: Baseline Survey

Data Sheet

School:_____

Surname:_____Name_____

___

D.O.B_____ Test Date:_____

Gender: M ☐ **F** ☐

Anthropometric Variables

	ID	Site	1	2	3	Mean or median
Basic	**1**	Body mass/Weight (kg)				
	2	Stature (cm)				
	3	Arm Span (cm)				
Skinfolds	**4**	Triceps (mm)				
	5	Biceps (mm)				
	6	Subscapular (mm)				
	7	Supraspenale (mm)				
	8	Medial Calf (mm)				
Girths	**9**	Arm relaxed (mm)				
	10	Arm-girth Flexed and tensed (cm)				
	11	Waist (minimum) (cm)				
	12	Gluteal (hips) (cm)				
	13	Calf (Maximum) (cm)				
Breadths	**14**	Humerus Bone breadth (cm)				
	15	Femur Bone Breadths (cm)				

Data Sheet

School:_____

Surname:_____Name_____

D.O.B_____ Test Date:_____

Gender: M ☐ F ☐

Motor Performance Variables

	ID	TEST	1	2	3	Final Value
Flexibility	1	Sit and Reach (cm)				
Leg power	2	Standing Broad Jump (cm)				
Balance	3	Flamingo Balance Test (falls/min)				
Strength	4	Handgrip strength				
Muscle endurance	5	Sit Up Test(max/30sec)				
	6	Bend Arm Hang (secs)				
Speed and Agility	7	10m x 5 shuttle run (secs)				
Speed	8	50m sprint (secs)				
Aerobic endurance	9	1.5 mile/600m run				

APPENDIX C:

INFORMED PARENTAL CONSENT

PROJECT TITLE: Nutritional and Physical Fitness profiles, Knowledge and Nutritional and Physical Activity Practices of Zimbabwean Primary School Children: The Zimbabwe Baseline Study.

PRINCIPAL INVESTIGATOR:

Mr. D. Makaza,

CO- INVESTIGATORS:

Mr. B. Khumalo, Dr. P. Makoni,

RESEARCHERS:

Dr. C.N. Chaibva, Mr. M.P.D. Gundani, Mr. E.M. Tapera, Mr. T. F. Mlalazi, Mr. M. Banda, Miss. K. Dlamini

What should you know about this research study:

- We give you this consent so that you may read about the purpose, risks, and benefits of this research study.
- The main goal of research studies is to gain knowledge that may help children.
- We cannot promise that this research will benefit your child
- You have the right to refuse to allow your child to take part, or agree for your child to take part now and change your mind later.

- Whatever you decide, it will not affect your child's regular school activities.

- Please review this consent form carefully. Ask any questions before you make a decision.

- Your choice to allow your child to participate is voluntary.

PURPOSE

You are being asked to allow your child to participate in a research study that is assessing the Nutritional and Physical fitness profile, Knowledge, Nutritional and Physical Activity practices. of Zimbabwean Primary School Children: to ascertain fitness for sporting and to institute remedial interventions where applicable.

PROCEDURES AND DURATION

If you decide to allow your child to participate in the study he/she will be required to fill in a questionnaire. Furthermore, if she is among those randomly selected, the child's height, weight, circumferences and skinfolds will be measured using skinfold calipers and tape measures. In addition physical fitness of the child will be assessed using stop watches and sit and reach boxes. Filling in the questionnaire will take about 20 minutes. The other measurements are estimated to take 40 minutes per child.

RISKS AND DISCOMFORTS

There are no anticipated risks related to participation in the study. However if the child experiences any form of discomfort, he/she should inform the research team members.

BENEFITS AND/OR COMPENSATION

There are no direct monetary benefits to participating in the study.

CONFIDENTIALITY

If you indicate your willingness for your child to participate in this study by signing this document, we plan to disclose the children's information that we will collect via questionnaires to the researchers for data analysis and report writing, and MRCZ for inspection purposes.

Any information that is obtained in connection with this study that can be identified with your child will remain confidential and will be disclosed only with your, and when appropriate, your child's permission. Participants will not be asked to enter their names, but will be asked to enter identification numbers created for this study, which will only be used for coding responses. Your child will be identified by a code number known only to the study staff. This number – not his/her name – will be used on all information about him. His/her name will never be used in any publication or presentation about the research study. His/her personal information will not be released without his/her written permission.

IN THE EVENT OF INJURY

In the event of injury resulting from your child's participation in this study, treatment expenses will be borne by the study. In the event of injury, contact Mr. Daga Makaza, Department of Sports Science and Coaching, National University of Science and Technology, Box AC939, Ascot, Bulawayo, Zimbabwe; Cell +263772295476, Landline +2639282842 ext 2487, e mail dmakaza@gmail.com

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you decide not to allow your child to participate in this study, your decision will not affect your child's ability to attend his/her school or receive any other services he/she normally receives. If you decide to allow your

child to participate, you and your child are free to withdraw your consent and assent and discontinue participation at any time without penalty.

OFFER TO ANSWER QUESTIONS

Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

AUTHORIZATION

YOU ARE MAKING A DECISION WHETHER OR NOT TO ALLOW YOUR CHILD TO PARTICIPATE IN THIS STUDY. YOUR SIGNATURE INDICATES THAT YOU HAVE READ AND UNDERSTOOD THE INFORMATION PROVIDED ABOVE, HAVE HAD ALL YOUR QUESTIONS ANSWERED, AND HAVE DECIDED TO ALLOW YOUR CHILD TO PARTICIPATE.

The date you sign this document to enroll your child in this study, that is, today's date, MUST fall between the dates indicated on the approval stamp affixed to each page. These dates indicate that this form is valid when you enroll your child in the study but do not reflect how long your child may participate in the study. Each page of this Informed Consent Form is stamped to indicate the form's validity as approved by the MRCZ.

Name of Parent (please print) Date

_____ _____

Signature of Parent or legally authorized representative Time

_____

Relationship to the Participant

_____

_____

Signature of Witness Signature of Research Staff

(*Optional*)

YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP.

If you have any questions concerning this study or consent form beyond those answered by the investigator, including questions about the research, your rights as a research Participant or research-related injuries; or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the Medical Research Council of Zimbabwe on telephone 791792 or 791193.

For children 7 years old to 13 years old

The investigator can use the Informed Parental Consent Form that the parents or guardians are signing. Following the parent's signature portion, a separate paragraph should be added which includes at least the following statement.

My participation in this research study is voluntary. I have read and understood the above information, asked any questions which I may have and have agreed to participate. I will be given a copy of this form to keep.

_____

Name of Participant

_____

Signature of Participant

ISIVUMELWANO LOMZALI

ISIHLOKO:

Nutritional and Physical Fitness profiles, Knowledge and Nutritional and Physical Activity Practices of Zimbabwean Primary School Children: The Zimbabwe Baseline Study.

OKHOKHELA ABAQHUBA LOMSEBENZI

Mr D. Makaza

ABAMNCEDISAYO

Mr. B. Khumalo, Dr P. Makoni

ABACUBUNGULI

Dr. C. N. Chaibva, Mr M. P. D. Gundani, Mr E. M. Tapera, Mr T. F. Mlalazi, Mr M. Banda, Miss K. Dlamini.

