PHYSICAL FITNESS IN SCHOOL CHILDREN LIVING IN A LOW SOCIO-ECONOMIC AREA OF ACCRA, GHANA

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Declaration

I, Stella Elikplim Lawerteh, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree at this or any other university. I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

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Abbreviations

20mSRT	20-meter Shuttle Run Test
AHKGA	Active Healthy Kids Global Alliance
ALPHA	Assessing Levels of Physical Activity
ALSPAC	Avon Longitudinal Study of Parents and Children
ACSM	American College of Sports Medicine
BMI	Body Mass Index
CAPL	Canadian Assessment of Physical Literacy
CAMSA	Canadian Agility and Movement and Skills Assessment
CRE	Cardiorespiratory endurance
CRF	Cardiorespiratory function
DCD	Developmental Coordination Disorder
DEXA	Dual Energy X-ray Absoptiometry
FMS	Fundamental movement skills
GES	Ghana Education Service
GSS	Ghana Statistical Services
IOM	Institute of Medicine
IOTF	International Obesity Task Force
IQR	Interquartile range
JHS	Junior High School
TGMD	Test of Gross Motor Development
LADMA	La Dadekotopon Municipal Assembly
LMICs	Low- and middle-income countries

MABC	Movement Assessment Battery for Children
Max	Maximum
Min	Minimum
MOE	Ministry of Education
MVPA	moderate-to-vigorous physical activity
NCDs	Non-communicable diseases
PA	Physical activity
PAR-Q	Physical Activity Readiness Questionnaire
PERF-FIT	Performance and Fitness Test
SD	Standard deviation
SES	Socioeconomic Status
SHS	Senior High School
SLJ	Standing long jump
SR	Shuttle run
SSA	Sub-Saharan Africa
UNICEF	United Nations International Children's and Emergency fund
VO_2 max	Maximal Oxygen Uptake
WHO	World Health Organization

Abstract

Background

Physical fitness is an important indicator of health in childhood and a strong predictor of wellbeing in later life. Adiposity, decreased aerobic fitness and low levels of physical activity (PA) are associated with cardiovascular disease risk in children (Andersen et al., 2004). Estimates of PA and fitness in young children at the population level is still lacking for many African countries such as Ghana. One major challenge to conducting research on PA and fitness in children in these settings is the lack of accurate and reliable measures of these constructs. Several valid and reliable field-based physical fitness tests require test kits that are too expensive for people working in low socio-economic settings and lack norms for this population (Smits-Engelsman et al., 2020a). The Alpha-fit is one of the most used tests in Europe (Cvejić et al., 2013; Kolimechkov et al., 2019; Ruiz et al., 2011) and is considered to be a valid, reliable, feasible and safe health-related fitness test battery (Assessing Levels of Physical Activity (ALPHA), 2009; Ruiz et al., 2011). However, the Alpha-fit does not assess movement skills (e.g. throwing and catching, hopping, and balance), and has no norms for children living in Sub Saharan Africa. In recognition of these challenges, the Performance and Fitness (PERF-FIT) test battery was developed to provide a set of valid, reliable field-based motor performance items for the assessment of health-related physical fitness in low resource communities (Smits-Engelsman, 2018). However, the validity of the PERF-FIT has not been examined in children within the Ghanaian context. The aims of this study were to determine: (1) the physical fitness levels of school children aged 6 to 12 years in a low-income urban area in Ghana using the Alpha-fit and (2) the construct validity of the PERF-FIT among school children aged 6 to 12 years in a low-income urban area in Ghana by comparing it to tests of the Alpha-fit which measure similar constructs.

Method

A cross-sectional study design was adopted. Three public elementary schools located in La, a suburb of the La Dade Kotopon Municipal Assembly (LADMA), Accra, Ghana which met the criteria of low socio-economic status, (on the basis of geographical location) was selected using convenience sampling. The total number of pupils aged 6 - 12 years in all three schools were 376. A total of 186 children (aged 6-12 years) took part in the study. Children who provided assent after their parents had consented to participate in the study were recruited. Prior to testing, demographic information, health status and PA levels of children provided by

a researcher-developed parent questionnaire were documented. Children with physical or medical conditions [determined with the Children's Physical Activity Readiness Questionnaire] that would have made testing unsafe were excluded. The two-item Physical Activity Questionnaire (Prochaska et al., 2001) was used to measure participants' PA and to identify those meeting the World Health Organization (WHO) PA guidelines for children.

Testing was done on a playground/designated classroom at the participants' school during Physical Education periods. Weight and height measurements were taken using an electronic weighing scale and a wall-mounted tape measure. Cardiorespiratory endurance, power, agility and motor skills performance were assessed using the PERF-FIT and Alpha-fit assessment batteries. Only the 20-meter shuttle run test (20mSRT), long jump, Body Mass Index (BMI), waist circumference and 4 x10 meter shuttle run (4 x10m SR) which are items 1, 3, 4, 5 and 7 respectively of Alpha-fit were assessed. The tests were carried out in accordance with the instruction manuals. In describing the fitness levels of the participants, the Alpha-fit norms were used (Kolimechkov et al., 2019), and scores for each component were categorized into very poor (below 3rd percentile), below mean (between 3rd and 25th percentile), normal range (between 25th to 75th percentile), above mean (between 75th and 97th percentile) and very good (above 97th percentile). For the PERF-FIT, scores were collated as raw scores.

Descriptive statistics: mean, median, standard deviation, percentages, and frequencies were used to summarize descriptive data. To compare differences of scores on the PERF-FIT and Alpha-fit between those who meet the WHO recommended guidelines and those who did not, the Mann-Whitney U test was used. To test the construct validity, hypotheses were formulated and tested for the expected magnitude of the relation between scores on the PERF-FIT and Alpha-fit intended to measure partly comparable constructs. The level of significance used was 0.05

Results

One hundred and eighty-six children (96 boys and 90 girls) from low-income homes participated in this study. The median age of participants was 10.00 years. Only 12% of fathers and 3% of mothers had tertiary education whereas 40% of fathers were Artisans and self-employed, 68% of mothers were traders.

Participants who were found to have met the WHO recommendation for moderate-to-vigorous physical activity (MVPA) were 65.6% (n = 120),only 15.6% (n = 29) participate in sports outside school. Majority of them, 86.6% (n= 161) walk to school and 28.5% (n = 53) were underweight. Categorizing the Alpha-fit items scores, for item 1(20mSRT), 72 % (n = 134) were below the mean, 1.3 % (n = 3) performed very poorly, 25.3 % (n = 47) had normal scores, only 0.5 % (n=1) scored above mean. For item 3 (long jump), 2.2 % (n = 4) scored very good, 23.7% (n = 44) were above the mean, 59.7% (n = 111) scored normal, 12.9% (n = 24) scored below the mean and 1.1% (n = 2) performed very poorly. For item 7 (4 x10m SR), 22.6% (n = 42) scored very good, 33.2% (n = 50), scored above the mean, 30.1 % (n = 56) scored normal range, 11.8% (n = 22) scored below the mean while 2.7% (n = 5) scored very poor.

No significant difference on the PERF-FIT ladder run, ladder step, side jump, long jump and overhand throw (p = 0.26,0.16,0.54,0.90 and 0.99 respectively) and Alpha-fit longjump,4 x 10m SR, and 20mSR level (p = 0.99,0.77 and 0.10 respectively) between the group that met the WHO recommendation for PA and those who did not were found. However, there was a statistically significant difference between the two groups on BMI (p =0.05, with those not meeting the recommendation having a higher BMI).

Significant correlations were observed between the PERF-FIT (power and agility) items and the Alpha-fit 4 x10m SR and Long jump. The Alpha-fit 4 x10m SR showed low to moderate correlation with the PERF-FIT ladder run, ladder step and long jump (r_s= 0.26, 0.20, and 0.35 respectively) while the Alpha- fit long jump showed moderate to high correlations with the PERF-FIT side jump, long jump and overhand throw (r_s= 0.36, 0.84 and 0.62 respectively).

Conclusion

Participants in the study demonstrated good muscular strength and agility measured by the long jump and 4 x10m SR as a result of habitual PA. However, the low participation in organized sports observed by this study could have accounted for the poor aerobic fitness demonstrated by low scores on the 20mSRT. The majority of the children were physically active and met global (WHO) recommendations for PA as reported by their parents. They mostly employed active transportation to get in and out of school (walking). Nevertheless, the BMI of the group of children not meeting the WHO recommendations was significantly

higher than the group that met the recommendations. Scores on both Alpha-fit and PERF-FIT were however not significantly different between the two groups. The relation between PERF-FIT and Alpha-fit was mainly (80%) of the hypothesised magnitude. Majority the PERF-FIT (power and agility) items showed moderate to high correlation with the Alpha-fit 4 x10m SR and long jump which shows that the PERF-FIT measures a partly comparable construct to these tests.

Identifying deficits in physical fitness in children living in low socioeconomic settings is recommended as a critical step toward the development of a large-scale effective prevention and/or intervention for children with low levels of physical fitness. Participants understood all the PERF-FIT instructions and carried out tests accordingly, testing was time-efficient since participants could be tested in small groups. Assessors found it easy to score participants. Our study findings show that the PERF-FIT performed well in this setting and may be used to assess fitness levels of children in this context.

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CHAPTER 1: Introduction

Physical fitness is a set of attributes that people have or achieve that relates to the ability to perform physical work (Bouchard et al., 2007). Physical fitness is an integrated measure of most of the body functions involved in the performance of daily physical activities and/or physical exercise (Ortega et al., 2008). Physical fitness can be categorized as either health-related or performance-related (Caspersen et al., 1985). Physical fitness includes different components such as endurance, strength, flexibility, coordination and balance (Knapik et al., 2006). Current attitudes toward public health consider physical activity (PA) and physical fitness as factors that influence health during childhood and adolescence (Venckunas et al., 2017). Poor physical fitness is a significant risk factor for cardiovascular disease, type 2 diabetes, hypertension, stroke, and mortality in young people (Ortega et al., 2008). This underscores the need to quantify physical fitness in children.

The relationship between physical fitness and PA is bidirectional (Haga et al., 2015). High or low levels of health-related fitness may either enhance or diminish the time spent in and intensity levels of PA (Cantell et al., 2008). Participation in PA is associated with an extensive range of health benefits, including increased cardiovascular fitness, increased bone strength, lower levels of body fat and improved cognitive and mental health (Janssen & LeBlanc, 2010). Therefore, the need for all children and adolescents to perform a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA), for most days of the week, and preferably every day, is unanimously accepted (WHO, 2010). However, it is known that the level of PA among young people has been decreasing considerably and is currently below the commonly recommended levels (Sallis et al., 2009; WHO, 2010).

A study regarding the temporal trend of cardiorespiratory fitness (CRF) of children and adolescent highlighted the gap in physical fitness trend data for low-income and middle-income countries (Tomkinson et al., 2019). In this study, temporal trends were estimated from 965-264 children and adolescents from 19 high-income and upper middle-income countries between 1981 and 2014, using data from 137 studies. Collectively, there was a moderate decline in CRF of 3.3 mL/kg/ min (95% CI −3.5 to −3.1), equivalent to a decline of 7.3% (95% CI −7.8% to −6.7%) over the 33-year time period. This international decline diminished with each decade and stabilised near zero around 2000. The decline was larger for boys than girls and was similar for children and adolescents. Trends also differed in magnitude and direction between countries, with most showing declines. There was a strong

negative association between country-specific trends in income inequality and trends in CRF across 18 countries; meaning, countries approaching income equality had more favourable trends in CRF. The only available work on the trends of physical fitness and activity among Sub-Saharan African school children concluded that there was a critical lack of representative, temporally sequenced data on PA, sedentary behaviours, and physical fitness measures in Sub- Saharan Africa's school-aged children and youth (Muthuri et al., 2014).

Since levels of PA and invariably physical fitness are affected by socio-economic circumstances and cultural factors (Kriska, 2000), results from other high-income countries cannot be extrapolated unto low-income settings. It is therefore essential to measure PA and fitness levels of children living in low-income nations such as Ghana. To be able to develop appropriate health strategies, it is important to regularly monitor trends in physical fitness and PA of children and adolescents. The World Health Organization (WHO) recently developed a global action plan on PA aimed at attaining a 15% relative reduction in the global prevalence of physical inactivity in adolescents and adults by 2030 (WHO, 2017). The plan involves a multifaceted approach to create a society that intrinsically values and prioritizes policy investments in PA as a regular part of everyday life (WHO, 2017). An important component of this plan is the evaluation process for monitoring global changes in the prevalence of physical inactivity and for assessing the global plan's impact and related efforts.

1.1 Physical Fitness and PA in Ghanaian children

Ghana is classified as a lower middle-income country by the World Bank income classification (United Nation Development Programme, 2020). Ghana has a population of over 24 million with 38.3% being under fifteen years of age (Ghana Statistical Service, 2013). The proportion of children who are currently attending school and those who have attended school before are 39.5% and 37.1% respectively (Ghana Statistical Service, 2013). The Ghanaian education system is divided into three parts: basic education, secondary cycle, and tertiary education. Basic education lasts 11 years (ages 4–15) which is divided into Kindergarten (2 years), Primary School (6 years) and Junior High (3 years) (Ghana Education Service, 2014). As at the year 2019, 56.7% of the total population were urbanized with the rate of urbanization as of 2015 pegged at 3.34% per annum (Central Intellegence Agency, 2019).

Ghana has sixteen administrative regions, and 275 local districts. This research was conducted in one of these regions called the Greater Accra region. The capital of this region is Accra, which is also the capital city of the country. The Greater Accra region has 16 districts, one of which is La Dadekotopon Municipal Assembly (LADMA) (Ghana Statistical Service, 2014), where the present study was conducted.

The Report Card is a comprehensive summary of best available and current evidence regarding key indicators of PA such as participation in Overall PA, Organized Sports and PA, Active Play, Nutritional Status, Physical Fitness, School environment, Family and Peers, Community and Environment, Government Policy etc. among children and youth (Tremblay et al., 2014). Nyawornota et al. (2018) in compiling Ghana's report card on PA for children and youth, graded physical fitness as incomplete as there were no national data available to describe children and youth's physical fitness level.

Expert observations of various forms of physical activities that children and youth engage in (e.g., school sports and physical education, walking and cycling to school, weekend keep fit activities, and games) revealed approximately 48% of children and youth engage in some form of MVPA (Nyawornota et al., 2018). This is poor compared to the 59% reported by Zimbabwe in 2018 and the 60% reported by Mozambique in 2014 in their respective Report Cards on PA in children and youth (Munambah et al., 2018; Prista et al., 2014). Still in question is how the frequency, intensity, and duration of PA impact on physical fitness among Ghanaian children. Examination of this issue is warranted to provide insights to inform policies and/or public health interventions in both the education and health sectors of the country.

1.2 Assessment of PA and Fitness

Physical fitness can objectively be measured in the laboratory. However, the use of such tests is limited in practice due to the necessity of sophisticated instruments, qualified technicians and time constraints. Field tests provide a reasonable alternative because they are more time-efficient, requiring a lower cost of equipment, and they are capable of testing more people at the same time (Castro-Piñero et al., 2010). Balance, coordination, speed, agility and power are often described as performance related fitness, because they are associated with enhanced performance in sports and motor skills (Howley, 2001). Despite the development and validation of numerous field test batteries for testing motor performance and fitness, the

application of agility, speed and power assessment as part of contemporary motor performance measurement has received little attention especially in young children (6-12-year-old children) living in economically deprived settings (Smits-Engelsman et al., 2020a). It is therefore important to develop a new motor and fitness performance test suitable for these circumstances.

Currently none of the available physical fitness tests for children have norms for developing countries and/or low resourced communities. For instance, the Alpha-fit was developed by ALPHA Fitness-Group to provide a set of valid, reliable, feasible and safe field-based fitness tests for the assessment of health-related physical fitness in children and adolescents to be used in public health monitoring in a comparable way within the European Union (Ortega et al., 2011). Also, the Movement Assessment Battery for Children (MABC), which is a tool for assessing the motor performance in children, was originally a British- American tool that has also been standardised for use among the Dutch population (Smits-Engelsman et al., 2008). The MABC, although used in developing countries like South Africa and Brazil has not been normed and validated in these settings.

The Report Card has now been exported and adapted for local/specific contexts in other jurisdictions including six African countries (Aubert et al., 2018). The Ghanaian Report Card team alluded that the existing evidence on PA behaviour among children is terribly limited and there was an urgent need for investing in primary research that will generate population-based evidence (Ocansey et al., 2016). The 2016 Report Card further called for investment in routine monitoring in addition to the primary research in PA and its determinants among Ghanaians, with particular focus on children and youth (Ocansey et al., 2016). Additionally, in evaluating the process and outcomes of the 2018 Report Card produced by the Active Healthy Kids Global Alliance (AHKGA) initiative to formulate recommendations for improvement (Aubert et al., 2020), the lack of good quality data was the issue most leaders noted and it was suggested that AHKGA should take the leadership on the development of standardized tools dedicated to the collection of PA behaviour data, or provide a clear recommendation of tools to use for the Report Card teams willing to collect their own data or contributing to the development of new national PA surveillance systems

Muthuri et al. (2014) concluded that to effectively observe trends in physical fitness of children living in low resourced communities, there should be a concerted effort for future research to use comparable or common measurement techniques, sampling procedures, and

cut points. In response to the lack of context-specific measurement tools, the PERF-FIT was developed to assess movement skills, agility and power in children in low resource societies (Smits-Engelsman et al., 2020a; Smits-Engelsman et al., 2020b). Since this is a new tool, research is needed to assess its psychometric properties in this context and establish norms.