Okumele ukwazi ngalumsebenzi wokucubungula

- Silinika lesisivumelwano ukuze lizibalele ngenjongo, ngobunzima Kanye lenzuzo ekhona kulomsebenzi.
- Injongo emqoka yalumsebenzi yikuthi kutholakale ulwazi olungaphathisa abantwana kwelizayo.
- Asingeke sithembise ukuthi lokhu kucubungula kuzaphathisa owakho umntwana.
- Ulelungelo lokungavumi ukuthi umntanakho angene kuloluhlelo, kumbe uvume khathesi bese utshintsha ingqondo sokuphambili.
- Loba yini oyikhethileyo ayisoke iphambanise umntanakho ezifundweni zakhe zansuku zonke.
- Liyacelwa ukuthi licungule kabanzi leliphepha eliyisivumelwano. Kuyadingeka ukuthi imibuzo yonke elilayo liyibuze lingakenzi isinqumo.
- Awuphoqelelwa ukuthi uvumele umntanakho angene kuloluhlelo, uyazikhethela.

INJONGO

Uyacelwa ukuthi uvumele umntanakho angene kuloluhlelo olulenjongo yokuhlolisisa ngezempilakahle yabantwana abakuzinga le Primary ezikolo ze Zimbabwe ukuze kwazakale ukuthi bayenelisa lokuthi kudingwe indlela zokubaphathisa uma kusenzakala. Umntanakho ukhethwe njengomunye wabazangena kuloluhlelo ngoba efunda esikolo esikhethelwe ukuphatheka kuloluhlelo. Kuzabe kulabantwana abayinkulungwane eyodwa abaleminyaka eyisikhombisa kusiya kwelitshumi lantathu abavela ezikolo ezehlukeneyo elizweni le Zimbabwe abazabe bephatheke kulolu hlelo.

INDLELA OKUZAQHUTSHWA NGAYO LESIKHATHI ESIZATHATHWA

Uma ungakhetha ukuthi umntanakho angene……

Isilinganiso sokuqina (fitness) sizakwenziwa ngabakufundeleyo lokho. Isilinganiso sobude(height), ukuqina(weight), ubuqatha bengalo(arm circumference) kanye lokumpompa kwenhliziyo(blood pressure) lakho kuzakwenziwa. Phezu kwalokho ukuqina komzimba womntwana kuzahlolisiswa kusetshenziswa imitshina eyenzelwa lokho. Okuzatholakala lapha yikho okuzasetshenziswa ukuveza impilakahle yomntwana. Abazali kuzodingeka ukuthi bachaze kabanzi ngempilo yemuli.

INGOZI LOKUNGAPHATHEKI

Akukhangelelwanga ukuthi kubelengozi uma ungangena kuloluhlelo, kodwa nxa umntwana engaphathekanga kuhle kumele azise abaphethe loluhlelo.

INZUZO

Bonke abazaphatheka kuloluhlelo bangakhangeleli ukuthola inzuzo yemali,

OKUYIMFIHLO

Uma ungavuma ukuthi umntanakho aphatheke kuloluhlelo, impumela izanikezwa kulabo abaqhuba lumsebenzi ukuze bayicubungule kuhle njalo babhale abakutholileyo, babuye bayidlulisele kwabe Medical Research Council of Zimbabwe (MRCZ) ukuze bayihlolisise.

Konke okumayelana ngomntanakho okuphathelane laloluhlelo akusoze kwatshelwa muntu ngaphandle kwemvumo yakho, kumbe uma kufanele, eyomntwana. Amabizo abantwana awasoze adingakale kodwa bazacelwa ukuthi basebenzise inombolo abazayiphiwa lapho elungiselelwe lo umsebenzi. Umntanakho uzabesaziwa ngalinombolo ezabisaziwa ngabaqhuba lumsebenzi kuphela, hatshi ibizo lakhe. Ibizo lomntwana alizukusetshenziswa ekulotshweni lekwethuleni kwalumsebenzi.

OKWENGOZI

Uma kuthe kwabalengozi emntwaneni ngokungena kuloluhlelo, indleko zonke zizaphathwa yiloluhlelo.

Uma kuthe kwabalengozi lingadinga u…….

INDLELA YOKUPHATHEKA

Akuphoqelelwa ukungena kuloluhlelo, uyazikhethela. Ukungavumi kwakho ukuthi umntwana aphatheke kuloluhlelo akusoze kwenqabela umntanakho ezifundweni zakhe esikolo lamanye amalungelo akhe. Ungavuma ukuthi umntanakho angene kuloluhlelo, wena lomntanakho lilelungelo lokuphuma noma ngasiphi isikhathi uma lingasafuni kungelasijeziso.

AMALUNGELO OKUBUZA

Ungakavumi kuyadingeka ukuthi ubuze yonke into engacacanga ngaloluhlelo Ungathatha sonke isikhathi osidingayo usacabangisisa.

OKWEMVUMO

WENZA ISINQUMO SOKUTHI UYAVUMA KUMBE UYALA UKUTHI UMNTANAKHO ANGENE KULOLUHLELO. UKULOBA IBIZO LAKHO KUVEZA

UKUTHI UBALILE WAZWISISA KONKE OKULOTSHWE PHEZULU, IMIBUZO YONKE OBULAYO IPHENDULWE KUHLE, NGAKHO USUKHE UKUTHI UVUMELE UMNTANAKHO ANGENE KULOLUHLELO.

Uhlelo lolu lusungulwa ngelanga lapho obhala khona ibizo lakho uvuma ukuthi umntanakho aphatheke kuloluhlelo kodwa lelilanga kumele lihambelane lelanga elikusidindo esifakwe kukhasi linye ngalinye.

Amalanga la aveza ukuphatheka komntanakho kuloluhlelo kodwa kawavezi ukuthi uzangena okwesikhathi esinganani. Ikhasi linye ngalinye lalesisivumelwano lilesidindo esiveza ubumqoka balesisivumelwano futhi livunyelwe ngabe (MRCZ)

Ibizo Lomzali (Bhala kucace) **Ilanga**

---------- ----------

Signature Yomzali **Isikhathi**

---------- ----------

Ubuhlobo Lomntwana

Signature Yomfakazi **Signature Kamphathi wohlelo**

---------- ----------

UZANIKEZWA LAWE LELIPHEPHA UKUZE UKULIGCINE

Nxa ulemibuzo kumbe ubona angani awuphathwanga kuhle njalo ufisa ukukhuluma lomunye wabaphathi, ungatshayela ucingo kwabe (MRCZ) kunombolo ezithi: 791792 kumbe 791193.

Ebantwaneni abaleminyaka eyisikhombisa kusiya kwelitshumi lantathu

Angiphoqelelwanga ukungena kuloluhlelo. Ngibalile ngazwisisa konke okubhalwe phezulu, ngabuza imibuzo lapho engingazwisisanga khona, ngavuma ukuba yingxenye yaloluhlelo. Ngizakuthola lesisivumelwano ukuthi ngisigcine.

Ibizo lomntwana

Signature yomntwana

MVUMO YOMUBEREKI KANA MUCHENGETI WEMWANA MUTSVAKURUDZO

MUSORO WETSVAKURUDZO:

Nutritional and Physical Fitness profiles, Knowledge and Nutritional and Physical Activity Practices of Zimbabwean Primary School Children: The Zimbabwe Baseline Study.

MUTSVAKIRIDZI MUKURU

Mr D. Makaza

VAMWE VATSVAKIRIDZI VAKURU

Mr. B. Khumalo, Dr P. Makoni

VAMWE VATSVAKIRIDZI

Dr. C.N. Chaibva, Mr. M.P.D. Gundani, Mr. E.M. Tapera, Mr. T. F. Mlalazi, Mr. M. Banda, Miss. K. Dlamini

ZVAMUNOFANIRA KUZIVA NEZVE TSVAKURUDZO IYI:

- Tinokupai gwaro iri kuti muverenge mugoziva zvinangwa, nezvingangonetsa nezvinobatsira patsvakurudzo iyi.
- Chinangwa chikuru chetsvakurudzo ndechekuti pawanikwe ruzivo rungabatsira mukurerwa kwevana.
- Hatigoni kuvimbisa kuti tsvakurudzo ino ichabatsira mwana wenyu.
- Mune mvumo yokurambidza mwana wenyu kuti apinde mutsvakurudzo iyi, kana kumubvumira kuti apinde mutsvakurudzo iyi, asi munokwanisa kushandura pfungwa dzenyu panguva inotevera.
- Kuti mapa mwana mvumo kana kusamupa mvumo yekupinda mutsvakurudzo iyi hazvikanganisi nenzira ipi zvayo kudzidza kwemwana wenyu kuchikoro.
- Verengai gwaro iri murinzwisise zvakakwana. Bvudzai mibvudzo musati matenda kana kuramba.
- Hamumanikidzwi kuti mwana wenyu apinde mutsvakurudzo iyi.

CHINANGWA CHETSVAKURUDZO

Muri kukumbirwa kubvumira mwana wenyu kupinda mutsvakurudzo ine chinangwa chekutarisa nezvehutano hwevana nezvimwe zvavanoita kuti vana vakure vakasimba.

MAITIRWO NENGUVA YETSVAKURUDZO

Kana mukapa mwana mvumo yukupinda mutsvakurudzo achabvunzwaopindura mibvunzo inenge iri pamapepa.Kuchatorwa zvakare hurefu hwemwana, uremu hwemwana, kukora kwakaita maoko nekukora kwakaita dzimwe nhengo dzomuviri.Izvi zvose zvichaitwa kuchishandiswa michina yakakodzera. Kupindura mibvunzi kuchatorera vana nguva inoita mimaminitsi makumi maviri. Kupimwa kwevana kungatora maminitsi anokwana makumi mama.

ZVINGATYIRWA PATSVAKURUDZO IYI

Hapana zvinotyisa zvingawira vana vachapinda mutsvakurudzo iyi. Zvisinei kana vana vanaenge vapinda mutsvakurudzo iyi vakaona vasisakwanisi kuenderera mberi netsvakurudzo iyi, vanofanira kuzivisa vatvakiridzi nokukurumidza.

ZVINGAWANIKWA/MURIPO KUBVA MUKUPINDA MUTSVAKURUDZO IYI

Hakuna muripo wemari uchapiwa kune vachapinda mutsvakurudzo iyi.

KUCHENGETEDZWA KWEVICHABUDA MUTSVAKIRIDZO

Kana mabvuma kuti mwana wenyu apinde mutsvakiridzo iyi nokusaina gwaro rino vatsvakiridzi nevechikamu cheMRCZ ndivo chete vachava nemvumo yokuziva nezvichawanikwa mutsvakiridzo.

Zvichawanikwa patsvakiridzo ino zvichavanziva zvichingozoburitswa chete nemvumo yenyu kana yemwana wenyu. Vana havanyori mazita avo pamapepa ose achashandiswa patsvakiridzo. Vana vachashandisa “manamba” anongozivikanwa navatsvakiridzi chete. Hakuna zita remwana richabuda muzvinyorwa zvinobva mutsvakiridzo.

KANA MWANA AKAKUVARA

Kana mwana akakuvara paanenge achiiita zvinoita netsvakurudzo, acharapiswa novanotungamira tsvakurudzo. Kana mwana akakuvara munotaura naMr. Daga Makaza, Department of Sports Science and Coaching, National University of Science and Technology, Box AC939, Ascot, Bulawayo, Zimbabwe; Cell +263772295476, Landline +2639282842 ext 2487, e mail dmakaza@gmail.com

KUSAMAKIDZWA KUPINDA MUTSVAKIRIDZO

Kupinda mutsvakiridzo hakumanikidzwi. Kana mafunga kuti mwana wenyu haangapindi mutsvakiridzo hazvikanganisi kupinda kwake chikoro uye kuwana zvaanofanirwa pachikoro. Kana mabvuma kuti mwana apinde mutsvakiridzo anokwanisa kubuda paanodira pasina chinomukanganisa.

MIBVUNZO NEZVETSVAKURUDZO

Munemvumo yokubvunza mibvunzo musati masaina gwaro rino. Munogona kutora nguva muchifunga musati masaina.

KUPA MVUMO

MURIKUTORA CHINHANHO CHOKUPA KANA KUSAPA MWANA WENYU MVUMO YOKUPINDA MUTSVAKIRIDZO. KUSAINA KWAMUNOITA KUNORATIDZA KUTI MAVERENGA MUKANZWISISA ZVIRIMUGWARO RINO HUYE MIBVUNZO YENYU YAPINDURWA. MABVUMA KUTI MWANA APINDE MUTSVAKURUDZO.

Zuva ramunobvuma kuti mwana apinde mutsvakurudzo (date), rinova zuva ranhasi, rinofanirwa kuenderana nezuva riripachitambi chiri pamapepa ari pagwaro rino. Zuva racho haritaridzi kuti mwana wenyu achange arimutsvakiridzo kwenguva yakadii. Zvitambi zviripagwaro rino zvinotaridzo kuti vechikamu cheMRCZ vakaongoorora vakabvumira tsvakurudzo ino.

Zita remubereki (nyorai zvinoverengeka) Zuva/Date

_____ _____

Panosaina mubereki kana anochengeta mwana Nguva/Time

_____

Ukama nemwana

_____

_____

Mufakazi Panosaina mutsvakiridzi

(*Optional*)

MUCHAPIWA RIMWE GWARO ROKUSARA NARO

Kana mune mune imwe mibvunzo inechekuita nezvetsvakiridzo kana gwaro rino pamusoro peyapindurwa nemutsvakiridzi, kusanganisira mibvinzo yetsvakiridzo, kodzero

dzevanhu vanopinda mutsvakiridzo kana kukuvadzwa kuburikidza netsvakiridzo; kana muchinzwa kuti hamuna kubatwa zvinokufadzai makasununguka kutaura nevechikamu che Medical Research Council of Zimbabwe panhamba dzinoti 791792 kana 791193

Kuvana vane makore manomwe kusvika gumi namatatu

Ndapinda mutsvakiridzo iyi pasina kumanikidzwa. Ndaverenga ndikanzwisisa zvose zviri mugwaro rino uye ndikabvunza mibvunzo yose yandanga ndinayo uye ndikabvuma kupinda mutsvakiridzo. Ndichapiwa rimwe gwayo rakafanana neiri kuti ndichengete.

_____

Zita remwana

_____

Panosaina mwana

APPENDIX D:

SCHOOL NUTRITION AND PHYSICAL ACTVITITY QUESTIONNAIRE

Questionnaire Number…… Date……

INSTRUCTIONS

- You will be asked to answer questions about what you eat and physical activity (exercise)
- You will be weighed, your height measured and other body measurements will be taken.
- No one at the school or at home will see the results.
- Taking part in this exercise is optional. Your choice about taking part will not affect your grades or your ability to take part in school activities.
- You may stop taking part in this project during the time you are being measured, while answering questions, or at any other time
- After you complete the questionnaire, the questionnaire will be returned to the interviewer.

Date of Birth……..