In summary, there is a critical lack of population-representative data on PA and fitness in school aged children in SSA, particularly those with lower socioeconomic background. To date, no published study has examined PA and fitness in elementary school children in Ghana. One major difficulty in conducting research related to PA and fitness in children in this setting is the absence of validated measures. It is therefore necessary to identify valid and reliable tools that are contextually relevant that can be applied across diverse cultures. To meet the criteria for developing a new outcome measure, it is important to establish whether the test is reliable and whether the test truly measures the construct being investigated (Aertssen et al., 2016). The purpose of this study is two-fold: (1) to determine the physical fitness levels of school children aged 6 to 12 years in a low-income urban area in Ghana using the Alpha-fit and (2) to determine the construct validity of the PERF-FIT test. In the absence of a gold standard for the evaluation of physical fitness in children, 3 items of the Alpha fitness battery were chosen for comparison with PERF-FIT items intended to measure a comparable construct. Both tests contain items for measuring explosive power and muscle endurance.

1.3 Aims and objectives of the study

The aim of this study was to investigate the physical fitness of school-aged Ghanaian children (i.e. aged 6-12 years) in a low-income area in Accra using field-based assessments.

The specific objectives were:

1. To determine the physical fitness levels of the children using the Alpha- fit test.
2. To determine the differences in physical fitness (determined by scores on the PERF-FIT and Alpha-fit) between children meeting the World Health Organization's PA recommendations and those who do not (subjectively measured by PA questionnaires)

3. To determine the construct validity between the Alpha-fit and PERF-FIT test scores. For examining the construct validity, scores from similar items on the PERF-FIT and Alpha-fit were compared based on hypotheses testing.

1.4 Hypotheses Testing

Since both the Alpha-fit and PERF-FIT contain items for explosive power and muscle endurance the following hypotheses were made:

1. High correlations (>0.6) are expected between the Alpha-fit long jump and PERF-FIT long jump.

2. High correlations (>0.6) are expected between lower and upper extremities explosive power items of the Alpha fit long jump and PERF-FIT overhand throw.

3. The 4 x10m SR item of the Alpha fit is intended to measure anaerobic capacity and running speed while the long jump is recognized as a valid and reliable test for measuring lower extremity muscle power. Since lower limb power is a component required in shuttle running, moderate correlation (0.3-0.6) is expected between the 4 x 10m SR and the PERF-FIT long jump.

4. In addition to agility and speed required for the 4 x 10m SR and PERF-FIT ladder items, the PERF-FIT ladder items demand high levels of neuromuscular coordination with accurate foot placement. Therefore, moderate correlations (0.3-0.6) are expected between the 4 x10m SR and PERF-FIT agility ladder items.

5. The Alpha-fit long jump intends to measure lower extremity muscle power. The PERF-FIT side jump item is intended to measure different components of agility (fast changes in direction) and anaerobic capacity (15 seconds moving your body rapidly by jumping sideways). However, the side jump also requires accurate foot landing in a constraint area. Hence, moderate correlations (0.3-0.6) are expected between Alpha long jump and the PERF-FIT side jump.

1.5 Significance of the study

Importantly, there is limited quality data to quantify physical fitness levels of children in Ghana. This study will provide information on physical fitness of school children aged 6-12 years. The data will be useful for planning and intervention development.

Globally, physiotherapists are encouraged to serve as change agents in the promotion of fitness, health, and wellness in the community (Ganley et al., 2011). To assume this responsibility however, therapists must have the proper tools to assess and monitor individual's fitness, health, and wellness. Perhaps more importantly, they must have the ability to interpret the results of their assessments in order to make appropriate recommendations for improvement (Douma-van Riet et al., 2012).

Strong evidence demonstrates that physical inactivity increases the risk of many adverse health conditions, including major non-communicable diseases (NCDs) such as coronary heart disease, type 2 diabetes, and breast and colon cancers, and shortens life expectancy (Lee et al., 2012). Early identification of deficits in PA and fitness is crucial for early intervention. Findings from this research might help influence behaviour of children at risk of NCDs caused by physical inactivity while still in school. Directing resources towards preventing NCDs rather than cure is more cost-effective especially for a developing country like Ghana.

This research, which is part of a larger study, seeks to validate and develop norms for the PERF-FIT test; an assessment tool suitable for use in low socio-economic societies. The PERF-FIT assesses both health related and performance related fitness components, does not require expensive tools, is easy to administer and has been standardized for use in low-income populations. For the broader society, validation of a relatively low-cost physical fitness test battery will provide Physiotherapists, Occupational therapists, Paediatricians and Physical Education teachers with a test which can be used in practice and research settings. Also, since there is currently no data on the physical fitness levels of children in the La Dadekotopon Municipal Assembly, this research will provide that data which can be used for planning and providing resources to improve physical fitness of children in this community.

1.6 Research setting

After independence from British Colonial rule in 1957, Ghana enacted the first free compulsory universal primary education policy in sub-Saharan Africa to cover 6 years of

primary education (Ghana Education Service, 2004), and since then, educational policy has been guided by the Education Act of 1961. This legislation established the right to education for every Ghanaian child of school going age (Foster, 1965; Ghana Education Service, 2004). Later on, the 1992 Constitution of Ghana also required that basic education became free and compulsory for all Ghanaians of school going age by the year 2005. Although this policy was very laudable, it has not been possible for all Ghanaians of school-going age to have access to school as yet. Learners with disabilities who form a significant proportion of the out-of-school population were not catered for (Ministry of Education, Ghana (MOE-Ghana), 2015). In order to realize the goal of full enrolment and completion, education for learners with special needs should be considered as critical. It is in this light that the Ghana Government's Education Strategic Plan 2010-20 set a strategic goal for that: "To provide education for those with physical and mental impairments, orphans, and those who are slow or fast learners, by including them, wherever possible, within the mainstream formal system or, only when considered necessary, within special units or schools" (MOE-Ghana, 2015) .

The official age for entry into primary schooling in Ghana is six years. However, only about a third of the primary 1 population in 2003 was aged 5-6 years old. The estimated mean age of 7.5 years included late entries, older-age entries, and repeaters. Children from more affluent households are likely to start school earlier (Akyeampong et al., 2007).

One important piece of evidence from research in Ghana is that malnutrition and stunted growth are correlated with delayed enrolment in school. A cross-sectional study investigated dietary intakes and nutritional status of school-age children participating in 2 semi-rural communities and found that 48% were stunted, 35% had low BMI for age scores, and 1% was overweight (Owusu, 2013). Another study exploring malnutrition among school-age children in the Volta Region found that, among 650 randomly selected children between 10 and 19 years, the prevalence of overweight was 7%, stunting 50%, and underweight 19% (Kubi & Laar, 2014). Where stunting is defined as height for age scores more than 2 standard deviations below the WHO child growth median.

Health factors are important determinants of when a child goes to school. Studies also indicate that health status has implications for attendance, retention and drop out, with hunger, malaria, headaches and poor eyesight noted as major causes of absenteeism and dropping out (Fentiman et al., 1999, 2001). It is estimated that around 5% of the population of Ghana have some sort of disability with sight problems noted as most prevalent (around

59%), then hearing/speaking. But, there is the possibility of under-recording of disability in rural areas which would make disability a sometimes less-visible factor in educational access (Akyeampong et al., 2007).

La Dadekotopon Municipal Assembly (LADMA) where the study took place (Ghana Statistical Service, 2014), is urban and hosts a number of companies, financial, tourism, education, health institutions and other important establishments. This accounts for diversity in the socio-economic status of its inhabitants. Because of this diversity, the municipality host a good proportion of private schools and fewer public schools. The public schools mostly have children from low income homes because tuition is free due to Ghana‘s Free Compulsory Basic Education Policy. The municipality has a total of 111 primary schools with 43 of them being public. The Education District has been broken into seven (7) circuits in the Municipality. The basis of this breakdown is to facilitate easy monitoring thereby promoting quality teaching and learning among schools. La township, the chosen area for the study is the most populated area in the municipality with a population of 98,683 making approximately 54% of the total population of the municipality. The La Dadekotopon municipal assembly report 2016, states that though poverty in Ghana is generally reducing, that of La is increasing due to various factors of population growth especially rural-urban drift (La Dadekotopon municipal assembly, 2016).

CHAPTER 2: Literature Review

2.1 Introduction

This chapter will cover the concept of physical activity (PA) and physical fitness in children. First, definitions and explanations of PA and fitness are provided. Next, studies related to the recommended guidelines for PA (for children) are reviewed. Current trends in PA and fitness among children will also be reviewed. Lastly, a review of various field-based tests used in the measurement of PA and fitness in children are reviewed.

2.2 Definitions of PA and Fitness

2.2.1 Physical Activity

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that result in energy expenditure (Caspersen & Christenson, 1985). PA in daily life can be categorized into occupational physical activity (OPA) and leisure-time physical activity (LTPA) (Howley et al., 2001). OPA is associated with the performance of a job. LTPA is a broad descriptor of the activities one participates in during free time, based on personal interests and needs. These activities include formal exercise programs like soccer and athletics. Participation in PA is associated with an extensive range of health benefits, including increased cardiovascular fitness, increased bone strength, lower levels of body fat and improved cognitive and mental health (Biddle et al., 2010; Eime et al., 2013).

The importance of promoting active lifestyles from a young age is widely recognized and the health benefits of regular PA are extensively acknowledged (Strong et al., 2005). An emerging body of literature also suggests that regular participation in PA is associated with better academic achievement, while sedentary children suffer from poor development of cognitive functions (Martin et al., 2014; Tomporowski et al., 2011).

2.2.2. Physical Fitness

Physical fitness can be considered as an integrated measure of most body functions (skeletomuscular, cardiorespiratory, hemato-circulatory, psycho- neurological and endocrine–metabolic) involved in the performance of daily PA and/or physical exercise (Ortega et al., 2008). Physical fitness is associated with lower prevalence of cardiovascular disease risk

factors, improved mental and bone health, increased academic performance, improved motor skills, and protection against all-cause mortality (Van Dusen et al., 2011).

Physical fitness can be categorized as either health-related or performance-related. Cardiorespiratory endurance, muscular fitness, body composition and flexibility are often referred to as health-related fitness (Howley, 2001) and are usually associated with disease prevention and health promotion (Powell et al., 2011). Balance, coordination, speed, agility and power are often described as performance related fitness, because they are associated with enhanced performance in sports and motor skills (Howley, 2001). Physical fitness can therefore be thought as a measurable outcome (Ortega et al., 2008), whiles PA can be considered as the means to achieve physical fitness (Biddle et al., 2010; Eime et al., 2013).

2.2.2.1 Health-related physical fitness

2.2.2.1.1 Cardiorespiratory fitness

Cardiorespiratory fitness (CRF) represents an intermediate variable between PA behaviours and health outcomes that reflects the capacity of numerous bodily organs, such as the heart, lungs and muscles, to support energy production during PA and exercise (Lang et al., 2018). The cardiorespiratory component is believed to be one of the most important components of health-related fitness (Ruiz et al., 2006). It reflects the total capacity of the cardiovascular and respiratory systems to supply oxygen during long-term PA and reflects the ability to perform prolonged strenuous exercise (Esteban-Cornejo et al., 2017).

During childhood and adolescence, high levels of cardiorespiratory fitness have been positively associated with academic performance and cognition, as well as brain functioning and structure (Chaddock et al., 2011; Esteban-Cornejo et al., 2014; Hillman et al., 2008; Ortega et al., 2019). In contrast, individuals with lower cardiorespiratory fitness are at greater risk of having cognitive deficits and developing neurodegenerative disorders later in life (Defina et al., 2013; Newson & Kemps, 2006; Nyberg et al., 2014). These findings suggest that increases in cardiorespiratory fitness and speed-agility may positively influence the development of distinctive brain regions and academic indicators (Esteban-Cornejo et al., 2017). High level of cardiorespiratory fitness in childhood and youth is also strongly associated with better cardiorespiratory health in later age (Ortega et al., 2011).

Cardiorespiratory fitness is often reported as maximal oxygen uptake (VO_2 max) in adults, peak oxygen uptake (VO_2peak) in children and adolescents or it is standardized as metabolic

equivalents (Ross et al., 2016). However, laboratory-based testing is costly and impractical for population- based assessments with large samples. The 20-meter shuttle run test has proven to be a valid and reliable field test to assess CRF in children (Ruiz et al., 2006).

In a recent systemic review, which aimed to compare variability of 20mSRT among 50 countries, 10 of which were from Africa, Tanzanian children were ranked the highest in the performance of the 20mSRT (Lang et al., 2018). Dencker et al. (2008) evaluated the associations between objectively measured daily PA (accelerometers for 4 days and daily accumulation of moderate-to- vigorous and vigorous activity) and aerobic fitness (indirect calorimetry during a maximal cycle ergometer exercise test), in 225 children (aged 7.9–11.1 years). Significant relationships were found between vigorous activity and aerobic fitness (r = .38), whereas moderate- to-vigorous activity displayed weaker relationships (r = .25). Low daily accumulation of vigorous activity was associated with lower aerobic fitness.

In a study by Dos Santos et al. (2015) which examined the secular trends in physical fitness of Mozambican school-aged children and adolescents, a decrease was observed in cardiorespiratory fitness between 1992 and 1999, and between 1992 and 2012 for both sexes. Unfortunately, there is no published data on the cardiorespiratory fitness of Ghanaian children. This underscores the need for more research to focus on CRF and related fitness variable in school-aged children in the country.

2.2.2.1.2 Muscular fitness

Musculoskeletal fitness is a multidimensional construct comprising the integrated function of muscular endurance, strength, and power which have an important association with markers of metabolic, bone, and cardiovascular health (Institute of Medicine, 2012). This requires that a particular muscle or group of muscles can produce force or torque force (i.e. muscle strength) to withstand repeated contractions over time or to maintain maximal voluntary contraction for a prolonged period (i.e. muscular endurance), and perform maximal, dynamic contraction of a muscle or group of muscles in a short period of time (explosive power) (Ruiz et al., 2006). Musculoskeletal fitness encompasses those components of physical fitness responsible for successful execution of motor tasks such as walking and running (Thivel et al., 2016).

Muscular fitness is an important marker of health that has been inversely and independently associated with insulin resistance, clustered cardiometabolic risk, and inflammatory proteins during childhood and adolescence (Artero et al., 2012; Cohen et al., 2014; Steene-

Johannessen et al., 2013). Longitudinal studies showed that changes in muscular fitness from childhood to adolescence are associated with changes in overall and central adiposity, systolic blood pressure, blood lipids, and lipoproteins (Ruiz et al., 2009). Therefore, these findings support the importance of assessing muscular fitness in children. Generally, muscular fitness has been found to be lower in SSA children, compared to various Western reference samples (e.g., United States, the Netherlands) (Benefice, 1992, 1998; Travill, 2007).

Some studies examining muscular fitness in children have used field-based tests such as grip strength, handheld dynamometry, softball throw, and standing long jump (Wouters et al., 2017). Standing long jump (SLJ) is considered the most valid and reliable field-based muscular fitness test in children and adolescents (Artero et al., 2012; Castro-Pinero et al., 2010; Ramırez-Velez et al., 2015) even when it is compared with isokinetic strength exercises (Artero et al.,2012).

A study by Castro-Pinero et al, (2010) in Spain among healthy children aged 6 to 17 years to examine the association among different measures of lower body muscular fitness in children, and the association between measures of lower- and upper-body muscular fitness, the findings were that the SLJ was strongly associated with other lower body muscular fitness tests (R2 = 0.829–0.864), and with upper body muscular fitness tests (R2 = 0.694–0.851). The SLJ test might be therefore considered a general index of muscular fitness in youth.

2.2.2.1.3. Flexibility

Flexibility is the ability of a muscle or group of muscles to move freely through a full range of motion (Ruiz et al., 2009). Flexibility is classified as static and dynamic. It depends on the soft tissues (ligaments, tendons and muscles) of a joint than on the body structures of the joint itself (Choi et al., 2016).

Flexibility is an important component of fitness ensuring the amplitude of movements (Knudson et al., 2000). This is very important for motor performance and physical activities in everyday life (Peck et al., 2014). Insufficient flexibility of joints disturbs performance and can lead to injuries (Knudson et al., 2000). With regard to flexibility, the following generalizations can be made: flexibility is an individually variable, joint-specific (Corbin, 1984), inherited characteristic that decreases with age (Gleim & McHugh, 1997), varies by gender and ethnic group (Grahame & Jenkins, 1972), bears little relationship with body proportion or limb length (Grahame, 1971) and can be modified through training (Grana &

Moretz, 1978). Finally, a lack of exercise has negative effects on flexibility (Jenkins & Beazell, 2010). Some authors reported that girls aged 6 to 18 years have a better flexibility than boys (Chen et al., 2006). Similar results have been found in Spanish adolescents aged 13 to 18 years (Casajús et al., 2007; Ortega et al., 2005) and 6 to 17 years (Castro-Piñero et al., 2013). Thus, the importance of developing flexibility should be more emphasized among elementary school students, especially among boys.

Laboratory based measurements used for assessment of flexibility include Leighton flexometer, Goniometry, Angular kinematic analysis whiles field based tests for its assessment include Sit-and-reach test, modified sit-and-reach tests, Back-saver sit and reach test, V sit and reach, Shoulder stretch (Caspersen & Christenson, 1985; Corbin et al., 2000). In a study by Gulías-González et al. (2014) to determine the physical fitness in Spanish school children aged 6-12 Years, it was found that boys scored higher in all the physical fitness tests, except for the flexibility test and that as boys aged, their flexibility scores reduced. In another study by Tokmakidis et al. (2006) to determine fitness levels of Greek primary schoolchildren in relationship to overweight and obesity, it was found that higher BMI categories were strongly associated with inferior performances in all fitness tests, except flexibility. South African studies assessing physical fitness in children found girls were more flexible and performed better in balance tests than boys (Monyeki et al., 2005; Toriola & Monyeki, 2012; Travill, 2007).