Grade…… ☐ …… ☐

Are you a boy or a girl? Boy Girl

NUTRITION

FOOD AND BEVERAGE INTAKE

I. How many servings of fruit did you have yesterday? (By a serve we mean a medium size apple, banana, orange or pear or two small pieces of fruit etc)

1. None ☐ 2. One ☐ 3. Two ☐

4. Three ☐ 5. More than three ☐

6. Don't Know ☐

2. Are Fruits good for your health?

1. Yes ☐ 2. No ☐ 3. Not really ☐

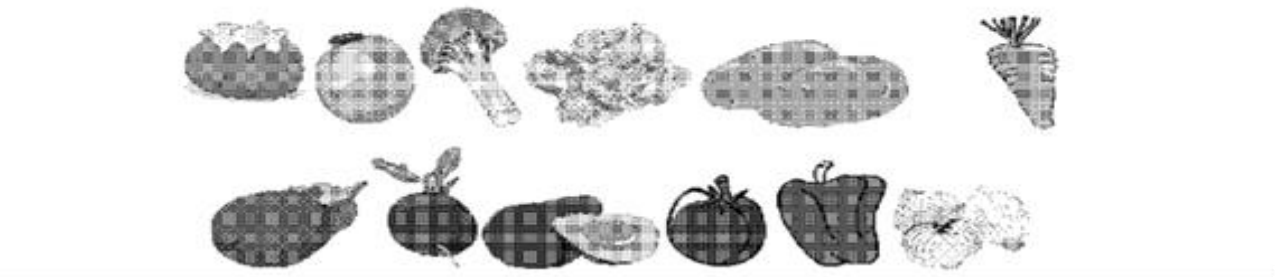
4. Don't know ☐

3. Do you like eating fruits?

1. Yes ☐ 2. No ☐ 3. Sometimes ☐

4. Don't Know ☐

4. How many servings of vegetables did you eat yesterday? (By a serving we mean *dishing spoon* cooked vegetable we mean rape, covo, cabbage, bhobola/muboora, ulude/rude, delele/derere, spinach/tsunga etc)



☐ ☐ ☐

1. None ☐ 2. One ☐ 3. Two ☐

4. Three ☐ 5. More than three ☐

6. Don't Know ☐

5. Are vegetables good for your health?

1. Yes ☐ 2. No ☐ 3. Not really ☐

4. Don't know ☐

6. Do you like eating vegetables?

1. Yes ☐ 2. No ☐ 3. Sometimes ☐

4. Don't Know ☐

7. How many servings of legumes did you eat yesterday? (By a serving we mean *dishing spoon* cooked sugar beans- madondo, green peas, cowpeas- n y e m b a / i n d u m b a , soya beans etc)

1. None ☐ 2. One ☐ 3. Two ☐

4. Three ☐ 5. More than three ☐

6. Don't Know ☐

8. Are legumes good for your health?

1. Yes ☐ 2. No ☐ 3. Not really ☐

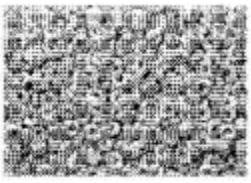
4. Don't know ☐

9. Do you like eating legumes?

1. Yes ☐ 2. No ☐ 3. Sometimes ☐

4. Don't Know ☐

10. How many servings of potato crisps or other packaged snacks (like rings, jiggies, corn chips, biscuits, sweets etc) did you eat yesterday? By a serving we mean half a standard bag of crisps or one small snack pack.



1. None ☐ 2. One ☐ 3. Two ☐

4. Three ☐ 5. More than three ☐

6. Don't Know ☐

11. Are potato crisps and other packaged snacks good for your health?

1. Yes ☐ 2. No ☐ 3. Not really ☐

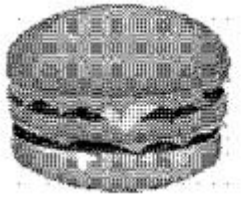
4. Don't know ☐

12. Do you like eating potato crisps and other packaged snacks?

1. Yes ☐ 2. No ☐ 3. Sometimes ☐

4. Don't Know ☐

13. How many servings of take away or 'fast food' (e.g. Fish and chips, pies/pastry. fried chicken, hot dog, pizza. and hamburger etc) did you eat yesterday?



1. None ☐ 2. One ☐ 3. Two ☐

4. Three ☐ 5. More than three ☐

6. Don't Know ☐

14. Are "take away" or "fast food" good for your health?

1. Yes ☐ 2. No ☐ 3. Not really ☐

4. Don't know ☐

15. Do you like eating "take away" or "fast food"

1. Yes ☐ 2. No ☐ 3. Sometimes ☐

4. Don't Know ☐

16. How many bottles of soft drink (e.g. soda.) did you drink yesterday?

1. None ☐ 2. One ☐ 3. Two ☐

4. Three ☐ 5. More than three ☐ 6. Don't Know ☐

17. Are soft drinks good for your health?

1. Yes ☐ 2. No ☐ 3. Not really ☐

4. Don't know ☐

18. Do you like taking soft drinks?

1. Yes ☐ 2. No ☐ 3. Sometimes ☐

4. Don't Know ☐

19. How many servings of fruit juice did you drink yesterday? By serving we mean a glass or 300ml. The juices include (fruit juice, diluted fruit juice drinks E.g. mazoe orange crush, cape camisa, minute maid, orange juice etc.)

1. None ☐ 2. One ☐ 3. Two ☐

☐

4. Three 5. More than three ☐

6. Don’t Know ☐

20. Are fruit juices good for your health?

1. Yes ☐ 2. No ☐ 3. Not really ☐

4. Don’t know ☐

21. Do you like taking fruit juices?

1. Yes ☐ 2. No ☐ 3. Sometimes ☐

4. Don’t Know ☐

22. How often do you take water to drink with meals or snacks?

1. Always ☐ 2. Quite often ☐ 3. Sometimes ☐

4. Rarely or never ☐ 5. Don't know ☐

23. Did you have breakfast this morning?

1. Yes ☐ 2. No ☐ 3. Don't Know ☐

24. Do you think breakfast is important?

1. Yes ☐ 2. No ☐ 3. Not really ☐

4. Don’t know ☐

25. How many meals did you have yesterday?

1. None ☐ 2. One ☐ 3. Two ☐

4. Three ☐

26. Of the following grain products tick the ONES which you ate over the last one week

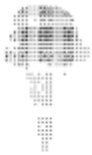


1. Bread ☐ 2. Cereals (Cornflakes, Wetabix) ☐

3. Muffins ☐ 4. Rice ☐

5. Noodles/pasta/spaghetti ☐ 6. Isitshwala/Sadza ☐

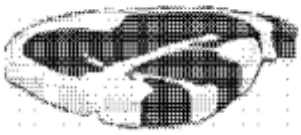
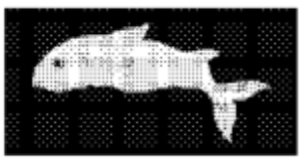
27. Of the following milk and milk products listed below tick the ones which you ate over the last one week.