2.2.2.1.4. Body composition

Body composition refers to the relative position of muscle, fat, bone, and other vital components of the human organism (Ruiz et al., 2009). Body composition is essential for optimal health and athletic performance.

Excess fatty tissue above the optimal value exposes a person to an increased health risk of obesity, cardiovascular disease, diabetes and malignant diseases (Ostojić et al., 2009), and prevents athletes from optimal performance in sports dominated by running or jumping activities (Ostojić, 2003).

Body composition may be influenced by factors such as genetics (Bouchard, 1990), birth weight (Rahman & Chowdhury, 2007), culture and geography (Brockerhoff & Hewett, 2000; Nikoi, 2018), nutrition (Van de Poel et al., 2007; Wamani et al., 2006) and PA (Leung & Robson, 1990).

A plethora of techniques and equations have been developed to quantify body composition and these include hydrostatic weighing, dual-energy x-ray absorptiometry (DEXA) and isotope dilution, bioelectric impedance analysis, skinfold thickness assessments, BMI, waist circumference and Waist to Height Ratio (Okorodudu et al., 2010). BMI is considered one of the most appropriate measures for the indirect assessment of adiposity in childhood and adolescence (Frontini et al., 2001), showing high correlation (0.83–0.98) with measures of adiposity derived from dual energy X-ray absorptiometry in children (Lindsay et al., 2001). Regarding classification of the study population into overweight and obese, the age- and sex-specific BMI cut-off points proposed by the Childhood Obesity Working Group of the International Obesity Task Force (IOTF) have been adopted (Cole et al., 2000). These cut-off points are based on average centiles estimated to pass through BMI 25 and 30 kilogram per meter square (kg/m^2), respectively, at age 18 and have been widely used in studies with children and adolescents (Katzmarzyk et al., 2013). As stressed by Cole et al. (2000), this definition is less arbitrary and more international than others and should encourage direct comparisons of trends in childhood obesity worldwide.

Aduama (2004) found that 6.4% of Ghanaian children of comparable age in sampled public primary schools in Accra were underweight as opposed to 1.1% that was obese. In another research, among ten randomly selected public schools in Kumasi, Ghana, it was found that none of the sampled children were obese but 2.7 % were underweight, 86.5% were normal weight and 10.5% were overweight. Additionally, the proportion of girls that were underweight was higher (14.2%) compared with 4.2% of boys (Annan et al., 2020).

2. 2. 2.2 Skills/Performance related Fitness

2.2.2.2.1 Motor coordination

Motor coordination can be conceptualized as a person's performance when executing different motor acts, including coordination of both fine (e.g., manual skills) and gross (e.g., static and dynamic balance) motor skills (Barnett et al., 2007; Haga, 2008a). Fundamental movement skills (FMS) are elementary forms of movement, and acquisition and refinement of these basic movement patterns are during childhood integrated into specialized and more complex skills which are used in popular forms of adult PA (Malina et al., 2004). Learning to move and developing FMS in childhood are important and form the foundation for future levels of PA (Stodden et al., 2009). These ‘building blocks’ for more developmentally advanced movement forms are commonly divided into categories including locomotor (e.g.,

running, hopping), object control (e.g., catching, kicking), and stability (e.g., balance, body roll) skills (Gallahue et al., 2012). Failure to develop competency in fundamental movement skills will make learning more advanced/specialized forms of these skills more difficult (Clark & Metcalfe, 2002).

Poor gross motor skills may be the cause of physical inactivity whereas physical inactivity also limits the opportunity to improve skills (Haga, 2008b). Motor coordination has important implications for different aspects of development in children and adolescents (Piek et al., 2006). For example, there is now increased awareness that children with low motor coordination are at risk of a variety of psychological difficulties (Piek et al., 2006; Poulsen et al., 2007). Motor coordination also significantly impacts upon the likelihood of participation in PA (Smyth & Anderson, 2000), overall performance on different fitness components (Hands & Larkin, 2006) and the magnitude of excessive weight and obesity (Piek et al., 2006).

Poor motor coordination is associated with low socioeconomic status and its concomitant problems like low birth weight and prematurity (Lingam et al., 2009). Low-income countries have reported, varying prevalence of delayed development of fundamental movement skills or developmental coordination disorder (DCD), from 4.3 to 18% (Cardoso et al., 2014; De Milander et al., 2016; Valentini et al., 2015). However, it is likely that the percentage of children is higher than the usually described 5 to 6% (American Psychiatric Association, 2013).

There is no gold standard for assessment of motor competence in children but some existing tools that have been used include the Test of Gross Motor Development-second edition (TGMD-2), Korperkoordination fur kinder (KTK), Bruininks-Oseretsky Test and Movement Assessment Battery for Children (2nd Edition) (MABC-2) which Slater et al., (2010) ranked highest in their evaluation of seven different motor assessment tests.

In a study conducted by Lopes et al. (2012) among 213 Portuguese school children aged 9 to 10, it was found that in both genders, the low sedentary group had significantly higher odds of having good motor coordination than the higher sedentary group. In a South African study, comprising 317 Grade one children aged 5 to 8 years, MABC-2 Test was used to identify DCD prevalence in the group. Results indicated that the prevalence of DCD (severe motor difficulties) was 6% and the at-risk group constituted another 6% (De Milander et al., 2016).

2.2.2.2.2. Balance

Balance refers to a person's ability to support and stabilize the body in the standing position and maintain balance (Libardoni et al., 2018). To achieve balance in quiet standing, the imaginary vertical line passing through the body's centre of mass (COM) should lie within the support base (Pollock et al., 2000). The postural control system is responsible for three basic functions: support, stability and balance. These functions help to prevent the body from falling down due to gravity and this system ensures that the appropriate muscles are contracted to support the body in an upright position (Rothwell, 1996). Postural control is a basic aspect to understand the ability that humans have to perform their activities and keep the body in balance in situations of rest, as in the case of static equilibrium, and moving when there is stability and guidance (López & Fernández, 2004).

It has been well established that balance ability is critical for performance of daily activities that children engage in like kicking (Shumway-Cook, 1985) and contributes to performance of skilled movements (Payne & Isaacs, 2012). Hopping on one leg is an advanced fundamental motor skill (Cech & Martin, 2002) and an asymmetrical pattern of locomotion which evolves after upright walking is established (Tveter & Holm, 2010). Adults rarely use hopping on one leg to move around but need to develop hoping skill in order to become skilful movers (Haywood & Getchell, 2005). Children also need these skills in many play-game activities (Keogh & Sugden, 1985), complex sports like lawn tennis and dancing skills (Gabbard, 1996).

The control of posture (body orientation and alignment) and balance depends primarily on the ability of the visual, somatosensory, and vestibular systems (Assaiante et al., 2005) to indicate the spatial position of each body segment correctly. During growth and development, the response of these systems varies with age, as does the body’s ability to achieve or maintain balance, especially when postural instability is present (Ferber-Viart et al., 2007).

Controlling body balance (or postural sway) is considered an important indicator of the proper functioning of the sensorimotor system and therefore must be evaluated not only in patients but in healthy individuals (Horak & Nashner, 1986) for this reason, most physical fitness test batteries for children inculcate its assessment. The Eurofit test battery has the flamingo balance test (Council of Europe Committee for the Development of Sport 1988), whiles the MABC-2 has one or two leg balance; walking lines; jumping or hopping (Henderson et al.,2007).

Among a sample of pre-schoolers aged 4 to 6 years in Switzerland, it was found that at baseline, sex- and age-adjusted positive associations were found between PA and balance (Bürgi et al., 2011). In a study to examine the secular trends in physical fitness and body size in Lithuanian children and adolescents between 1992 and 2012, it was found that though flexibility, leg muscle power, upper body strength and cardiorespiratory fitness decreased between 1992 and 2012, there was an improvement in balance in both genders during the same period (Venckunas et al., 2017).

2.2.2.2.3. Reaction time, Speed and agility

Reaction time (RT), speed of movement and agility are some components of motor skills related to fitness. RT is the time interval between the application of a stimulus and the appearance of an appropriate voluntary response by a subject. It involves three phases as follows: (a) stimulus processing, (b) decision making and (c) response programming (Merkel, 1885).

Speed is one of the most important biomotor abilities in sports and from a mechanical point of view is expressed through a ratio between space and time. On the other hand, agility has associations with trainable physical qualities such as: strength, power and technique, as well as cognitive components (Sheppard & Young, 2006). There is a positive association between PA and agility (Bürgi et al., 2011). Speed/agility rather than cardiorespiratory fitness is independent predictors of bone mineral density (Ortega et al., 2008).

The 30-m sprint test and the 4x 10-m shuttle run test are useful tests for assessing speed and/or agility, respectively, in young people (Ruiz et. al., 2006; Ortega et. al., 2005).

In the analysis of the secular trends in health-related physical fitness in Spanish adolescents between 2001–2002 and 2006–2007, the results indicated that levels of both speed/agility and cardiorespiratory fitness were higher in 2006–2007 than in 2001–2002, whereas muscular strength components were lower in 2006–2007 (Moliner-Urdiales et al., 2010).

2.3 PA guidelines for children

Childhood and adolescence are crucial periods of life, since dramatic physiological and psychological changes take place at these ages (Ortega et al., 2008). Likewise, lifestyle and healthy/unhealthy behaviours are established during these years, which may influence adult behaviour and health status (Catley and Tomkinson, 2013, Dyrstad et al., 2012).

Recommendations for children to meet a minimum standard of physical activities in order to harness the health benefits is therefore of public health concern. Janssen and Leblanc (2010) performed a systematic review of studies examining the relation between PA, fitness, and health in school-aged children and youth and found that, PA is associated with numerous health benefits. The dose-response relations observed in observational studies indicate that the more PA, the greater the health benefit. Results from experimental studies indicate that even modest amounts of PA can have health benefits in high-risk youngsters (e.g. Obese). To achieve substantive health benefits, the PA should be of at least a moderate intensity. Vigorous intensity activities may provide even greater benefit. Aerobic-based activities had the greatest health benefit, other than for bone health, in which case high-impact weight bearing activities were required. Their recommendation was therefore that, children and youth 5-17 years of age should accumulate an average of at least 60 minutes per day and up to several hours of at least moderate intensity PA (Janssen & LeBlanc, 2010).

In developed countries, recommended guidelines for physical activities in children have been developed through extensive research. Canada's first set of PA guidelines for children and youth were introduced in 2002 (Health Canada, 2002). The basic recommendation within these guidelines was that children and youth, independent of their current PA level, should increase the time they spend on moderate-to-vigorous intensity PA by 30 minutes per day, and over a 5-month period progress to adding an additional 90 minutes of daily PA . The 90-minute increase in PA should include 60 minutes of moderate activity (e.g., brisk walking, skating, and bicycle riding) and 30 minutes of vigorous activity (e.g., running, basketball, soccer) (Health Canada,2002). The American PA Guidelines recommend that school-aged children and adolescents participate in at least 60 minutes of MVPA each day (Physical Activity Guidelines Advisory Committee., 2008).

Sadly, there are no recommended guidelines for SSA. The significance of PA on public health, the global mandates for the work carried out by WHO in relation to promotion of PA and NCDs prevention, and the limited existence of national guidelines on PA for health in low- and middle-income countries (LMIC) make evident the need for the development of global recommendations that address the links between the frequency, duration, intensity, type and total amount of PA needed for the prevention of NCDs.

WHO’s - Global Recommendations on PA for Health states that children 5 to 17 years should accumulate at least 60 minutes of MVPA daily. It was also recommended that most daily PA

should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week (World Health Organization, Global Recommendations on PA for Health, 2010). For children, PA includes play, games, sports, transportation, recreation, physical education or planned exercise, in the context of family, school, and community activities.

2.4 Current trends in PA

Despite the undisputed benefits of PA in children and the concerted global effort to establish guidelines and recommendations, the level of PA among young people has been decreasing considerably. Globally, many children and adolescents do not meet the current PA recommendations (Jago et al., 2005; Riddoch et al., 2007; Strong et al., 2005). Moreover, previous research has shown a decline in PA from childhood to adolescence (Lopes et al., 2007), with the end of elementary school (9–11 years old) being a critical period of change (Nader et al., 2008).

A report on the global level of PA suggests that the majority (80%) of 13–15-year-olds are doing less than 60 min of MVPA per day (Hallal et al., 2012). Children are not faring any better than adolescents. For example, in Canada, only 9% of boys and 4% of girls accumulate 60 minutes of MVPA on at least 6 days a week, according to the Canadian Health Measures Survey from 2007 to 2009 (Colley et al., 2011). In England, only 2.5% of children participating in the Avon Longitudinal Study of Parents and Children (ALSPAC) met the current internationally recognised objectively measured PA recommendations (Riddoch et al., 2007). In the United States, 42% of children ages 6-11 years and only 8% of adolescents obtained the recommended 60 minutes of objectively measured MVPA per day (Troiano et al., 2008).

Increases in physical inactivity and sedentary behaviour have also been observed in Chinese school-age children in recent decades and are associated with declines in physical fitness (He et al., 2011) and an upward trend in obesity (Ren et al., 2017). According to the 2010 National Physical fitness and Health Surveillance, only 22.7% of Chinese elementary and secondary school students aged 9–18 report being physically active for at least 60 min a day (Zhang et al., 2012).

Sub-Saharan Africa seems to be in a transition state with varying country statistics on the trend of PA. In a study conducted by Craig et al, (2012), among South African children aged 7 to 15, it was found that the total PA was generally high (mean accelerometer counts per minute ranged 485–1017), but MVPA was low with less than 1% of the total sample meeting the MVPA guidelines. MVPA in boys comprised 1.7% of waking hours (12 min/day) at age 7, 1.3% (10 min/day) at age 11, and 0.6% (4 min/day) at age 15. MVPA in girls comprised 1.5% (11 min/day) at age 7, 0.9% (6 min/day) at age 11, and 0.2% (1 min/day) at age 15 years. More so, findings from a Kenyan study of children aged 9 to 12 showed rural children were more physically active than urban children and that 87% rural children and 42% urban children used active transport to get to school (Onywera et al., 2012). Puckree et al. (2011) also report 92% of extracurricular sporting activities participation among a sample of South African children aged 10 to 12 years. A study in Tanzania reports that among a sample of 156 children aged 9 to 10 years, 88% of rural children walked to school, 71% for more than 15 min, and 34% participated in outdoor games after school on most or all days (Aandstad et al., 2006). Another study conducted in Mozambique among children aged 6 to 17 years concluded that low SES children and adolescents had higher levels of PA due to higher demands of survival activities and playing but spent less time in formal sports than their more privileged peers (Prista et al., 2009). In Nigeria, less than half (47%) of children and youth 5–19 years were reported to participate in MVPA on 3 or more days per week (Akinroye et al., 2014; Senbanjo & Oshikoya, 2010).

In summary, the literature seems to point to a decline in PA levels in both developed and developing countries. There is therefore the need to monitor closely the effects of such decline on the physical fitness of children.

2.5 Assessment of PA

Physical fitness has been recognized as a powerful indicator for good health in children and adolescents (Ortega et al., 2008; Tomkinson et al., 2003). As a result, there is a global push for PA and fitness surveillance in young people at the population level (Tomkinson et al., 2019).

Due to the complexity and multifaceted nature of PA, measurement of this behaviour can be challenging (Janz, 2006). Valid and reliable PA measurement is essential for establishing prevalence, including trends over time (Shephard, 2003), and verifying if efforts to promote

PA are having a positive influence (Milton et al., 2013). Prevalence rates are dependent on the instrument used to measure it (Sarkin et al., 2000).

Warren et al. (2010) suggests that the population under study (e.g., children versus adults), the research question, domain of PA, resources, capacity for data analysis and participant burden, amongst other things, be considered carefully when selecting an appropriate instrument. However, the accurate measurement of PA is fraught with challenges, especially in children, given their complex and multi-dimensional activity patterns (Adamo et al., 2009).

Objective or direct measures of PA are often used to increase precision and accuracy and to validate self-report measures. Objective measures are believed to offer more robust estimates of PA and remove the issues of recall and response bias (Janz, 2006). Direct measures include various tools, such as doubly labelled water (DLW), calorimetry (indirect, direct), physiologic markers (i.e., heart rate monitoring [HRM] and respiratory rate), motion sensors (i.e., accelerometers, pedometers), and direct observation (Welk et al., 2000). Despite the advantages to using objective methods, these types of measures are often time-consuming, expensive, intrusive and burdensome, rendering them difficult to apply in large epidemiologic settings (Adamo et al., 2009). Direct measures each possess their own limitations and no single 'gold standard' exists for measuring PA (Dishman et al., 2001). Trost (2007) compared different measurement techniques and their application specifically in studies on children. While Trost concludes that the selection of a measurement tool will always depend largely on the scope and aims of the specific study, it is evident that objective measures such as accelerometry and heart rate monitoring have a great deal of utility, particularly among children (Trost, 2007).

The most common and feasible method of measuring PA at the population level is through self-report using indirect measures, such as questionnaires, diaries/logs, surveys, and interviews. The self-report methods of recalling intensity, frequency and duration of bouts of activity are considered problematic in children who are less time-conscious than adults and tend to engage in PA in sporadic bouts with varied intensities rather than consistent patterns (Armstrong & Bray, 1991; Bailey et al., 1995). Self-report methods possess several limitations in terms of their reliability and validity (Shephard, 2003).In addition, self-report methods also have the ability to alter one's PA habits by acting as a motivational tool (reactivity) (Dishman et al., 2001). Despite the limitations, these measures are often used due

to their practicality, low cost, low participant burden, and general acceptance (Dishman et al., 2001).