1. Milk ☐ 2. Yoghurt ☐ 3. Ice cream ☐

4. Cheese ☐ 5. None ☐

28. Of the following meat and meat products listed below tick the ones which you ate over the last one week

☐ ☐ ☐

1. Eggs ☐ 2. Fish ☐ 3. Meat ☐

4. Pork ☐ 5. Sausage ☐ 6. Bacon ☐

7. Turkey ☐ 8. Chicken ☐ 9. None ☐

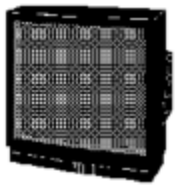
ACTIVITY

1. How many hours do you spend outside playing after school?

1. None ☐ 2. Less than one hour ☐

3. More than one hour ☐ 4. Don't know ☐

2. How many hours did you spend watching video or TV yesterday?



1. Less than half an hour ☐ 2. Half an hour ☐

3. One hour ☐ 4. One and half hours ☐

5. Two hours ☐ 6. Two and half hours ☐

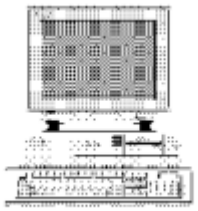
7. Three hours ☐ 8. Three and half hours ☐

9. Four hours ☐ 10. Four and half hours ☐

11. Five hours ☐ 12. More than five hours ☐

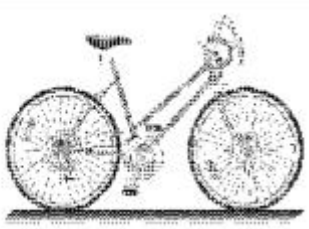
13. Don't know ☐

3. How many hours did you spend playing electronic games (computer games, play station)?



1. Less than half an hour ☐
2. Half an hour ☐
3. One hour ☐
4. One and half hours ☐
5. Two hours ☐
6. Two and half hours ☐
7. Three hours ☐
8. Three and half hours ☐
9. Four hours ☐
10. Four and half hours ☐
11. Five hours ☐
12. More than five hours ☐
13. Don't know ☐

4. What method of travel did you use to and from school yesterday?




1. Walking ☐
2. Bicycle ☐
3. Motorcycle ☐
4. Bus/Kombi ☐
5. Train ☐
6. Car ☐

5. What is your preferred method of getting to and from school?

1. Walking ☐
2. Bicycle ☐
3. Motorcycle ☐
4. Bus/Kombi ☐
5. Train ☐
6. Car ☐

6. Yesterday, did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes? (E.g. fast dancing, swimming, tennis, aerobics)

1. Yes ☐ 2. No ☐ 3. Don't know ☐

7. Yesterday did you exercise or participate in sports activities that made your heart beat fast and made you breathe hard for at least 20 minutes? (E.g. ploughing, hoeing, digging, running to or from school, herding animals etc.)

1. Yes ☐ 2. No ☐ 3. Don't know ☐

Thank You

SCHOOL NUTRITION AND PHYSICAL ACTVITITY QUESTIONNAIRE

Iphepha lemibuzo…… Usuku……

IZIXHWAYISO

- uzabuzwa ngovame ukukudla langendlela ezelula ngayo umzimba.
- isisindo somzimba wakho lobude lezinye izikalo zomzimba wakho zizosetshenziswa.
- impumela izaba yimfihlo akula muntu ngakhaya kumbe esikolweni ozabayazi.
- ukubayinxhenye yalokhu, yikuthanda kwakho njalo ngeke kwakuphazamisa emsebenzini yakho yesikolo.
- ukhululekile ukutshiya loba yisiphi isikhathi, loba usuqalile ukuphendula imibuzo kumbe sokuthatha izikalo zomzimba wakho.
- ungaqeda ukuphendula imibuzo uphendukise amaphephe emibuzo.

Usuku lokuzalwa…… Iviyo/Ibanga ……

Ungumfana kumbe uyinkazana? Ngingumfana ☐ Ngiyinkazana ☐

OKUDLIWAYO LOKUPHUZWAYO

I. Izolo udle isilinganiso esinganani sesithelo? (Isilinganiso sibalisela okungaba liwolentshisi kumbe i-aphuli elilingeneyo kumbe izithelo ezincane ezimbili loba incezu ezimbili njalonjalo)

1. Ngitsho ☐ 2. eyodwa ☐ 3. ezimbili ☐

4. Ezintathu ☐ 5. Ezingaphezulu kwezintanthu ☐

6. Angazi ☐

2. Izithelo zilungile emzimbeni wakho na?

1. Yebo ☐ 2. Hatshi ☐ 3. Kangilaqiniso ☐

4. Angazi ☐

3. Uyakukhwabitha ukudla izithelo na?

1. Yebo ☐ 2. Hatsi ☐ 3. Kwesinye isikhathi ☐

4. Angazi ☐

4. Izolo udle isilinganiso esinganani sombida? (isilinganiso lukhezu olulodwa lokuphakulula, olubalisela ikhabitshi, ibhobola, ulude, idelele leminye imihlobo yemibhida etshiyeneyo)

1.ngitsho ☐ 2. esisodwa ☐ 3. ezimbili ☐

4. Ezintathu ☐ 5. Ezingaphezulu kwezintanthu ☐

6. Angazi ☐

5. Imibhida ilungile emzimbeni yakho na?

1. Yebo ☐ 2. Hatshi ☐ 3. Kangilaqiniso ☐

4. angazi ☐

6. Uyakukhwabitha ukudla umbida na?

1. Yebo ☐ 2. Hatsi ☐ 3. Kwesinye isikhathi ☐

4. Angazi ☐

7. Izolo udle isilinganiso esinganani sendlubu kumbe indumba. ((isilinganiso lukhezu olulodwa lokuphakulula)

1.Ngitsho ☐ 2. Esisodwa ☐ 3. Ezimbili ☐

4. Ezintathu ☐ 5. Ezingaphezulu kwezintanthu ☐

6. Angazi ☐

8. Iindumba lendlubu zilungile emzimbeni wakho na?

1. Yebo ☐ 2. Hatshi ☐ 3. Kangilaqiniso ☐

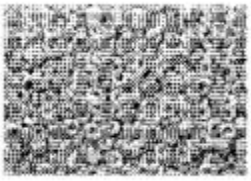
4. Angazi ☐

9. Uyakukhwabitha ukudla umbida na?

1. Yebo ☐ 2. Hatsi ☐ 3. Kwesinye isikhathi ☐

4. Angazi ☐

10. Izolo udle isilinganiso esinganani samabhisikiti, seziwiji loba amachipisi. Ngesilinganiso sithi inxhenye yepakede lamabhisikiti, leziwiji loba amachiphisi.



1. ngitsho ☐ 2. esisodwa ☐ 3. ezimbili ☐

4. ezintathu ☐ 5. Ezidlula ezintathu ☐

6. angazi ☐

11. Amabhisikiti, iziwiji loba amachipisi alungile emzimbeni na?

1. Yebo ☐ 2. Ngitsho ☐ 3. Kangilaqiniso ☐

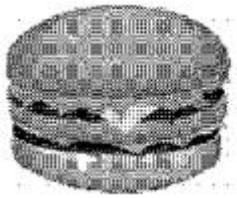
4. Angazi ☐

12. Uyathanda ukudla amabhisikiti, iziwiji loba amachipisi na?

1. Yebo ☐ 2. Ngitsho ☐ 3. Kwesinye isikhathi ☐

4. Angazi ☐

13. Izolo udle isilinganiso esinganani sokudla okuphekwa ezitolo okugoqela inyama yenkukhu ekhanzingiweyo, amachipisi akhanzingiweyo loba inhlanzi ekhanzingiweyo. Ngesilinganiso sithi inxhenye amachiphisi loba iqatha elilodwa lenyama ekhanzingiweyo.



1. ngitsho ☐ 2. esisodwa ☐ 3. ezimbili ☐

4. ezintathu ☐ 5. Ezidlula ezintathu ☐

6. angazi ☐

14. Ukudla okuphekwa ezitolo okugoqela inyama yenkukhu ekhanzingiweyo, amachipisi akhanzingiweyo loba inhlanzi ekhanzingiweyo kuqakathekile emzimbeni na?