2.6 Assessment of Physical fitness

Physical fitness can objectively be measured in the laboratory. However, the use of such tests is limited in practice due to the necessity of sophisticated instruments, qualified technicians and time constraints. Field tests provide a reasonable alternative because they are more time-efficient, requiring a lower cost of equipment, and they are capable of testing more people at the same time (Castro-Pinero et al., 2010).

In a systemic review to collate temporal trends and correlates of PA, sedentary behaviour, and physical fitness among school-aged children in SSA by Muthuri et al. (2014), 36 included studies, presented in 37 papers examined the physical fitness of African children, using different and varied tests. Moreover, since there were no African normed references, and different cut offs were used based on the researchers preferred norm references. This made it problematic to collate a general trend hence it was recommended that future work entail concerted efforts in carrying out nationally representative surveys, using comparable or common measurement techniques, sampling procedures, and cut points, in order to effectively monitor PA and fitness transitions over time in this region.

A test that measures a component of physical fitness can be laboratory-based or field-based. Two or more tests can be combined to measure desired components of physical fitness but a test battery consist of carefully selected tests of physical performances, ideally each depending on and limited by one prime physiological function, e.g. the cardio respiratory system, the muscles, neuromuscular coordination etc.

Numerous test batteries have been developed to assess physical fitness in children (Castro-Piñero et al., 2010). Some of the discussed fitness tests have been studied in American (Baquet et al., 2006), Finnish (Mikkelsson et al., 2006), Russian (Izaak & Panasiuk, 2005), Greek (Koutedakis & Bouziotas, 2003), Flemish (Deforche et al., 2003), African (Monyeki et al., 2005), Spanish (Ortega et al., 2005), Dutch (Kemper et al., 2000) and Swedish and Estonian (Ruiz et al., 2006) populations. In reviewing the literature, some of the most common test batteries used to assess physical fitness of children and adolescents are discussed below:

2.6.1 The Eurofit

Since its inception in 1988, the Eurofit has become the most popular test battery used to assess the physical fitness of European children and adolescents and the effectiveness of national physical education curricula (Tomkinson et al., 2007). The Eurofit comprises numerous health-related and skill-related fitness tests, including: (1) flamingo balance (balance), plate tapping (upper body speed), sit-and-reach (extent flexibility), standing broad jump (lower body muscular power), handgrip strength (upper body muscular strength), sit-ups (abdominal muscular endurance), bent arm hang (upper body muscular endurance), 10×5 m agility shuttle run (running speed-agility) and the 20 m shuttle run (CRF) anthropometric tests measuring height, mass and skinfold (various sites) and age-identification and sex-identification data (Council of Europe Committee for the Development of Sport, 1988). The Eurofit has excellent field-based utility because it is cheap and simple to administer, is practical in the school and club settings, requires minimal equipment and personnel and is appropriate for mass testing (Tomkinson et al., 2007). The Eurofit tests demonstrate very good test-retest reliability and good criterion validity for tests where appropriate criterion measures have been identified (e.g., the 20 m shuttle run, standing broad jump, handgrip strength) (Artero et al., 2012; Castro-Pinero et al., 2010; Ruiz et al., 2011) suggesting that it is a good test battery to measure physical fitness in youth.

2.6.2 FitnessGram

The FitnessGram (Cooper Institute for Aerobics Research., 2004) concept began in 1977 in America and is widely used in the United States of America (Cvejić et al., 2013. The FitnessGram test is a validated and reliable health-related fitness assessment toolkit designed by Cooper Institute (Meredith & Welk, 2007).

The FitnessGram battery of tests comprises a program for the assessment of physical fitness of children concerning health. It includes a variety of tests designed to evaluate: a) cardiovascular endurance, b) body composition, c) muscle strength, d) muscle durability and e) flexibility (Meredith & Welk, 2007). The FitnessGram battery test uses the criterion that indicates health standards and the standards associated with good health. Specifically, the standards are based on what kind of fitness is necessary to keep a child in good health (Cvejić et al., 2013). The results of previous scientific research were used to define the fitness required to meet the basic health requirements and to define “physical fitness in a healthy zone”. Results below this zone are classified as “needing improvement” (Corbin et al., 2000).

2.6.3 Alpha-fit

The Alpha-fit Test Battery for children and adolescents is the first European approach at providing evidence-based recommendations and operating instructions to assess the health-related fitness status in children and adolescents on a population base in the European Union (ALPHA, 2009). Based solely on new scientific evidence from currently available transversal and longitudinal research in the world, the Alpha-fit battery test includes the following tests: (1) the 20 meter shuttle run to assess cardio respiratory fitness, (2) the hand grip, and (3) the standing jump to evaluate muscular-skeletal fitness, and (4) the body mass index BMI, (5) waist size and (6) skin fold thickness (triceps and subscapular skin fold) for body composition assessment. Alpha-fit is a valid, reliable, feasible and safe health-related test battery (ALPHA, 2009; Ruiz et al., 2010; Santos & Mota, 2011) and is considered as an ideal instrument of field-based tests for assessing health- related physical fitness in children and adolescents (Cvejic et al., 2013).

2.6.4 Canadian Agility and Movement Skills Assessment (CAMSA)

The Canadian Agility and Movement Skill Assessment (CAMSA) was recently developed, as part of the Canadian Assessment of Physical Literacy (CAPL) (Healthy Active Living and Obesity Research Group (HALO), 2014). The CAPL was developed and refined between 2009 and 2013, and its overall aim is to provide a reliable, feasible, and valid instrument to assess physical literacy in Canadian children (Longmuir, 2013; Longmuir et al., 2015;Tremblay & Lloyd, 2010).

The CAMSA was designed to more authentically measure the 'real world' skills required for sport and PA, such as linking several skills together in succession, and transitioning from one skill to another efficiently (e.g., catching then throwing while on the move) (HALO, 2014; Longmuir et al., 2015). The CAMSA required children to travel a total distance of 20 meters while completing 7 movement skill tasks. The movement skills selected were: (1) 2-footed jumping into and out of 3 hoops on the ground, (2) sliding from side to side over a 3 meter distance, (3) catching a ball and then (4) throwing the ball at a wall target 5 meters away, (5) skipping for 5 meters, (6) 1-footed hopping in and out of 6 hoops on the ground, and (7) kicking a soccer ball between 2 cones placed 5 meters away (Francis et al., 2016).The feasibility, validity and reliability of the CAMSA has been demonstrated for Canadian children (8–12 years) (Longmuir et al., 2015) and feasibility has also been established in an Australian school setting (Lander et al., 2016).

2.7 Assessment tool for children living in a low socio- economic society

None of the aforementioned fitness test batteries have adaptation to low-resource settings and norms for children in low SES. Since levels of PA and invariably physical fitness are affected by factors such as the socio-economic and cultural environment (Kriska, 2000), and evidence indicates that participation in specific leisure-time physical activities differs according to age (i.e., childhood, adolescence, adulthood) and/or geographic region (Hulteen et al., 2018), contextual differences may cause children to respond or perform poorly on tests developed in Western societies. Hence the need for context specific assessment tools with norms for low SES.

Most of the existing tools assess either the health related or skills related aspect of physical fitness. For example, the Eurofit, Alpha and Fitnessgram tests have gained much traction around the world (Plowman et al., 2006; Ruiz et al., 2010) while these fitness tests are valid and reliable, most of them do not assess movement skills (e.g. throwing and catching, jumping, hopping, and balance), attributes known to be critical for promoting active lifestyles in children (Caspersen & Christenson, 1985).

The MABC-1 &2 is a standardized test used for the identification of motor impairments among children aged 3–17 years. The MABC-2 (Henderson et al., 2007) has been widely adopted by clinicians and researchers in several countries (Chow & Henderson, 2003; Croce. et al., 2001; Ellinoudis et al., 2011) but it also does not assess the health-related physical fitness components like cardiorespiratory endurance and muscular strength. For many children in low SES settings who are less familiar and skilled in sport specific motor patterns because of the absence of sport facilities but tend to engage more in active transportation and active play, a tool that assess all aspect of physical fitness is appropriate.

There is a lack of data on trends in physical fitness of children living in low SES (Tomkinson et al., 2019). In order to generate such data, tools for assessing physical fitness should be apt for comparing longitudinal data. Some assessment tools use different items for different age bands [e.g. Movement Assessment Battery for children, second edition (MABC-2)] (Henderson et al., 2007), which makes it harder to compare children of different age groups or follow children longitudinally.

Additionally, most testing tools developed in Western countries have standardized kits or tools (example the Fitnessgram kits and MABC kits). These equipment and tools may not be easily accessible and affordable to researchers and therapists working in low SES settings.

It is therefore important to use cost-efficient tools that can be applied to characterize both motor skill and health related fitness, and to investigate potential factors that are associated with poor physical fitness during critical periods across developmental time. A good tool for the evaluation of motor skills and the identification of atypical or delayed motor development is therefore crucial.

2.8 Performance and fitness battery (PERF-FIT)

The PERF-FIT test battery has motor skills subscale and power and agility subscales and was developed by Smits- Engelsman (2018). Items for this test have been formulated to make the test suitable for low resourced areas. Test items were selected to meet the following criteria:1) No expensive material needed (includes agility ladder which can be made easily using instructions, plastic bottles, soda cans, tennis balls, coloured lace, cut foam pieces, 2kg sand bag, stop watch, tape measure and yard stick). 2) Cover all aspects of skills related fitness. 3) Use different (increasing) levels of skills. 4) No specific space requirements (outside or inside). 5) Be suitable for children between 6-12 independent of culture. Items selected are also close to the ones used in play and recreational activities like hopscotch (popularly called Pele in Ghana).

The PERF-FIT is a valid test to measure movement skills, musculoskeletal fitness and agility in children between the ages of 7 and 10 years in low resourced communities and able to discriminate between gross motor skills, and agility and power in children (Smits-Engelsman et al., 2020b). The PERF-FIT test battery is easy to administer and has excellent content validity and good structural validity (Smits-Engelsman et al., 2020a).

This test combines movement skills, agility and power and incorporates progressive increase in task difficulty (i.e. task loading) to all skill items. For example, the Jump item of the PERF-FIT test, there are 4 tasks with increasing difficulty. First the child is required to jump in each square of the agility ladder. The second task is to jump in every other square. The third task is to jump over four 5cm foams and the fourth is to jump over four 10cm foams.

2.9 Summary of Key gaps in the Literature

This review highlights the scarcity of data on PA and physical fitness of children living in low SES. There are many factors which could be the reason for this situation, but an outstanding reason could be the lack of cheap, reliable and feasible tests with norms for this context.

At present, there are limited reliable prevalence estimates on levels of key physical fitness indicators in Ghana in particular and SSA in general. The lack of such data or information mean that the evidence needed to inform the development of effective strategies to combat these public health challenges, and the capacity to appropriately assess and evaluate future interventions, are limited. This study therefore provides data on the physical fitness of Ghanaian school children aged 6 to 12 years old, living in a low SES and to validate a cheap, reliable and feasible tool which can be used by assessors in low-income settings.

CHAPTER 3: Methodology

3.1 Research Design

A cross-sectional descriptive analytical design was used for this study.

3.2 Participants

A sample of convenience, consisting of children aged 6 to 12 years attending mainstream schools within LADMA were recruited for study. Since we were interested in children from low SES background, selection of schools was limited to schools in the Manle Dada circuit (i.e. schools located within the La township). There are 7 primary schools within this circuit. Three of them were chosen based on proximity (selected schools were at least 500 meters apart) to ensure maximum area coverage.

3.2.1 Inclusion criteria

- School children between the ages of 6 and 12 years.
- Children enrolled at the three selected schools.
- Children who provided assent to participate after their parents had consented.

3.2.2 Exclusion criteria

- Children who were sick/absent on the day of testing.
- Children with physical or medical conditions that would have made testing unsafe for them were excluded (this was determined with the Children's Physical Activity Readiness Questionnaire).

3.3 Measurement instruments

3.3.1 Demographic Data Questionnaire

A self-developed questionnaire, approved for use in this study was administered to parents to obtain their demographic data: age, gender, residence, parents' educational levels and occupation as well as information on children such as birth history, development of motor skills, participation in sports and means of transportation to school (See Appendix K).

3.3.2 Physical Activity Readiness Questionnaire (PAR-Q)

This questionnaire was used to screen for safe exercise participation (Quinn, 2018). The PAR-Q was originally created by the British Columbia Ministry of Health and the Multidisciplinary Board on Exercise with direct adaptation from the American College of Sport Medicine (ACSM) Standards and Guidelines for Health and Fitness Facilities (Warburton et al., 2011). A systematic review undertaken by Warburton et al. (2011) concluded that the PAR-Q is now the international standard pre-participation screening instrument. A recent report from Israel recommended the use of the PAR-Q by primary health care physicians when screening healthy individuals for non-competitive PA (Scheinowitz et al., 2008). The completion of the PAR-Q prior to initiation of a PA is considered to be best practice (Eickhoff-Shemek, 2010; Herbert & Eickhoff-Shemek, 2010).The PAR-Q Child, ask parents to report on medical conditions of their children that will make exercising unsafe for them for example high or low blood cholesterol, childhood epilepsy, asthma or respiratory problems, bone, joint or muscular problems with arthritis (See Appendix L).

3.3.3 Physical Activity Assessment

The two- item physical activity questionnaire (See Appendix M), developed by Prochaska et al. (2001) was used to assess PA. The parents answered the questions "During the past 7 days, on how many days was your child physically active for a total of at least 60 minutes per day?" and "During a typical or usual week, on how many days are your child physically active for a total of at least 60 minutes per day?" For analysis, the number of active days "during the past week" and the number of active days "during a typical week" are averaged. According to the scoring protocol of the PACE+ (Patient-Centred Assessment and Counselling for Exercise Plus Nutrition), a score of 5 indicates meeting the World Health Organization's recommendation for PA (Prochaska et al., 2001). In a Finnish study, it was found to have acceptable reliability with intraclass correlation coefficients (ICC) ranging from 0.6 to 0.8 (Vuori et al., 2005). It has been validated via correlations with accelerometer derived MVPA. It demonstrated moderate validity in a sample of school aged children in the U.S ($r = 0.40$, $p < 0.001$; test-retest ICC= 0.77) (Prochaska et al., 2001).

3.3.4 Anthropometric measures

Height, weight and waist circumference were measured, and BMI calculated using the formula [BMI = weight (kilogram, kg)/height (meter, m) ^{2}]. Waist to height ratio (WHtR) was also calculated by dividing waist circumference in cm by height in cm. Height was measured to the nearest 0.1cm with a wall-mounted tape measure while weight was be measured to the nearest 0.1 kg using an electronic scale. Participants' weight was measured in light clothes and without shoes. Waist circumference (centimetre, cm) was measured at the level of the umbilicus zone in the horizontal plane. All measures were taken twice and the mean score was used in the analyses. BMI was categorised (underweight, normal weight, overweight, obese) using age- and gender-specific BMI cut-points (Cole et al., 2007).

3.3.5 Performance and Fitness (PERF-FIT) test battery

Content validity for the PERF-FIT was carried out by seven experts (all experienced clinicians with doctorate degrees; three from Africa, two from South America, and two from Europe). This evaluation was done using a 4-point scale developed based on the criteria proposed by Davis (Davis, 1992). Score 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant. Specifically, Item Content Validity Index (I-CVI) was computed for each test item as the number of experts giving a rating of either 3 (quite relevant) or 4(highly relevant), divided by the total number of experts in the study. Scale level-Content Validity Index (S-CVI), representing the overall content validity of the PERF-FIT, was computed as the average of the I-CVIs for all the test items. I-CVI for the Throw and Catch item was 0.86 and 1.00 for the other nine items, leading to a S-CVI of 0.99, indicating excellent content validity (Lynn, 1986). Norm scores for the PERF-FIT are yet to be established but once enough data is generated, the values will be transformed to standard scores. The test has two subscales: a PERFormance part; Motor skill subscale (5 Skill Item Series) and a FITness part; Power and Agility subscale (5 items) (Smits-Engelsman, 2018). Full assessment time per child was about 30-40 minutes.

The power and agility subscale contains five items intended to measure aspects of anaerobic capacity (explosive power, running and agility): long jump, overhand throw, running, stepping, and side jump. The Motor Skill Performance subscale contains five series of tasks with increasing difficulty, which are called Skill Item Series (SIS). Items in this subscale include: bounce and catch, throw and catch, balance, jump and hop. For the Skill Item Series all children start at the easiest level of the series. If they perform first trial with no mistakes, no second trial is given but they proceed to next level of the task. If a child does not obtain

maximum score in the first test trial a second trial is given. If the child does not score more than half of the maximum points in either of the 2 test trials for a SIS item, then that series is discontinued, and the rest of that series is not tested in that child. See Appendix O for PERF-FIT score sheet.

3.3.6 Alpha fitness test Battery (Alpha-fit)

The Alpha-fit presents three slightly different versions depending on the available time to administer the tests.

a) Evidence based ALPHA health related fitness test battery. This version of the battery includes weight and height (BMI), waist circumference; skinfolds thickness (triceps and subscapular), handgrip strength, standing long jump, and 20m shuttle run tests.

b) High priority ALPHA health related fitness test battery. When there are time constraints, as it can be the case in the school setting, the assessment of the skinfold thickness is omitted.

c) Extended ALPHA health related fitness test battery. In those cases where there are no time limitations, all the tests included in the evidence-based battery together with one additional test (4 x10mm shuttle run) is used to assess motor fitness.

For the purposes of this study which is to validate a tool to be used in low SES, only certain items of the Alpha-fit were used: the standing long jump, 4 x 10 metre shuttle run, 20metre shuttle run and BMI. These tests measure constructs similar to the PERF-FIT test (power and agility subscale), they require no expensive equipment and the actions required by the tests are similar to what children require in their everyday play activities.

3.3.6.1 Standing long jump

This test measures explosive power of the legs. The children stood barefoot with knees bent, feet together and arms back. They swung their arms and jumped as far forward as possible, landing with their feet. The measurement is taken from take-off line to the nearest point of contact on the landing (back of the heels) that is the longest distance jumped. Castro-Piñero et al.(2010), in a study to examine the association among different measures of lower body muscular strength in children, and the association between measures of lower- and upper-body muscular strength concluded that the SLJ was strongly associated with other lower body muscular strength tests (R2 = 0.829-0.864), and with upper body muscular strength tests (R2 = 0.694-0.851). The SLJ test might be therefore considered a general index of muscular fitness in children (Castro-Piñero et al., 2010). See Appendix Q for norms.

3.3.6.2 4 x 10m Shuttle Test

The 4x 10m Shuttle Test measures speed of movement, agility and coordination. Two lines are marked 10 meters apart using marking tape or cones. The two blocks are placed on the line opposite the line they are going to start at. On the signal "ready", the participant places their front foot behind the starting line. On the signal, "go!" the participant sprints to the opposite line, picks up a block of wood, runs back and places it on or beyond the starting line. Then turning without a rest, they run back to retrieve the second block and carry it back across the finish line. Two trials are performed. Time to complete the test is recorded in seconds to the nearest one decimal place. The shortest of the two times is recorded. A trial is void if a block is dropped or thrown. Benefice et al. (1999) investigated the reliability of this test in pre-schoolers aged 4–5 years and concluded that the test showed an acceptable reliability (r = 0.50 for girls, r = 0.58 for boys). See Appendix Q for Norms

3.3.6.3 20m Multistage Fitness Test (20mSRT)

The 20mSRT is a commonly used maximal running aerobic fitness test. It is also known as the beep or bleep test among other names. The 20MSR test consists of one- minute stages of continuous, incremental speed running. The initial speed is 8.5 km/h and increases by 0.5 km/h per minute (Léger et al., 1988). The individual is required to run between two lines 20-m apart, while keeping pace with audio signals emitted from a pre-recorded cassette or compact disk. The test ends when the individual fails to reach the end lines concurrent with the audio signals on two consecutive occasions. Matsuzaka et al.(2014) found out that, when participants were examined under the same experimental conditions (e.g. field and laboratory tests protocols, equipment, and testers), the criterion-related validity of the 20MSR test for children was (r = 0.75) and (r = 0.76) for adolescents. Leger et al. (1988), found test-retest reliability coefficients were 0.89 for children (139 boys and girls 6–16 years old). Kolimechkov et al. (2019) produced percentile scores with the appropriate interpolations with age and sex specific norms for European children aged 5 to 18 (Appendix Q). These norms were used in the current study.

3.4 The research team

The research team comprised: the researcher, a trained physiotherapist and 6 research assistants who were physiotherapists and occupational therapists with expertise from working

in the Paediatric Departments of 37 Military Hospital and Korle Bu teaching Hospital, both in Accra, Ghana.

The student researcher was responsible for recruiting research assistants and coordinating the activities of this study including data collection and data analysis. Comprehensive training sessions were organised for research assistants to ensure that they were familiar with the measurement protocols and procedures. A confidentiality agreement was signed between student and the research assistants for the protection of the data (See Appendix N).

3.5 Procedure

3.5.1 Ethical Approvals and permission

Ethical approval was obtained from the University of Cape Town, Faculty of Health Sciences Human Research Ethics Committee (UCT HREC Ref 598/2019) and the Ghana Health Service Ethics Review Committee (GHS-ERC 084/04/19) (Appendices A and B). This research forms part of a multi-site study designed to develop and validate a new motor-skill assessment test battery in South Africa UCT (HREC ref 139/2019 and NWU (NWU- 00491-19- A1)] Permission to conduct the study in the schools was obtained from the Circuit Supervisor of Manle Dada (Appendix C).

3.5.2 Recruitment, Consent and Assent procedures

First, the student researcher met with and presented the proposal to principals, teachers and Parent Teacher Association (PTA) chairs. In consultation with the PTA, a general meeting was held with the parents. The purpose of the study and the content of the information sheet were explained to them by the student researcher in English, Twi and Ga. Help desks were made available after the meeting to answer personal concerns and help in filling out consent forms and questionnaires. Some parents also picked forms at the meeting and returned it to student researcher through their children. Recruitment and information tables were also set up at strategic places during school hours to engage parents who bring their children to school or pick them up. Additionally, recruitment and information letters to children were distributed to children for parents who could not attend the meetings. Parents were given consent forms, Demographic Data Questionnaire, as well as Children's Physical Activity Readiness Questionnaire (PAR- Q). Children whose parents gave consent for them to take part in the study who passed the initial screening (i.e. Parents who answered NO to all questions of the

Children PAR-Q), were approached. The study was explained to the children in an age-appropriate manner. They were given time to decide whether they wanted to participate (if they elected not to, they were not enrolled, even if their parents had consented). They provided assent by writing their names on assent forms. (See Appendices I and J). Participant education, recruitment and screening took three weeks. A summary of recruitment procedure is shown in figure 1.

3.6 Pilot study

The questionnaires (Demographic, Two- item Activity and PAR-Q) were piloted among a smaller sample of parents (n= 20) to see if they understood the items in questionnaires. Answers from the pilot study showed that questions were clear, feasible and acceptable.

3.7 Data collection

First, demographic information, health status and PA levels of children were collected from parents using parent questionnaires. Next, anthropometric measurements were taken. Then children were tested on items in the PERF-FIT battery and on the selected items on the Alpha-fit in randomized order to cancel out probability of the effect of fatigue or learning effect. The 20mSRT was always done last.

Protocols for administering the PERF-FIT and Alpha-fit were strictly followed. Each test item was explained and demonstrated before the child started. The child had the opportunity for a practice trial. Participants were given verbal encouragement and support throughout the testing procedures. Fifteen seconds rest were allowed in between trials. Participants were also allowed rests in between tests. All the power and agility items were done by children of all age groups with always 2 test trials independent of the score obtained. Children had at least 15 seconds rest between the two test trials.

Testing of each child was done on a playground at the participant's school at a time convenient for teachers, participants, and researchers usually during break time and free periods. Testing for all participants in the three schools took four weeks. Tests and measurements were taken once for each child.

3.8 Data management

Paper-based records are to be kept in a locked cupboard in the researcher's office and they will only be accessible to the student researcher. Hardcopies will be stored for 2 years before they will be archived electronically (in password protected cloud storage system) for a further 5 years and then papers will be shredded. Computer-based records are only available to personnel involved in the study with access privileges and passwords. Data was coded to protect participant's identity.

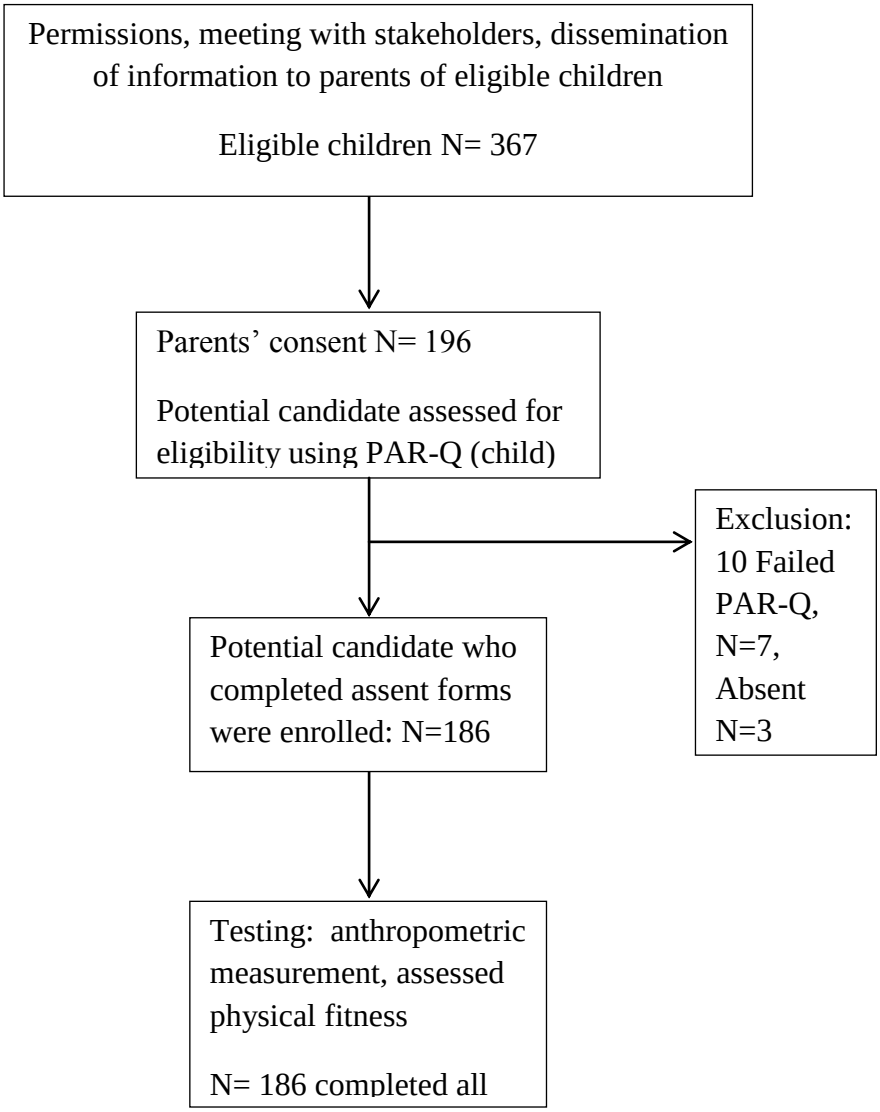

Figure 1: Flow chart of study procedure

3.9 Data analysis

Responses from the demographic questionnaire and scores of physical fitness tests were entered into an excel spread sheet, while the analysis was performed with the Statistical Package for the Social Sciences for Windows (Version 25.0 SPSS Inc., Chicago, IL). Shapiro Wilk's test was used to check for normality of data. All data were not normally distributed except for height and the Alpha-fit and PERF-FIT long jumps.

Descriptive statistics: mean, standard deviation (SD), median, interquartile range (IQR), minimum (min) and maximum (max) scores, range, percentages (%), and frequencies were used to summarize data. To document the fitness levels of children, categorisations of Alpha-fit item scores were made based on age and sex specific percentiles using European norms, corroborated by Kolimechkov et al. (2019). Scores were then categorized into very poor (below 3rd percentile), below mean (between 3rd and 25th percentile), normal range (between 25th to 75th percentile), above mean (between 75th and 97th percentile) and very good (above 97th percentile).

To compare differences of scores on the Alpha-fit and PERF-FIT between those who met the WHO recommended guidelines and those who did not, Mann Whitney U test was used and an alpha value of 0.05 was set as the level of significance.

To assess construct validity Spearman's correlations were calculated between the items of the PERF-FIT and Alpha fit intended to measure a more or less comparable construct. Values <0.30 were considered a low, 0.3–0.6 a moderate and >0.6 a high correlation (Waltz et al., 2010).

3.10 Ethical Considerations

The study adhered to the World Medical Association Declaration of Helsinki (2013) ethical principles. Participation in this research was voluntary. Only children who gave assent after parents had consented and were enrolled. Participants were not financially rewarded for participating in the study; however, children were given fruit snack after completion of the tests. Consent could be withdrawn at any time without any penalty. There were no major risks involved except for the daily minimal risk that children face by playing and running on the school's playground. First aid kit was on site in case of minor bruises from falls but there

were no such incidents recorded. Also, because the tests are all physical, most children felt tired during or after the tests. This was managed with breaks given between each test. Water was made available for those who needed to drink water.
No economic loses were incurred for participating in this study. Meetings to inform parents of the study were scheduled to coincide with already scheduled PTA meetings; tests were conducted during break time and free periods in order not to disrupt classroom activities. There were no immediate direct benefits to participating with regards to the children and their parents.

No child was discriminated against based on religion, ethnicity, gender etc. All children who met the inclusion criteria were tested. Data were coded to protect participants' identity. Only the principal investigator (PI) and co-investigators had access to the data and identifiers. All research assistants involved in the study signed statements agreeing to protect the security and confidentiality of participant information.

3.11 Dissemination of findings

Results generated from the thesis have been handed to the Ghana Health Service and the Municipal Education office. Physical Education teachers in the participating schools have also been informed about the study results and have been advised to tailor their PE activities to address the specific needs of the children (i.e. cardiorespiratory endurance).

3.12 Conflict of interest

The researcher has no conflict of interest to declare.

CHAPTER 4: Results

4.1 Demographic Characteristics of children

The total number of participants was 186. The sample consisted of 96 boys (51.6%) and 90 (48.4%) girls. The median age of the children was 10.00 years with interquartile range (IQR) of 2.00, whiles the median BMI was 15.40 kg/m^2 with IQR of 2.60. The anthropometric characteristics of participants are shown in Table 1. Using the Cole et al. (2007) cut-off points for BMI, 10 (5.4%) children were classified as overweight, only 1(0.5%) was obese,53(25.8%) were underweight and 122 (65,6%) had normal weight.

About 79% of the sample was in Grades 3 and 4. There were old children in lower grades. The age to grade ratio is shown in Figure 2.

Table 1: Anthropometric characteristics of participants (n=186)

Variables	Mean	SD	Median	Min	Max	IQR
Age (years)	9.79	1.72	10.00	6	12	2
Weight (Kg)	30.93	8.96	30.00	11.60	59.10	11.77
Height (cm)	139.11	12.13	139.00	113.00	185.00	18.00
BMI (kg/m^2)	15.70	2.75	15.40	6.00	24.93	2.60

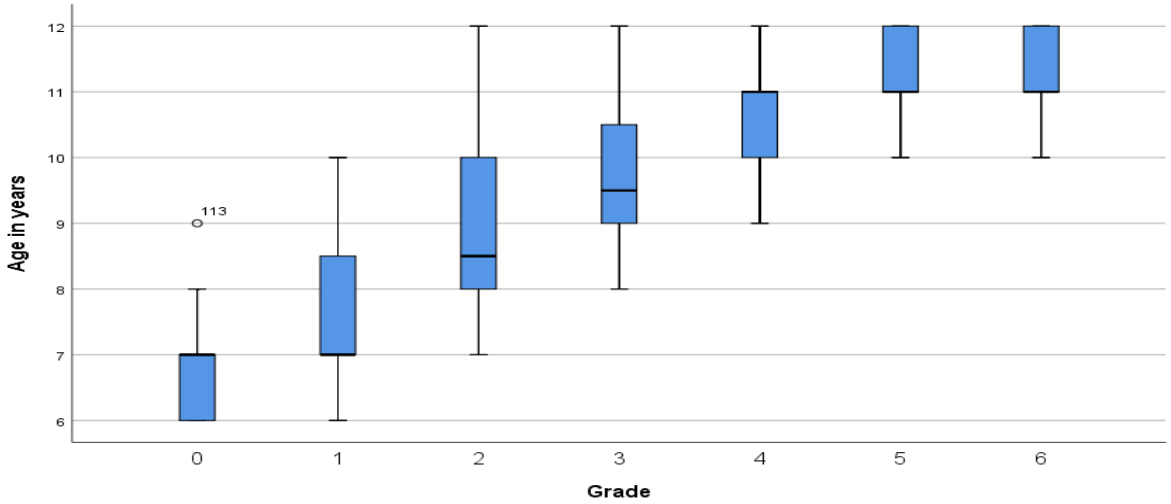

Figure 2: Graph of age to grade ratio. Grade 0 in the plot represent grade KG. The shaded boxes represent the categories where majority of the children's ages fall within that grade.

4.2 Parent Demographic Characteristics

Majority of the parents had up to Junior High School (JHS) education (i.e. 60% for fathers and 63% for mothers) followed by Senior High School (SHS) (22% for fathers and 17% for mothers). There were more mothers (13%) without any form of formal education than fathers 4%. Likewise, more fathers (12%) had tertiary education than mothers (3%). Fathers and mothers who had only primary education were 2% and 4%, respectively. Only 14% of the fathers were full time employees employed as public servants. Most of the fathers (40%) were Artisans and self-employed. As La is situated along the Gulf of Guinea, majority of the fathers in agriculture were artisanal fishermen. Majority of the mothers (68%) were traders whiles 3% of fathers and 9% of mothers were unemployed. Details of parents' education and employment are summarized by Figure 3 and 4.