1. Yebo ☐ 2. Ngitsho ☐ 3. Kangilaqiniso ☐

4. Angazi ☐

15. Uyakuthanda ukudla okuphekwa ezitolo okugoqela inyama yenkukhu ekhanzingiweyo, amachipisi akhanzingiweyo loba inhlanzi ekhanzingiweyo kuqakathekile emzimbeni na?

1. Yebo ☐ 2. Ngitsho ☐ 3. Kwesinye isikhathi ☐

4. Angazi ☐

16.Izolo unathe amabhodlela amangaki enamnede ?

1. anginathanga ☐ 2. Elilodwa ☐ 3. Amabili ☐

4. amathathu ☐ 5. Angaphezu kwamathathu ☐ 6. angazi ☐

17. Inamnede iqakathekile emzimbeni na?

1. Yebo ☐ 2. ngitsho ☐ 3. kangilaqiniso ☐

4. angazi ☐

18. Uyakuthanda ukunatha inamnede?

1. Yebo ☐ 2. ngitsho ☐ 3. kangilaqiniso ☐

4. angazi ☐

19.Izolo unathe isilinganiso esinganani somhluzi wezithelo? Isilinganiso yinkomitsho eyodwa.

1. akula ☐ 2. esisodwa ☐ 3. ezimbili ☐

☐

4. ezintathu 5. Ezidlula ezintathu

6. angazi

20. Umhluzi wezithelo uqakathekile emzimbeni na?

1. Yebo 2. hayi 3. kangilaqiniso

4. kangikwazi

21. Uyathanda ukunatha umhluzi wezithelo?

1. Yebo 2. ngitsho 3. Kwezinye izikhathi

4. angazi

22. Uvame ukunatha amanzi kangaki ngemva kokudla?

1. sikhathi sonke 2. Esikhathini esinengi 3. Kwesinye isikhathi

4. kangivamanga 5. Kangazi

23. Udlile ukudla kwekuseni namhla?

1. Yebo 2. hatshi 3. angazi

24. Ucabanga ukuthi ukudla kwekuseni kuqakathekile?

1. yebo 2. hatshi 3. kangilaqiniso

4. angazi

25. Udle kangaki izolo?

1. kangidlanga 2. kanye 3. kabili

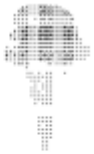
4. kathathu

26. Khetha okudla okwenziwa ngamabele okewakudla kuliviki



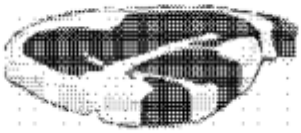
1. isinkwa ☐
2. Amasireli ekuseni ☐
3. amabhanzi ☐
4. ilayisi ☐
5. isipagethi ☐
6. Isitshwala ☐

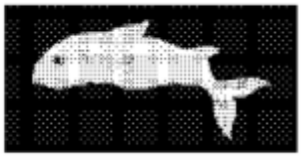
27. Yikuphi okudla okwenziwa luchago okudlileyo kuliviki

1. uchago ☐
2. iyogathi ☐
3. Ulaza uluqandayo ☐
4. itshizi ☐
5. akula ☐

28. Khetha imhlobo yenyama oyidlileyo ivekini leyi





1. amaqanda ☐
2. inhlanzi ☐
3. eyenkomo ☐
4. eyengulube ☐
5. isosage ☐
6. ibhekhoni ☐
7. eyengalukhuni ☐
8. eyenkukhu ☐
9. akula ☐

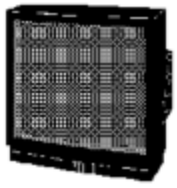
IMISEBENZI

1. Uvame ukuthatha isikhathi esinganani udlala ngemva kokutshayisa esikolo?

1. Ngitsho ☐ 2. Ngaphansi kwehola ☐

3. Okwedlula ihola ☐ 4. Angazi ☐

2. Izolo uthethe isikhathi esenganani ukhangele umabonakude?



1. ngaphansi kwenxhenye yehola ☐ 2. Inxhenye lehola ☐

3. ihola eliloldwa ☐ 4. Iholo elilodwa lenxhenye ☐

5. amahola amabili ☐ 6. amahola amabili lenxhenye yehola ☐

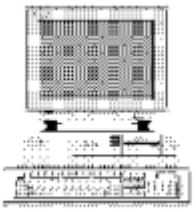
7. amahola amathathu ☐ 8. amahola amathathu lenxhenye yehola ☐

9. amahola amane ☐ 10. amahola amathathu lenxhenye yehola ☐

11. amahola amahlanu ☐ 12. amahola amahlanu lenxhenye yehola ☐

13. angazi ☐

3. Izolo uthethe isikhathi esinganani udlalisa imtshina kagetsi yokuzilibazisa okugoqela imidlalo yamakomputha?



1. ngaphansi kwenxhenye yehola ☐ 2. Inxhenye lehola ☐

3. ihola eliloldwa ☐ 4. Iholo elilodwa lenxhenye ☐

5. amahola amabili ☐ 6. amahola amabili lenxhenye yehola ☐

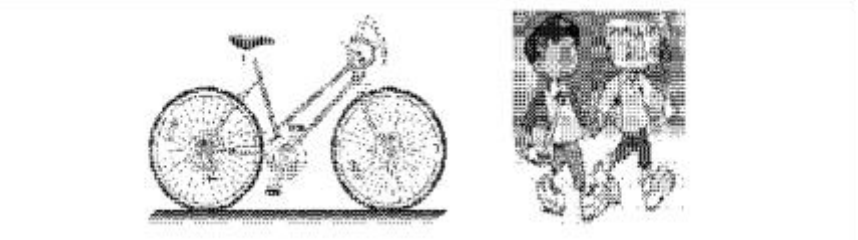
7. amahola amathathu ☐ 8. amahola amathathu lenxhenye yehola ☐

9. amahola amane ☐ 10. amahola amathathu lenxhenye yehola ☐

11. amahola amahlanu ☐ 12. amahola amahlanu lenxhenye yehola ☐

13. angazi ☐

4. Izolo uhambe ngani esikolo?



1. ngenyawo ☐ 2. ngebhayisikili ☐
3. Ngesithuthuthu ☐ 4. ngebhasi ☐
5. ngesitimela ☐ 6. ngemota ☐

5. ukhetha ukuhamba ngani esikolo?

1. ngenyawo ☐ 2. ngebhayisikili ☐
3. Ngesithuthuthu ☐ 4. ngebhasi ☐
5. ngesitimela ☐ 6. ngemota ☐

6. Izolo ukuwaphatheka kwezemidlalo okwenze inhliziyo yakho yatshaya ngamadla okwemizuzo engangadlula amatshumi amabili? (lokhu kugoqela ukugijima, ukudlala unobhutshuzwayo, ukubhukutsha leminye imidlalo etshiyeneyo)

1. Yebo ☐ 2. Ngitsho ☐ 3. Angazi ☐

7. Izolo ukuwaphatheka ekweluleni umzimba kumbe emsebenzi onzima okwenze inhliziyo yakho yatshaya ngamadla okwemizuzo engangadlula amatshumi amabili? (lokhu kubalisela ukulima, ukuhlakula ukwelusa izifuyo, ukugijima usiya esikolo)

1. Yebo ☐ 2. Ngitsho ☐ 3. Angazi ☐

Siyabonga

GWARO REMIBVUNZO RAKANANGANA NERUZIVO RWEZVEKUDYA NEKUTAMBA KWAVANA

Namba YeGwaro…… Zuva……

MAFAMBISIRWO

- Uchabvunzwa mibvunzo yakanangana nezvaunodya uye matambiro ako (exercise)
- Uchayerwa pachikero, urefu hwako huchatorwa uye dzimwe nhengo dzomuviri wako dzichayerwa.
- Hapana munhu achaziva zvichawanikwa pakuyerwa kwako.
- Haumanikidzwi kupinda mutsvakiridzo iyi, uye sarudzo yako yokupinda mutsvakiridzo haikanganisi madzidziro ako kana zvimwe zvaunoita pachikoro.
- Unokwanisa kurega nezvekuita netsvakiridzo iyi paunodira: paunenge uchiyerwa, paunenge uchipindura mibvunzo kana nguva ipi zvayo.
- kana wapedza kupindura mibvunzo iri pagwaro rino udzorere kumutsvakiridzi.