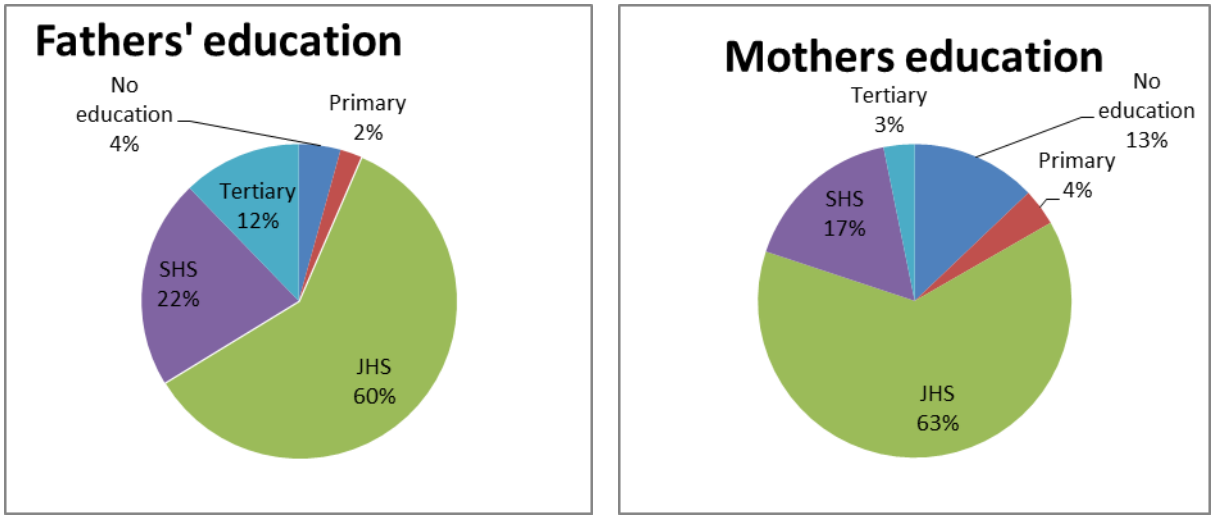

Figure 3: Parent's education

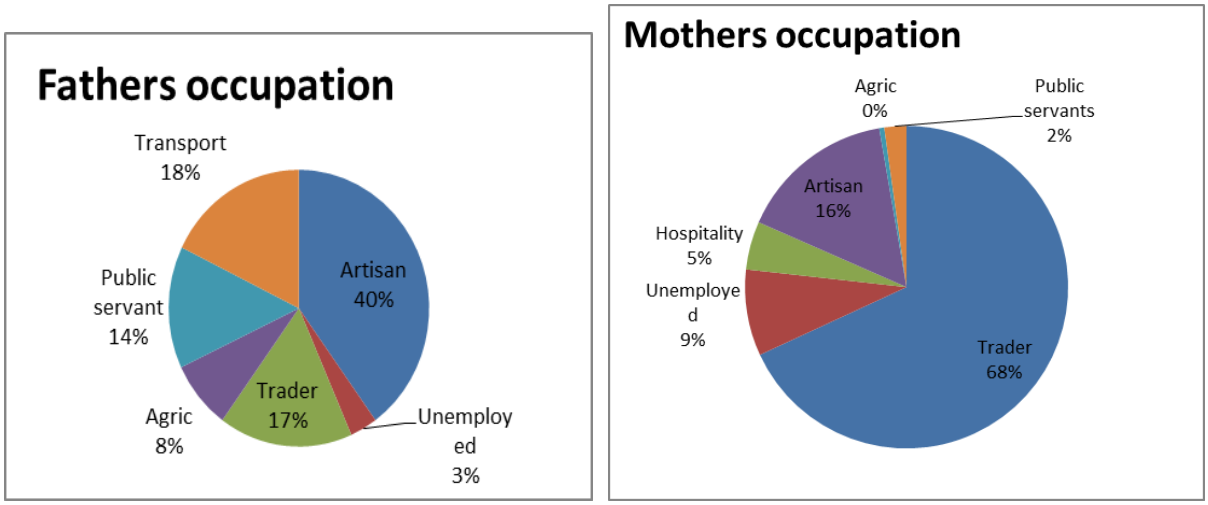

Figure 4: Parent's employment

4.3 Developmental characteristics of participants

96% (n=175) of the children were right-handed. Only 4.8 % (n=9) of the children reportedly had mothers who had complicated pregnancies. Those complications included breech presentation, prolonged labour, premature labour, and inadequate amniotic fluid. 14.5% (n=27) were born premature or underweight. 8.1% (n=15) had seriously been sick and hospitalized before. Malaria (n=7) was the top cause of hospitalization. Other causes included cholera, burns, febrile convulsion, neonatal jaundice, prematurity and swollen feet.

4.4 Motor characteristics of children

5.4% of parents (n=10) reported that children struggled with motor activities at home while15.6% (n= 29) reported that their children struggled to learn some motor activities. Such activities included walking, climbing, throwing and catching a ball, riding a bike, skipping and jumping. 27.4% (n= 51) of the parents reported that their children struggled to pay attention, 32.1% (n=58) of the children had failed a grade before. When parents were asked if they think their children had motor problems, 80.1 %(n=146) answered No, 3.2% (n= 6) answered Yes and 16.7 % (n= 31) answered Maybe. Table 2 shows a summary of the developmental and motor characteristics of the participants.

Table 2: Developmental and motor characteristics

Characteristics	no		yes		maybe	
	n	%	n	%	n	%
Complications during birth & Pregnancy	177	95.2	9	4.8		
Born Premature or underweight	159	85.5	27	14.5		
Seriously ill & hospitalized before	171	91.9	15	8.1		
Struggles with motor activity at home	176	94.6	10	5.4		
Struggled to learn motor activity	157	84.4	29	15.6		
Struggle to pay attention	135	72.0	51	27.4		
Failed grade	128	68.8	58	31.2		
Parents think child has motor problem	146	80.1	6	3.2	31	16.7

4.5 PA of children

Parents reported that 64.5 % (n=120) of the children met the WHO recommendation for PA (60min MVPA per day) with 51.1 % (n=95) of the children being active for at least 60mins seven times a week. The mean number of days that children were active in a week was 5.13± 2.32. Only 15.6 % (n=29) of the children participated in organised sports outside school.

These sports included football (n =19), Taekwondo (n=3), boxing (n=2), athletics (n=3), handball and basketball (n=2). Such sport activities were usually during the weekends. Frequency of such sport activities ranged from once a week to seven times a week. With twice a week being the most frequent. Table 3 shows the summary of the PA characteristics of the sample.

Majority of the children, 86.6% (n=161) walked to and from school every day, average distance of 300 metres (5x a week), 10.2% (n= 19) took public transport, 2.7% (n=5) went by private transport and only one child cycled to and from school. Figure 5 gives a pictorial breakdown for mode of transportation.

Table 3: Physical activity characteristics of participants (N=186) using PA questionnaire

Variables	no		yes	
	n	%	n	%
Participate in sports outside school	157	84.4	29	15.6
Meets WHO recommendation for PA	66	34.4	120	65.6

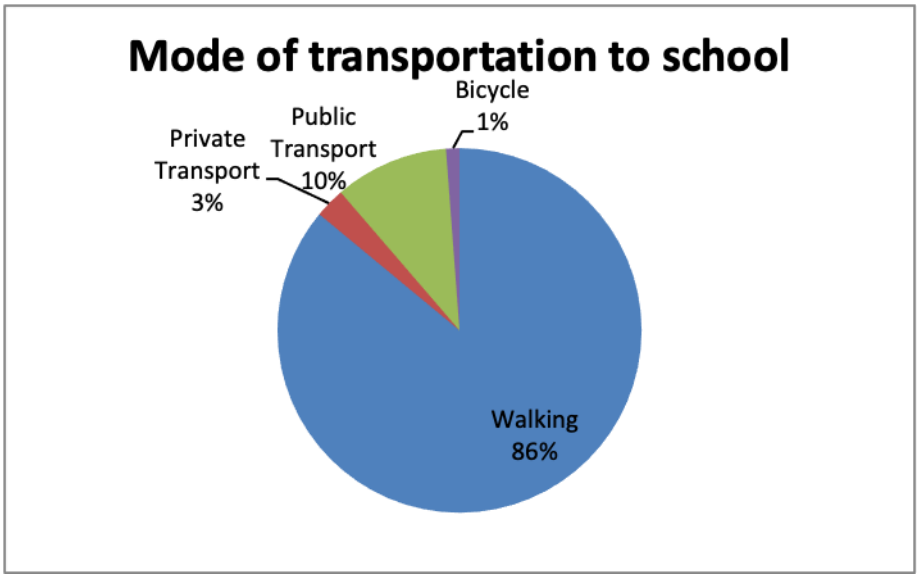

Figure 5: Chart showing mode of transportation to school.

4.6 Objectively measured physical fitness of participants

4.6.1 Participants' Performance on the Alpha-fit

The scores of the Alpha fit test battery and that of the PERF-FIT are summarized in Table 4. The maximum 20mSR level reached was 5.00 and the median was 1.50. The median distance jumped for the Alpha fit long jump was 134.00 cm and the median time taken to run the 4 x10m SR was 12.11 sec.

When describing the fitness levels of the sampled children using the Alpha-fit battery test norms (Kolimechkov et al., 2019), scores were categorized into very poor (below 3rd percentile), below mean (between 3rd and 25th percentile), normal range (between 25th to 75th percentile), above mean (between 75th and 97th percentile) and very good (above 97th percentile). For the 20-meter shuttle run, majority of the children, 72% (n= 134) were below the mean which is between the 3rd and 25th percentiles, 25.3 % (n=47) had normal scores, only 0.5 % (n=1) scored above mean between the 75th and 97th percentiles. 1.3 % (n=3) of the children performed very poorly that is at and below the 3rd percentile. The children performed better on the 4 x10m shuttle run and Alpha-fit Long jump. 22.6% (n= 42) and 2.2% (n=4) scored very good, which is the 97th percentile on the 4 x10m shuttle run and Long jump, respectively. The categorization of children using the European normative values of the Alpha-fit test battery is shown in Figure 6.

4.6.2 Participants' Performance on the PERF-FIT

Overall, participants performed well on the PERF-FIT items. The maximum scores possible for the PERF-FIT ball bounce and throw is 50. The median numbers of catches of participants for the ball bounce and ball throw were 45.00 and 46.50 respectively. The maximum possible score for the jump series of the PERF-FIT is 20.00. Meanwhile, the median score of the participants in this series was 20. Scores of participants on the PERF-FIT items will be corroborated with other study sites in order to generate norms for children living in low SES. The PERF-FIT scores are tabulated in Table 4.

Table 4: Alpha-fit and PERF-FIT scores

Alpha-fit scores	Mean	SD	Median	Min	Max	Interquartile range
20mSR Level (stage)	1.98	1.00	1.50	0.00	5.00	1.50
Long jump (cm)	132.92	22.21	134.00	56.00	187.00	31.75
4 x10m SR (sec)	12.43	1.91	12.11	8.67	20.52	2.30
PERF-FIT scores						
Ladder run (sec)	7.35	1.03	7.26	1.12	10.36	1.12
Ladder step(sec)	14.40	2.73	14.00	8.88	22.70	3.74
Side jump (number)	28.06	6.34	29.00	7.00	49.00	7.75
Long jump (cm)	128.70	23.36	130.00	54.00	191.00	31.75
Overhand throw(cm)	231.88	64.79	230.00	100.00	430.00	86.50
Ball bounce (number)	42.18	9.52	45.00	0.00	50.00	7.00
Ball throw (number)	43.02	9.94	46.50	0.00	50.00	8.00
Total jump (number)	19.79	0.91	20.00	9.00	20.00	0.00
Hop right (number)	17.98	4.22	20.00	0.00	20.00	1.00
Hop left (number)	18.04	4.31	20.00	0.00	20.00	1.00
Static balance (sec)	59.31	4.57	60.00	45.00	60.00	0.00
Dynamic balance (number)	29.87	2.94	31.00	16.00	32.00	3.00

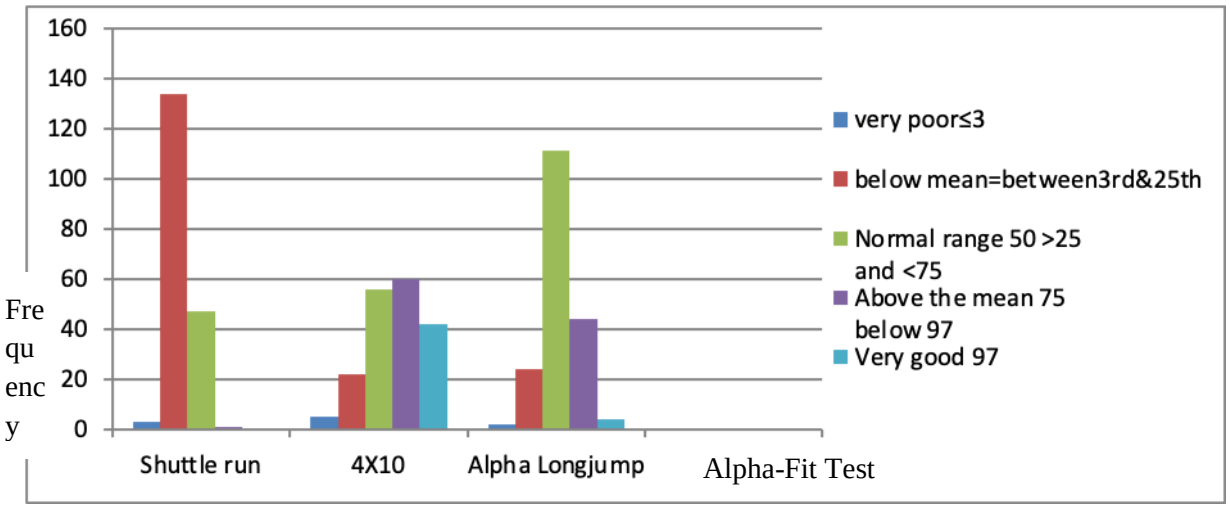

Figure 6: Graph showing categorization of data using European norms.

4.7 Group differences

The number of children meeting the WHO recommendation (n=120) and those who do not (n=66) based on the two- item activity questionnaire were comparable in age, height, (see Table 4) and sex (x^2=1.84, p=0.18) but a statistical difference was seen in their BMI. Even though both groups had BMI that fall within the normal range, the group that did not meet the WHO recommendation had a significant higher BMI than those who did not. No significant difference was observed between the two groups both on the PERF-FIT and Alpha-fit test items (see Tables 5 and 6).

Table 5: Differences in anthropometric measures between children who meet the WHO recommendation and those who do not

	Group	Mean	Median	Min	Max	SD	z value	p value
Age (years)	Not meeting	9.96	11.00	6.00	12.00	1.79	-0.92	0.36
	Meeting	9.67	10.00	6.00	12.00	1.72		
Height (cm)	Not meeting	140.15	139.00	113.00	167.00	12.85	-1.28	0.20
	Meeting	137.87	137.50	115.00	185.00	11.79		
Weight (kg)	Not meeting	32.69	30.30	17.20	59.10	9.79	-1.75	0.08
	Meeting	29.69	28.60	11.60	52.50	8.26		
BMI (kg/m^2)	Not meeting	16.31	15.89	11.35	24.93	2.79	-1.95	0.05
	Meeting	15.38	15.08	6.00	23.30	2.66		

Table 6: Differences in scores on the Alpha-fit between those who meet the WHO recommendation for MVPA and those who do not.

Alpha-fit test	Group	Mean	SD	Median	Min	Max	z value	p value
4 x 10m SR (sec)	Not meeting	12.50	2.03	12.11	8.67	20.62	-0.29	0.77
	Meeting	12.42	1.85	12.24	9.49	17.55		
Long Jump (cm)	Not meeting	132.53	23. 64	134.50	78.00	187.00	-0.01	0.99
	Meeting	132.82	21. 41	134.00	56.00	178.00		
20m SRT (level)	Not meeting	1.76	0.85	1.50	0	4	-1.67	0.10
	Meeting	2.01	1.06	2.00	0	5		

Table 7: Differences in scores on the PERF-FIT (power and agility items) between those who meet the WHO recommendation for MVPA and those who do not.

	Group	Mean	SD	Median	Min	Max	z value	p value
Ladder run(sec)	Not meeting	7.22	1.18	7.12	1.12	10.07	-1.13	0.26
	Meeting	7.45	0.97	7.28	5.44	10.36		
Ladder step(sec)	Not meeting	14.06	2.45	13.71	9.60	22.7	-1.39	0.16
	Meeting	14.65	2.91	14.19	8.88	21.56		
Side jump (number)	Not meeting	28.35	6.48	30.00	7	42	-0.61	0.54
	Meeting	27.85	6.31	29.00	11	49		
PERF-FIT long jump(cm)	Not meeting	127.86	24.41	130.00	470	181	-0.12	0.90
	Meeting	128.88	22.84	130.00	54	191		
Overhead throw(cm)	Not meeting	233.71	72.63	230.00	106	430	-0.01	0.99
	Meeting	229.31	59.73	230.00	100	400		

4.8 Construct validity of the PERF-FIT

4.8.1 Correlation between Alpha- fit and PERF-FIT test items scores

Table 8: Spearman's Correlation between Alpha-fit and PERF-FIT test items

PERF-FIT items	Alpha-fit test items	
	4 x10m SR (sec)	Alpha-fit long jump (cm)
Ladder run (sec)	0.26**	-0.25**
Ladder step (sec)	0.20**	-0.45**
Side jump (number)	-0.34**	0.36**
PERF-FIT long jump	-0.35**	0.84**
Overhand throw	-0.33**	0.62**

**. Correlation is significant at the 0.01 level (2-tailed).

From the above table, it can be seen that all the power and agility items of the PERF-FIT show significant correlation with the Alpha-fit 4x10m SR and long jump. A high correlation (r_s = 0.84) was found between the Alpha-fit long jump and PERF-FIT long jump. High correlation (>0.60) emerged between lower and upper extremities explosive power items of the Alpha-fit long jump and PERF-FIT overhand throw (r_s = 0.62) indicating that strength in upper and lower extremities items are related. Moderate correlations were found between the 4x 10m SR and long jump (r_s= 0.35). However, low correlations (< 0.30) were found between the 4x10m SR and PERF-FIT agility ladder items (r_s = 0.26 and 0.20). Moderate correlation was also found between the Alpha-fit long jump and the PERF-FIT side jump (r_s = 0.36).

CHAPTER 5: Discussion

This study assessed the PA level and physical fitness (using the Alpha-fit and PERF-FIT test batteries) of a sample of Ghanaian children. The study also investigated the construct validity of the PERF-FIT.