Zuva rako rekuzvarwa (Date of Birth)……..

Grade……

Uri mukomana here kana musikana? Mukomana ☐ Musikana ☐

ZVAKANANGANA NEKUDYA

ZVAUNODYA NEZVAUNONWA

I. Wakadya michero (fruit) yakawanda zvakadii nezuro

1. Handina kudya ☐ 2. Umwechete/One ☐ 3. Miviri/two ☐

4.Mitatu/ Three ☐ 5. Yakadarika mitatu/more than three ☐

6. Handichazivi ☐

2. Michero inoita kuti hutano hwako huve hwakanaka here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Pamwe/ Not really ☐

4.Handizivi/ Don't know ☐

3. Unofarira kudya michero/fruits here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Dzimwe Nguva/Sometimes ☐

4. Handizivi/Don't Know ☐

4. Wakadya muriwo wakawanda zvakadii nezuro? (Tinoera uwandu hwemuriwo nechipunu chinoshandiswa kupakura (dishing spoon) murivo wakabikwa we rape, covo, cabbage, bhobola/muboora, ulude/rude, delele/derere, spinach/tsunga etc)

1. Handina/None ☐ 2. Chimwe/One ☐ 3. Zviviri/Two ☐

4. Zvitatu/Three ☐ 5. Zvinopfuura zvitatu/more than three ☐

6. Handichazivi/Don't know ☐

5. Muriwo unoita kuti hutano hwako huve hwakanaka here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Pamwe/Not really ☐

4. Handizivi/Don't know ☐

6. Unofarira kudya muriwo here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Dzimwe Nguva/Sometimes ☐

4. Handina mhinduro/Don't Know ☐

7. Wakadya chikafu chemhando rwebhinzi kana nyemba (legumes) chakawanda zvakadii nezuro? (Tinoera uwandu nechipunu chinoshandiswa kupakura (dishing spoon) chikafu chakabikwa chemhando yesugar beans- madondo, green peas, cowpeas- n y e m b a / i n d u m b a , soya beans etc

1. Handina/None ☐ 2. Chimwechete/One ☐ 3. Zviviri/Two ☐

4. Zvitatu/Three ☐ 5. Zvinopfuura zvitatu ☐

6. Handizivi/Don't Know ☐

8. Chikafu chemhando hwebhinzi(legumes) chinoita kuti hutano hwako huve hwakanaka here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Pamwe/Not really ☐

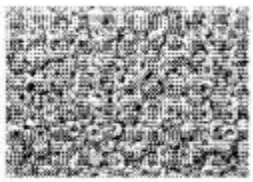
4. Handizivi/Don’t know ☐

9. Unofarira kudya chikafu chemhando hwebhinzi (legumes) here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Dzimwe Nguva/Sometimes ☐

4. Handizivi/Don’t Know ☐

10. Wakadya chikafu chemuzvipepa chakafanana namachipisi (maringisi, jiggies, maputi, mabhisikitsi, zvihwitsi etc) chakawanda zvakadii nezuro? Tinoera uwandu hwemachipisi nehafu yepaketi inonyanya kushandiswa yemachipisi.



1. Handina/None ☐ 2. Chimwe/One ☐ 3. Zviviri/Two ☐

4. Zvitatu/Three ☐ 5. Zvinopfuura zvitatu ☐

6. Handizivi ☐

11. Chikafu chemuzvipepa chakaita samachipisi chakanakira hutano hwako here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Pamwe/Not really ☐

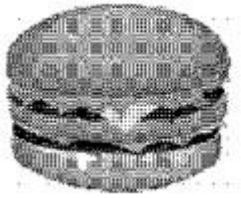
4. Handizivi/Don’t know ☐

12. Unofarira kudya machipisi kana chimwe chikafu chakaputirwa muzvipepa here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Dzimwe nguva/Sometimes ☐

4. Handizivi/Don't Know ☐

13. Wakadya chikafu chomuma takeaway akaita seChicken Inn, Nandos (e.g. Hove n e machipisi, pies/pastry. Huku yakafurayiwa, pitsa nemahambega etc) chakawanda zvakadii nezuro?



1. Handina/None ☐ 2. Chimwe/One ☐ 3. Zviviri/Two ☐

4. Zvitatu/Three ☐ 5. Zvinopfuura zvitatu ☐

6. Handizivi ☐

14. Chakafu chomumatakeway (Chiken Inn, Nandos etc) chine hutano here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Pamwe/Not really ☐

4. Handizivi/Don't know ☐

15. Unofarira kudya chikafu chokumatakeaway here (Chicken Inn, Nandos etc) here?

1. Hongu/Yes ☐ 2. Kwet/No ☐ 3. Dzimwe nguva/Sometimes ☐

4. Handizivi/ Don't Know ☐

16. Wakanwa mabhodhoro mangani (e.g. coke, fanta.) nezuro?

1. Handina/None ☐ 2. Rimwe/One ☐ 3. Maviri/Two ☐

4. Matatu/Three ☐ 5. Anopfuura matatu ☐ 6. Handichazivi/Don't Know ☐

17. Zvinwiwa zvemumabhodhoro zvemhando yakaita secoke, fanta etc zvinopa hutano here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Pamwe/Not really ☐

4. handizivi/Don't know ☐

18. Unofarira zvinwiwa zvemumabhodhoro zvakaita secoke nefanta here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Dzimwe Nguva/Sometimes ☐

4. Handizivi/Don't Know ☐

19. Wakanwa zvimwiwa zvinobva mumichero (fruit juice) zvakawanda zvakadii nezuro? Tinoera uwandu hwechimwiwa tichishandisa girazi kana 300ml. Zvimwiwa zvinobva mumichero zvinobatanidza (zvisina kupamidzirwa mvura (kudhailutwa), zvakadhailutwa zvakaita semazoe orange crush, cape camisa, minute maid, orange juice etc.)