5.1 Main findings

A majority of the children were found to be physically active and engaged in daily tasks like walking. The study also found that only a small percentage of children were involved in organised sports outside school hours. Children performed satisfactorily on tests examining strength, power and agility (Alpha-fit long jump and the 4 x10m shuttle run) but not so well on the cardiovascular endurance test (20m shuttle run test). Children who did not meet the WHO recommendation for MVPA (60min per day) had a significant higher BMI than those who did, but no significant difference was observed among the two groups on both the PERF-FIT and Alpha-fit items scores.

Five hypotheses were formulated to test the construct validity of the PERF-FIT. Four of these showed moderate to high correlations as hypothesized between the Alpha-fit items (long jump and 4 x 10m SR) and the PERF-FIT (power and agility) items. This shows that the PERF-FIT (power and agility) items measure a partly comparable construct to these tests items of the Alpha-fit.

5.2 Demographic Characteristics of children and parents

5.2.1 Participant Age and Grade level

This study found there were many children older than the average age expected for those grades. This study, however, was limited in calculating the average age until 12 years. Ghana's educational system consists of five levels. Children begin their education from pre-school at the age of 3 to 4 years then to kindergarten at the age of 5 to 6 years, primary school which lasts 6 years, usually starts from 7 years then to lower secondary school (3 years) and then to upper secondary school (3 years), and finally to university with a four-year curriculum (MOE-Ghana, 2015). The phenomenon of having older children in lower grades might have been caused by late entries, older-age entries, and repeaters as stipulated by

Akyeampong et al.,(2007). This study did not recruit many children from Grade 5 and 6 because by then, most of them had exceeded the age limit of the study.

The only findings from this study that could explain this phenomenon was the high percentage (31.2%) of children who had failed a grade before. Ascertaining the cause of failing a grade (either cognitive or social) was beyond the scope of this study.

5.2.2 Parent education level

The study found more fathers with higher education than mothers. This finding is similar to findings by Owusu et al.(2004) even though their survey was among parents of high economic class living in affluent areas in Accra. In the study by Aryeetey et al. (2017) though only maternal education was explored, only 6% of children in public schools had mothers with tertiary education, which is comparable to the 3% found in this study given the fact that this study was limited to a very low socioeconomic area of Ghana. Maternal job descriptions of children in public schools were also similar to what was found in the current study, majority (65.5%) of them were traders.

There is a reverse association between maternal level of education and meeting WHO recommendation for PA in low socioeconomic countries (Muthuri et al., 2016). In that, the lower the level of education of the mother, the higher the PA of the child. The mother's level of education is a variable used as a measure of socioeconomic status (Lopes et al., 2012). The findings of this research seem to agree with this actuality. The high numbers: 65.5% of children who met the WHO recommendation for PA might have done so out of necessities imposed by the economic situation of the household like walking to and from school, doing household chores and engaging in free play with friends.

5.2.3 Anthropometric characteristics of children

Underweight was more prevalent (28.5%) than overweight and obesity combined (5.9%) among a sample of school children living in a low socio-economic urban area. Aduama (2004) observed that 6.4% of children of comparable age in sampled public primary schools in Accra were underweight as opposed to 1.1% that was obese. This may imply Ghana is battling the double burden of underweight and overweight with the former more prevalent than the later. This is in contrast with what was found in similar studies in South Africa which found a higher percentage of obesity (27.3%) as opposed to underweight (12.4%) (Pretorius et al., 2019).

Findings in literature seem to suggest that obesity is more prevalent among the low socio-economic class in industrialized (middle to high income) countries but prevalent among the high socioeconomic class of low to middle income countries (De Onis & Blossner, 2000; Wang et al., 2002). In worldwide studies examining the weight of adolescents and children, it was revealed that Asia and SSA countries have always had the lowest prevalence of obesity confirming obesity might not be a problem for some SSA countries (Martorell et al., 2000). However, this narrative may soon change, especially if PA of children is not given the needed attention. This study identified a significant difference in BMI between the group of children meeting the WHO recommended guideline for PA and those who did not with those who did not meet the guidelines having higher BMI than those who did.

Parents' jobs will ultimately dictate the income flow in the household hence the quality and frequency of food served to meet the nutritional needs of these children. Parents report that 14.5% of the children were born premature or underweight which is in tandem with the national value for children born underweight which is 14.1 % (Gulati, 2010). It is likely that the low weight of these children might have been carried over from birth as stipulated by Rahman and Chowdhury (2007). Emphasis is placed on adequate weight gain of children from 0 to 5 years with adequate public health measures in place to monitor and immunize them but there are no health monitoring systems in place once children get into school from age 6 onwards. Both obesity and underweight are debilitating to a child's health. An underweight child may not have the energy to play and keep physically active which will eventually impact negatively on physical fitness. A child's nutrition is linked to her/his cognitive development (Gulati, 2010). Studies also indicate that health status has implications for attendance, retention and the rate of student attrition, with hunger, malaria, headaches and poor eyesight noted as major causes of absenteeism and student attrition (Fentiman et al., 1999, 2001). Perhaps, the high rate of underweight children could also account for the high rate of children that were reported to have failed grades.

The government of Ghana has introduced the school feeding programme to supplement the nutritional needs of school children from low socio societies (Gelli et al., 2016) and all children sampled were beneficiaries of this programme but it is necessary to evaluate the success of this programme to see if children are getting the required nutrients. To do this there is the need to constantly monitor BMI among school children and see how it impacts on their physical fitness.

5.3 Developmental and motor characteristics of children

Some 5.4% of parents (n=10) reported their children struggled with motor activities at home. Developmental Coordination Disorder (DCD) is defined, using the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), as a condition marked by a significant impairment in the development of motor coordination, which interferes with academic achievement and/or activities of daily living (ADL). These difficulties are not due to a general medical condition (e.g., cerebral palsy) and are in excess of any learning difficulties if present (American Psychiatric Association, 2013). Studies have found a prevalence of 5 to 6% of DCD in apparently healthy children. This research though did not objectively assess the prevalence of DCD; found that 5.4 % of the sampled children may have poor motor coordination per the parents' report.

Low SES and underweight has been noted to be risk factors of poor motor coordination (Lingam et al., 2009). Given the debilitating effects of motor problems in children mentioned in the literature like poor fitness scores (Hands & Larkin, 2006) and higher risks of obesity (Piek et al., 2006), some children demonstrate inability to process social cues (Smyth & Anderson, 2000) and suffer from loneliness (Poulsen et al., 2007), further compounding their ability to have a good quality of life.

It is of great importance to identify children with motor difficulties, allowing appropriate early intervention in order to reduce the potential adverse effects on perceptual, cognitive and social development (Mandich et al., 2003). The MABC-2 is a standardized tool for the assessment of motor competence in children. The cost of a complete kit of the MABC-2 is about $1400 which is very expensive for a PE teacher in Ghana to buy or even for the Government to buy for each public school. The PERF-FIT also measures motor performance with its ball bounce and ball throw, static and dynamic balance, hop and jump items. In a recently published study (Smits-Engelsman et al., 2020b), it was concluded that all PERF-FIT balance tasks were significantly correlated with the MABC-2 balance sub score and the Throwing and Bouncing SIS are moderately related to the MABC-2 Aiming and Catching items.

5.4 PA of children

This study found that 65.5% of the sampled children met WHO recommendation for PA. However, this was subjectively measured in a parent-reported questionnaire. Results from Ghana's 2018 report card on PA for children and youth revealed approximately 48% of children and youth engage in some form of MVPA (Nyawornota et al., 2018). The annual report card on PA for children and youth is prepared by experts from various sectors related to PA and formed the Ghana Report Card Working Group that gathered data and information. A combination of manual literature search, document review, and systematic evidence gathering for relevant information spanning 2016 to 2018 was conducted. Grades were based on the best available evidence. Sources included policy guidelines, peer-reviewed published literature, and grey literature including reports of government and nongovernment institutions. The data were aggregated and consolidated following a harmonized process (Tremblay, et. al 2016). Grades (A = excellent, to F = failing) were assigned to each of ten common indicators using a standardized grading rubric. The ten common indicators were: Overall PA, Organized Sport and PA Participation, Active Play, Active Transportation, Sedentary Behaviours, Physical Fitness, Family and Peers, School, Community and Environment, and Government.

Furthermore, this study found that 86% of the sampled children walked to school every day. This finding is similar to what was found in other sub-Saharan African countries (Aandstad et al., 2006; Onywera et al., 2012). These findings are in tandem with conclusion drawn from a study in Mozambique among children aged 6 to 17 that reported higher levels of PA among low SES children and adolescents compared those of high SES (Prista et al., 2009).

The study also found that, only 15.6% of them engaged in organised sport activities outside school hours. This trend may exist because children from low SES are likely to spend their time after school doing household chores or helping their parents at work instead of engaging in organised sporting activities for leisure, as reported by Prista et al (2009) who noted that children from lower SES spent less time in formal sports than their more privileged peers. Another possibility is that the facilities for these sports are also lacking in low SES. Ghana's report cards from 2014 to 2018 have always graded Government Policies, Strategies and investments to promote PA as D. Where D is interpreted as 'we are succeeding with less than half but some children and youth (20–39%)' (Tremblay et al., 2014). Armstrong et al. (2011) estimated that in children an appropriate 12-week CRE training programme will induce on

average, an 8–9% increase in VO_2 peak independent of sex, age and maturation, which should be enough for a child to shift upwards from one quintile band to the next or above the relevant criterion-referenced standard for low cardiometabolic risk. Perhaps the Governing Authorities should invest in sport infrastructure in low SES.

Generally, children who engaged in the recommended MVPA for their age are presumed to be physically fitter than peers who did not meet the recommendations. On this premise, we expected them to score higher on the PERF-FIT and Alpha-fit items than those who did not meet the recommendations. However, this assumption was not met. Several reasons may have accounted for this. One of these is that, meeting the recommendation was measured by proxy. Subjective reports are used extensively to measure PA (Helmerhorst et al., 2012) but they are not valid as objectively measured methods (Adamo et al., 2009). Generally all the children were active considering that majority of them went to and from school by active transport. Additionally the mean number of days that children are active was more than the 5 days considered as meeting the WHO recommendation guidelines.

5.5 Health related physical fitness of participants

5.5.1 20m shuttle run test (20mSRT) - cardiorespiratory endurance (CRE)

Only 25.4% of the sampled children fell into the normal range. 72.4 % were below the mean, 1.6% performed very poorly and only 0.5% above the mean. The mean number of laps in this study was 17.12±7.73. This is a very poor performance compared to what was found among Estonian 5th graders where 33% of girls and 14.5% of boys were classified as having high cardiovascular endurance with the mean number of being 37.91±16.96 (Sepp et al., 2017). In a systemic review by Lang et al. (2018) to compare variability of 20mSRT among 50 countries, 10 of which were from Africa, Tanzanian children were ranked the highest in the performance of the 20mSRT. The international 20mSRT mean of the last completed stage (level) was calculated for children 9 to 17 years for 9 years, the mean last completed level was 9.71 ± 0.70. For this study, the mean age was 9.4 ±1.73 but the mean last completed level of the 20mSRT was 1.96± 1.00 which falls far below the international mean. Tomkinson et al., (2017) had previously developed age and sex specific centiles norms using over a million children from the same 50 countries. Using these norms, the mean completed level of 1.96 ±1.00 for 9 years was found to be below the 20th percentile for both boys and

girls. Children below the 20th percentile were classified as having very low cardiorespiratory endurance (Tomkinson et al., 2017).

There are several reasons for this poor aerobic performance. One reason could be that majority (84.4%) of the children do not engage in any organised sporting activities, a form of leisure time PA. Though no statistical significant difference was found in scores of the 20mSRT between the two groups, it was observed that the median scores for children who met the WHO recommendation for MVPA was 2.00 and 1.50 for children who did not meet the WHO requirements .

Majority of the children reported walking to school and engaging in active play, however these results may also reflect the fact that MVPA is not a good correlate of maximal-effort CRE in children and youth (Lang et al., 2018).

The test was explained to the understanding of children before they started. Children were motivated to continue test till they reached maximum exhaustion, but most children started the test with maximum speed running and became exhausted in no time hence unable to catch up with the pacing and fall out. Furthermore, since children might be less willing to endure discomfort of strenuous effort, have less motivation, and/or a limited attention span for monotonous tasks, the 20mSR test performance could be affected (Mayorga-Vega et al., 2015).

Children who were sampled, performed worse under this parameter, which conforms to the observation by Chen et al. (2018) that compared to the other health-related fitness components, boys and girls exhibited the lowest percentage of meeting the healthy fitness criteria for cardiovascular endurance.

5.5.2 4 x10m shuttle run - Running speed and agility

22.6% of children were classified as very good, 32.4% scored above the mean, 30.3% were in the normal range, 11.9% were below the mean and 2.7% were classified as very poor. The mean time for executing this test 12.5±1.9 seconds is comparable but slightly better than studies in similar age groups. Ramírez-Vélez et al. (2017) found a mean of 14.5±2.0 seconds in sampled Colombian children similar to the 14.8±2.3 seconds found in Spanish children aged 8 to11 (Villa-González et al., 2015). Moradi and Esmaeilzadeh (2015) found a shorter mean time (10.9±0.9 seconds) among Iranian boys 9 to 12 years however this may be due to the fact that girls were not part of the study. Tomkinson et al., (2017) asserted that boys tend

to perform better than girls on agility and speed measures.

5.5.3 Standing long jump - Muscular strength

Majority of children who were sampled (60%), had normal scores with only 1.1% obtaining very poor scores. 13% performed below the mean, 23.8% above the mean and 2.2% scored very good. The mean distance jumped was 132.7±22.2 cm. This performance seems to be good when compared with the performance of urban South African children aged 9 to 12 years old with mean distance of 114.1±22.4 (du Toit et al., 2011) but the higher average BMI of the South African sample, 18.9± 4.1 compared to the 15.7± 2.7 could account for this observation.

The trends of performance in this test confirms the assertion by Sepp et al. (2017) that compared to the other components of physical fitness, very small proportion of children achieve low scores. This may be due to the fact that most games and activities engaged in by children like soccer, skipping rope and hopscotch involve explosive muscle strength. Lower BMI (Veligekas et al., 2012) and high levels of PA (Ortega et al., 2008a) are also known to positively affect scores on the long jump.

5.6 Construct validity of the PERF-FIT

Construct validity refers to the extent to which scores on a particular instrument relate to other measures in a manner that is consistent with theoretically derived hypotheses concerning the concepts that are being measured (Kirschner & Guyatt, 1985; Streiner & Norman, 2003). Construct validity is arguably among the most important characteristics of a test. For the purpose of this study, five hypotheses were formulated about the magnitude of possible relations between items of the Alpha-fit and PERF-FIT. Correlation values between items of <0.30 were considered a low, 0.3–0.6 a moderate and >0.6 a high correlation (Waltz et al., 2010).

The outcomes of Alpha-fit, which is widely used and valid tool to measure fitness, was chosen to formulate hypothesis for determining the construct validity of the PERF-FIT.

Both the Alpha-fit and PERF-FIT contain items for explosive power and muscle endurance for upper and lower extremities. The Standing long jump is a valid item for assessing explosive power in the lower limbs (Molnár & Livingstone, 2000). As expected, very high correlation was seen with the Alpha-fit long jump and PERF-FIT long jump item (r_s = .84) as

both items have similar instructions. A high correlation is also seen between the overhand throw (r_s=.62) and long jump. This means as children are involved in play, they strengthen both upper limbs and lower limbs simultaneously. The standing long jump test is therefore strongly associated to both upper and lower muscular strength in youth (Ferreira et al., 2007). This may be because children's PA is mostly outside play or games consisting mostly of high-intensity, fast speed, and short duration sprints followed by low-intensity walking or jogging, which characterizes common games, i.e., short, intermittent bouts of vigorous PA (Molnár & Livingstone, 2000), and often involves balls and throwing activities.

The 4 x 10m SR showed moderate correlation with the PERF-FIT long jump test. The long jump is a measure of explosive power and muscular strength of the lower limbs both of which are required when running from one point to the other as demanded by the 4x10 SR. However, the 4 x10m SR demands more than running from one point to the other but also speed control and changing direction hence the moderate correlation observed.

The 4x10m shuttle run, part of the Alpha-fit, is a valid test for assessing speed of movement, agility and coordination (Ortega et al., 2008). The ladder running and stepping item of the PERF-FIT involve running with maximum speed with precise foot placement and explosive leg movements and one 180 degrees change in direction at the end of the ladder. The 4x10m shuttle did not demand any precise foot placement but demands slowing down suddenly to pick up sponge, changing direction and picking up speed again. Given that the power and agility subscale of the PERF-FIT tasks demand not only running speed and explosive power but also high levels of neuromuscular coordination of the fast-moving body and accurate foot placement, it is likely that speed was traded for accuracy to the extent that a low correlation was observed between this 4 x10m SR and the PERF-FIT ladder running and stepping items though a moderate correlation was hypothesized.

Moderate correlations were also observed between the Alpha fit long jump and PERF-FIT side jump. The Alpha-fit long jump requires taking off and landing as far forward as possible on both feet, the PERF-FIT side jump also demands taking off and landing on sideways on both feet in a restricted area. Therefore this magnitude of correlation is expected as the side jump apart from demanding explosive power of the lower limbs and fast changes in direction, also demands coordinative precision foot placing at maximum speed, which are not part of the task requirement in the Alpha-fit long jump.

Five a priori formulated specific hypotheses were tested based on the expected construct(s) that were intended to be measured. Data showed that correlations went into the expected direction (all positive) and four of the five hypotheses were of the expected magnitude. Only the correlation between 4x10 meter sprint and PERF-FIT agility ladder items was lower than expected, which is most likely explained by the precision stepping needed in the PERF-FIT ladder items. Although the construct validity is a difficult characteristic to determine and is therefore difficult to establish, we can nevertheless state that 80% of results accord with the formulated hypotheses which is higher than the 75% criteria formulated by Terwee et al. (2007).