1. Handina/None ☐ 2. Rimwe/One ☐ 3. Maviri/Two ☐

4. Matatu/Three ☐ 5. Anopfuura Matatu ☐

6. Handizivi/Don't Know ☐

20. Zvimwiwa zvinobva mumichero zvakanakira hutano hwako here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Pamwe/Not really ☐

4. Handizivi/Don't know ☐

21. Unofarira kumwa zvinwiwa zvinobva mumichero here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Dzimwe nguva/Sometimes ☐

4. Handizivi/Don't Know ☐

22. Unonwa mvura zvakadii panguva yekudya kana paunodya zvokudyiradyira (snacks)?

1. Chero nguva/Always ☐ 2. Kakati wandei/Quite often ☐

3. Dzimwe nguva/Sometimes ☐

4. Kashoma/rarerly or never ☐ 5. Handizivi/Don't know ☐

23. Wadya kudya kwemangwanani (breakfast) here nhasi?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Handizivi/Don't Know ☐

24. Unofunga kudya kwamangwanani (breakfast) kwakakakosha here?

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Pamwe/Not really ☐

4. Handizivi/Don't know ☐

25. Wakadya kangani nezuro?

1. Handina/None ☐ 2. Kamwe chete/One ☐ 3. Kaviri/Two ☐

4. Katatu/Three ☐

26. Pane chikafu chinobva muzviyo zvinotevera isa tsvunha pane chikafu/zvikafu chawakadya/zvawakadya svondo rakapera.



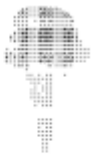
1. Chingwa ☐ 2.Zviyo (Cereals (Cornflakes, Wetabix) ☐

☐ ☐

3. Zvikeke/Muffins 4. Mupunga/Rice

5. Noodles/pasta/spaghetti ☐ 6. Isitshwala/Sadza ☐

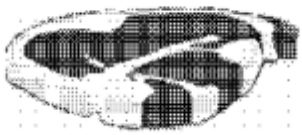
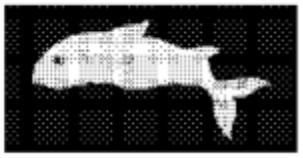
27. Pamukaka nezvinobva mumukaka zvinotevera isa tsvunha pane zvawakadya pasvondo rakapera..

1. Mukaka/Milk ☐ 2. Yogati/Yoghurt ☐ 3. Ice cream ☐

4. Chizi/Cheese ☐ 5. Hapana/None ☐

28. Pane nyama nezvinobva munyama zvinotevera isa tsvunha pane zvawakadya svondo rakapera.

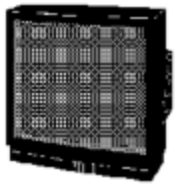
1. Mazai/Eggs ☐ 2. Hove/Fish ☐ 3. Nyama yemombe/Meat ☐
4. Nguruve/Pork ☐ 5. Sausage ☐ 6. Bacon ☐
7. Garikuni/Turkey ☐ 8. Huku/Chicken ☐ 9.Hapana/ None ☐

KUTAMBATAMBA

1. Unotamba kwamaawa mangani kana wabuda chikoro?

1. Handitambi/None ☐ 2. Pasi peawa rimwe ☐
3. Zvinopfuura awa rimwe ☐ 4. Handizivi/Don't know ☐

2. Wakatora maawa mangani uchiona chivhitivhiti (television) kana mafirimu pavidhiyo (video) nezuro?

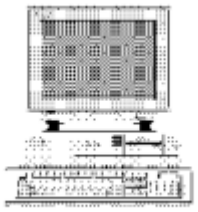


1. Pasi peawa rimwe ☐ 2. Chikamu cheawa (half) ☐
3. Awa rimwe ☐ 4. Awa nechikamu ☐
5. Maawa maviri ☐ 6. Maawa maviri nechikamu ☐
7. Maawa matatu ☐ 8. Maawa matatu nechikamu ☐
9. Maawa mana ☐ 10. Maawa mama nechikamu ☐

11. Maawa mashanu ☐ 12. Zvinopfuura maawa mashanu ☐

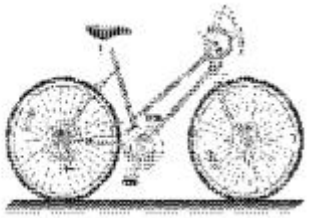
13. Handizivi ☐

3. Wakatora maawa mangani uchitamba mitambo yepamacomputer ne Television (computer games, play station e.t.c) nezuro.



1. Pasi peawa rimwe ☐ 2. Chikamu cheawa ☐
3. Awa rimwe ☐ 4. Awa nechikamu ☐
5. Maawa maviri ☐ 6. Maawa maviri nechikamu ☐
7. Maawa matatu ☐ 8. Maawa matatu nechikamu ☐
9. Maawa mana ☐ 10. Maawa mana nechikamu ☐
11. Maawa mashanu ☐ 12. Zvinopfuura maawa mashanu ☐
13. Handizivi ☐

4. Wakashandisei pakufamba kuuya kuchikoro nekudzokera kumba nezuro?



1. Ndakafamba netsoka ☐ 2. Bhasikoro ☐
3. Chimudhudhu ☐ 4. Bus/Kombi ☐
5. Chitima ☐ 6. Car ☐

5. Ndeipi nzira yaunofarira kushandisa pakufamba kana uchiuya kuchikoro nokudzokera kumba?

1. Kufamba netsoka ☐ 2. Bhasikoro ☐
3. Chimudhudhudhu ☐ 4. Bhazi/Kombi ☐

5. Chitima ☐ 6. Motikari ☐

6. Nezuro wakaita here zvinosimbisa muviri zvakaita sekumhanyamhanya kana kutamba mitambo yakaita kuti hana yako irove uchifemereka kwemaminitsi makumi maviri? (Kutsava, kutuhwina, kutamba bhora etc)

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Handizivi/Don't know ☐

7. Nezuro wakaita here zvinosimbisa muviri zvakaita sekumhanyamhanya kana kutamba mitambo yakaita kuti hana yako irove uchifemereka kwemaminitsi makumi maviri? (Kurima mumunda nemombe kana madhongi, Kusakura, Kutimba, Kumhanya kuenda nekudzoka kuchikoro, Kurisa mombe e.t.

1. Hongu/Yes ☐ 2. Kwete/No ☐ 3. Handizivi/Don't know ☐

Tatenda

APPENDIX E:

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

SPORTS SCIENCE & COACHING DEPARTMENT

The Provincial Education Director

Bulawayo Province

Bulawayo

2 September 2014

Dear Sir/Madam

REF: REQUEST TO CONDUCT RESEARCH PROJECT ON SCHOOL PUPILS

The Department of Sports Science and Coaching is seeking your permission to use primary school pupils as subjects in a research project. The study will run for two months starting 5 October 2014. The national project is being done jointly with Nestle Zimbabwe and in your province, it is targeting Mabhukudwana Primary School. Permission from the ministry was applied for through Nestle and was granted (attached). The title of the project is **Nutritional and Physical Fitness profiles, Knowledge and Nutritional and Physical Activity Practices of Zimbabwean Primary School Children: The Zimbabwe Baseline Study**

The objectives of the study are to:

1. To determine the knowledge of primary school children towards nutrition at 15 selected primary in schools in Zimbabwe.

2. To determine the attitudes of primary school children towards nutrition at 15 selected primary in schools in Zimbabwe.

3. To determine the nutritional and physical activity practices of primary school children towards nutrition at 15 selected primary in schools in Zimbabwe.

4. To describe the nutritional and physical fitness status of primary school children at 15 selected primary schools in Zimbabwe.

5. To determine the physical activity levels of primary school children at selected 15 primary schools in Zimbabwe.

The significance of the study:

1. The findings of the study will provide baseline data on which Nutritional Health policies affecting children could be based.

2. The results will be helpful in identifying children with abnormal Physical Growth and Development characteristics so that appropriate corrective intervention programmes could be designed.

3. The data on Physical Fitness could be harnessed by the Physical Education teachers and Sports Coaches and used to identify talented children who could be trained for competitive sports.

4. The study will provide normative data upon which future estimates of growth and developmental characteristics of Zimbabwean children could be compared.

5. The data will permit a comparison of Nutritional and Physical Fitness status of Zimbabwean children with those of children in populations elsewhere.

We are ready to provide further details of the research when called upon. We have attached the research proposal.

Research proposal.

Yours Faithfully

Makaza. D

Principal Investigator: Nestle Healthy Kids Project

Cc : E.O. Physical Education

Cc: Headmaster: Mabhukudwana Primary School