CHAPTER 6: Conclusions

6.1 Limitations

The first limitation of this study was that it did not objectively measure PA. Accelerometers can be used to objectively measure PA, but it would have been expensive and time consuming, and would have required expertise to use it. As much as this is a research, the aim is to make it as reproducible as possible in any low SES.

Another limitation was that it was restricted to children living in a low socio-economic urban societies. Therefore, extrapolating results to all children in Ghana should be done cautiously. Since, the PERF-FIT was specifically developed for children living in low SES, it needed to be tested in such a setting. Also, because this was a cross-sectional study, cause-and-effect relationships between variables could not be determined. The study, however, needed to be cross- sectional so as to give the exact picture of the status quo, nonetheless, modifications can be made based on the findings of this research after which a longitudinal study can be conducted to see the effects of these modifications. Additionally, using Alpha-fit European norms to categorize physical fitness of children in SSA because of lack of regional norms was, indeed, a limitation.

6.2 Recommendations

The importance of children's physical fitness will be raised if as a matter of policy, their physical fitness levels are periodically (preferably end of every academic year) tested and documented. This is why there is the need to develop norms that are context specific. Evidence shows that in higher socioeconomic countries, where physical fitness is tested in schools, children from more educated parents engage in more MVPA (Ferreira et al., 2007).

It is recommended that further studies make use of objective measure like accelerometers to measure PA levels.

Cardiorespiratory endurance is one of the foremost markers of health. As observed by Mayorga-Vega et al. (2015), the monotonous nature of the 20mSRT was a likely disincentive for the children hence future studies can measure maximal oxygen uptake directly by the use of treadmill or bicycle as an ergometer in order to determine, more accurately, the cardiorespiratory status of children living in a low socio-economic area in Ghana.

6.3 Conclusion

Given the importance of physical fitness in children, it was very expedient to carry out testing in this population. This study helped to identify children who were performing below the norms in some aspects of physical fitness. The study has shown that the majority of the children living in a low socioeconomic society of Ghana were physically active and met global (WHO) recommendations for PA as reported by their parents. They mostly employed active transportation to get in and out of school (walking). Nevertheless, the BMI of the group of children not meeting the WHO recommendations was significantly higher than the group that met the recommendations. Instead of maintaining the status quo, the younger generation should be empowered through education, and while in school, be taught the importance of physical activities and physical fitness. A gradual change of lifestyle in the future, conditioned by industrialization and automation (reduced PA and an increased sedentary lifestyle), consequently, will lead to reduction in physical fitness, which will have a negative impact, particularly on health statuses. Therefore, children must be made to understand that physical exercise is not a matter of personal choice, or just for fun and pleasure, but a necessity for everyday functioning (Council of Europe Committee for the Development of Sport, 1988).

This study once again showed good results for muscular strength and agility measured by the long jump and 4 x10mmSR. However, their participation in organized sports outside school was limited and likely accounted for the poor performance on the cardiorespiratory endurance test which could have dire long-term health consequences. Finding from this study is therefore a clarion call to all stakeholders (i.e. Government, Physiotherapists, parents, teachers) to collaborate and put measures in place to improve the cardiorespiratory fitness of Ghanaian children.

Children understood all the PERF-FIT instructions and carried out tests accordingly. The testing was also time efficient since children could be tested in small groups. Assessors found it easy to score children. Our study findings show that the PERF-FIT performed well in this setting and may be used with confidence to assess fitness levels of children in this context. Additionally, the PERF-FIT may be considered as a valid tool for assessing the construct of explosive power, agility and speed. Having such an affordable and simple tool with contextual norms would assist in advocating for schools to periodically monitor, not only the

health-related aspect of physical fitness, but also the motor aspect. This will help to identify physical fitness problems early in children at a stage where it is amenable to treatment.

CHAPTER 7: References

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CHAPTER 8: Appendices

A. Ghana Health Service Approval Letter

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
GPS Address: GA-050-3303
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com

MyRef. GHS/RDD/ERC/Admin/App 19/186
Your Ref. No.

8th May, 2019

Stella Elikplim Lawerteh
University of Cape Town
37 Mil Hosp Neghelli Barracks
Accra Ghana

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC 084/04/19**
Project Title	Physical Fitness in School Children Living in a Low Socio-Economic Area of Accra, Ghana
Approval Date	8th May, 2019
Expiry Date	7th May, 2020
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.
- Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

Signature Removed

SIGNED.....
DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

B. UCT HREC Approval letter

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room G50-46 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-enquiries@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

17 December 2019

HREC REF: 598/2019

Dr G Ferguson
Department of Health & Rehab Sciences
F-46, OMB

Dear Dr Ferguson

PROJECT TITLE: PHYSICAL FITNESS IN SCHOOL CHILDREN LIVING IN A LOW SOCIO-ECONOMIC AREA OF ACCRA, GHANA. (SUB-STUDY 139/2019) (MSC DEGREE - MRS S E LAWERTEH)

Thank you for your response letter addressing the issues raised by the Faculty of Health Sciences Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 January 2021.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: Mrs S Lawerteh will also be involved in this study.

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

Signature Removed

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
NHREC-registration number: REC-210208-007

HREC 598/2019 sa

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC 598/2019 sa

C. Permission letter from Circuit Supervisor

LA DADEKOTOPON MUNICIPAL EDUCATION DIRECTORATE

In case of reply the number and date of this letter should be quoted.

My Ref:
Your Ref:

La Manle Dada Circuit
La - Accra
Contact: 0244649781
E-mail: manledadacircuit@gmail.com

3rd June, 2019.

LETTER OF INTRODUCTION

I write to introduce to you STELLA ELIKPLIM LAWERTEH, a Physiotherapist at the 37 military hospital. She is carrying out a research on the topic "physical fitness in school children living in low socio-economic area in Accra, Ghana" from three selected schools: Kaajano, La Anglican and African Unity in the circuit.

Please accord her the necessary support to carry out her task. You are also advised to monitor her activities so it would not interrupt academic work.

GHANA EDUCATION SERVICE
La DMEO
MANLE DADA CIRCUIT
3rd June, 2019.

FRANCISCA ANABA
CIRCUIT SUPERVISOR

Cc: The Head teacher – Kaajano
The Head teacher – La Anglican
The Head teacher – African Unity

Signature Removed

D. Permission letter to Municipal Education office

Physiotherapy Department,

37 Military Hospital,

Negheli Barracks-Accra.

11th March 2019

THE CHIEF EDUCATION OFFICER,

LA DADEKOTOPON MUNICIPAL ASSEMBLY,

ACCRA.

Dear Sir/Madam.

PERMISSION TO RECRUIT SCHOOL CHILDREN FOR A RESEARCH PROJECT IN SOME PUBLIC SCHOOLS WITHIN THE MUNICIPALITY

I am Stella Elikplim Lawerteh, a Paediatric Physiotherapist at the 37 Military Hospital. I am currently pursuing a master's degree in Physiotherapy at the University of Cape Town in South Africa. As a partial fulfilment for my degree, I will be carrying out a research project in Ghana. The title of my project is "PHYSICAL FITNESS IN SCHOOL CHILDREN IN A LOW SOCIO-ECONOMIC AREA OF ACCRA, GHANA".

Children from two public schools within the La enclave will be recruited and assessed using standard tools for assessing physical fitness (i.e. PERF-FIT and ALPHA-FIT TEST BATTERIES)

This study is part of a multi-site study to evaluate the physical fitness of children in developing countries in order to extrapolate norms for children living in low socio- economic societies. Findings from this research will also help to identify aspects of physical fitness that are lacking in order to draw specific training programmes to address them.

Children within the La Dadekotopon municipal area make a perfect cross section of the various social economic classes in Ghana hence they will be a perfect representation of Ghanaian children. Therefore, I am writing to ask for your permission to recruit students attending public schools in your municipality.

I hope my request will be favourably considered.

Yours faithfully,

Signature Removed

STELLA ELIKPLIM LAWERTEH

(0246853085)

stella.eli.adrah@gmail.com

E. Permission letter to Circuit Supervisor

Physiotherapy Department,

37 Military Hospital,

Negheli Barracks-Accra.

May 2019

THE CIRCUIT SUPERVISOR,

MANLE DADA CIRCUIT,

LA,

ACCRA.

Dear Sir/Madam:

PERMISSION TO RECRUIT SCHOOL CHILDREN FOR A RESEARCH PROJECT IN SOME PUBLIC SCHOOLS WITHIN THE MANLE DADA CIRCUIT

I am Stella Elikplim Lawerteh, a Paediatric Physiotherapist at the 37 Military Hospital. I am currently pursuing a master''s degree in Physiotherapy at the University of Cape Town in South Africa. As a partial fulfilment for my degree, I will be carrying out a research project in Ghana. The title of my project is "PHYSICAL FITNESS IN SCHOOL CHILDREN IN A LOW SOCIO-ECONOMIC AREA OF ACCRA, GHANA".

Children from two public schools within the La enclave will be recruited and assessed using standard tools for assessing physical fitness (i.e. PERF-FIT and ALPHA-FIT TEST BATTERIES)

This study is part of a multi-site study to evaluate the physical fitness of children in developing countries in order to extrapolate norms for children living in low socio economic societies. Findings from this research will also help to identify aspects of physical fitness that are lacking in order to draw specific training programmes to address them.

Children within the La area make a perfect cross section of the various social- economic classes in Ghana hence they will be a perfect representation of Ghanaian children. Therefore, I am writing to ask for your permission to recruit schools under your supervision.

I hope my request will be favourably considered.

Yours faithfully,

Signature removed

STELLA ELIKPLIM LAWERTEH
(0246853085)

stella.eli.adrah@gmail.com

F. Information sheet to Circuit Supervisor and Principals of schools

Dear Sir/ Madam,

My name is Stella Elikplim Lawerteh, a Physiotherapist at 37 Military Hospital and currently registered for a Masters in Physiotherapy at the University of Cape Town. I am doing a study on the PHYSICAL FITNESS OF SCHOOL CHILDREN IN ACCRA, GHANA.

Who are the investigators?

This study will be carried out by investigators from the University of Cape Town. We are working with researchers from other developing countries to validate and provide norms for a newly developed tool to assess physical fitness in children living in low socio economic societies.

What is the purpose of the research study?

The purpose for this study is to measure the current physical fitness levels of school children and to also collect information that would be used to validate a new tool which can be conveniently used to assess the physical fitness for children living in societies like Ghana. This research is necessary because early detection of deficits in physical fitness will lead to early intervention. Also, since there is currently no data on the physical fitness levels of children in your community, this research will provide that data which can be used for planning and providing resources to improve physical fitness of children in your community.

What role do I play?

Your permission is needed in order to include the children in your school and for the researcher to conduct the tests at the school premises.

What is expected of the parents?

Letters will be sent to them through the children, their consent will be needed in order to recruit their children in the study. They will also be required to answer simple questions about themselves and health conditions of their children.

What is expected of the children?

Once the parents have consented and the child is willing to partake in the study, they will perform a few activities that test their physical fitness. The children would be asked to:

1. Throw and catch a ball

2. Throw a sand bag

3. Run

4. Jump

5. Hop

Will testing interfere with learning activities?

No. testing will not interfere with learning activities. These tests will only take 30 to 40 minutes and it will be done during PE time, break time or any time convenient for teachers and participants. Each child would just be tested once. Depending on the number of parental consents and child assents, researchers will be stationed on school premises during school hours for 1- 2 weeks.

What happens if I do not want this school to be part in the study?

Your school's participation depends entirely on your permission which is voluntary. If you change your mind about your school's participation in the study, you may withdraw your consent at any time. There will be no consequences to refusal to partake in the study or withdrawal. However, we kindly ask you to consider your school's participation favourably.

What are the risks involved?

There are no major risks involved except for the daily minimal risk that children face by playing and running on the school's playground. First aid kit will however be on site in case of minor bruises. Also, because the tests are all physical, children may feel tired during or after the tests. To ensure safety we will breaks between each test. Water will be made available for those who need something to drink. A researcher will be present at all times to ensure the safety of children.

Who will know the results of the tests?

All the information gathered from parents and children of this school shall be confidential. Information will be stored in a secured place. The name of the school will be anonymous in research reports and publications.

What are the benefits of participating?

The researcher will liaise with the PE teacher to train your child on specific skills that were lacking during the data collection. Children with significant problems, should they be identified will be referred to the appropriate health professionals as recommended by the schools. Additionally, once the new tool is developed, the PE teachers will be trained on how to administer it so that the Physical Fitness levels of school children is monitored regularly so that deficits can be picked early and worked on.

Is there payment for taking part in the study?

There will be no payment to the school, parent or children for taking part in this study.

For further clarifications and questions about the study you may contact the following:

Stella Elikplim Lawerteh (Principal Investigator).
Email;stella.eli.adrah@gmail.com.Telephone: 0233 246853085

Dr. Gillian Ferguson, Department of Health and Rehabilitation Sciences, Faculty of Health Sciences, University of Cape Town. Telephone: (027) 829743924. Email: Gillian.Ferguson@uct.ac.za

Dr. Emmanuel Bonney, School of Biomedical and Allied Health Sciences, Physiotherapy Department. Korle Bu. Telephone:(0233) 243936728. Email: ebonney10@gmail.com

To complain about participant's rights and welfare you may contact the following:

Hannah Frimpong, Administrator, Ghana Health Service Ethics Review Committee, Research Development Division, Ghana Health Service. Telephone: (0233) 507041223

Head of the University of Cape Town Human Research Ethics Committee: Prof Marc Blockman. Email: Marc.Blockman@uct.ac.za

G. Information sheet for parents

Dear Parents / Guardians,

My name is Stella Elikplim Lawerteh, a Physiotherapist at 37 Military Hospital and currently registered for a Masters in Physiotherapy at the University of Cape Town. I am doing a study on the PHYSICAL FITNESS OF SCHOOL CHILDREN IN ACCRA, GHANA.

Who are the investigators?

This study will be carried out by investigators from the University of Cape Town. We are working with researchers from other Developing countries to validate and provide norms for a newly developed to assess physical fitness in children living in low socio economic societies.

What is the purpose of the research study?

The purpose for this study is to measure the current physical fitness levels of school children and to also collect information that would be used to validate a new tool which can be conveniently used to assess the physical fitness for children living in societies like Ghana. This research is necessary because early detection of deficits in physical fitness will lead to early intervention. Also, since there is currently no data on the physical fitness levels of children in your community, this research will provide that data which can be used for planning and providing resources to improve physical fitness of children in your community.

What am I asking you to do?

You will be required to answer simple questions about yourself (like where you stay and work) and about your child (health status and how active he/she is). Only if you agree for your child to partake in the study, will he/she be approached.

What does my child have to do?

Your child will perform a few activities that test his physical fitness. Your child would be asked to:

1. Throw and catch a ball

2. Throw a sand bag

3. Run

4. Jump

5. Hop

These tests will only take 30 to 40 minutes and it will be done during PE time so your child will not miss class because it.

Can my child refuse to take part in the study?

Your child also has the right to refuse to participate. If your child agrees to participate, we will ask him/her to sign a form that shows their agreement.

What happens if I do not want my child to take part in the study?

Your child's participation depends entirely on your consent. Your consent is voluntary. If you change your mind about your child's participation in the study, you may withdraw your consent at any time. There will be no consequences to withdrawal from the study. Refusal to take part in this study will not affect the quality of education or treatment that your child will receive in future. However, we kindly ask you to consider your child's participation favourably.

What are the risks involved?

There are no major risks involved except for the daily minimal risk that children face by playing and running on the school's playground. First aid kit will however be on site in case of minor bruises. Also, because the tests are all physical, your child may feel tired during or after the tests. To ensure safety we will breaks between each test. Water will be made available for those who need something to drink. A researcher will be present at all times to ensure the safety of children.

Who will know the results of the tests?

To protect your privacy, we will replace your name with a code. We will only use this code on your sample and information about you. We will do our best to keep the code private. It is however always possible that someone could find out your name but this is very unlikely to happen.**What are the benefits of participating?**

When your child is physically fit, he/she will be able to engage in play with other children which help their brain, bones, heart and muscles to develop well. Feedback will be given to

you if your child performed below standard and you will be advised on how to support your children to improve their physical fitness.

What happens when my child gets hurt taking part in this study?

This research study is covered by an insurance policy taken out by the University of Cape Town if you suffer a bodily injury because you are taking part in the study. The insurer will pay for all reasonable medical costs required to treat your bodily injury, according to the South Africa Good Clinical Practice Guidelines 2006 which are based on the Association of the British Pharmaceutical Industry Guidelines. The insurer will pay without you having to prove that the research was responsible for your bodily injury. You may ask the researcherfor a copy of these guidelines. If your child is harmed and the insurer pays all necessary medical cost, usually, you will be asked to accept that insurance payment as full settlement of medical cost. However, accepting this offer of insurance cover does not mean you give up your right to make a separate claim for other losses in a Ghanaian court. However, all necessary precautions will be taken to avoid injury.

What happens at the end of the study?

At the end of the study, the general findings will be shared with you and the school authorities at a Parents Teacher Meeting. It may take one year to compile the report of this study. This study is part of a larger study for the development and evaluation of a new tool. The results from this study will be collaborated with results from other study sites to extrapolate norms for physical fitness for children living in low socio-economic societies.

How many times will this testing be done?

Testing your child just once is enough to assess his physical fitness level, however for the researcher to know how true and good the tests used are, some children will be tested twice to compare the two results. Please indicate if you want your child to be tested twice for this purpose.

Will I be paid for taking part?

There will be no payment to you or your child for taking part in this study.

For further clarifications and questions about the study you may contact the following:

Stella Elikplim Lawerteh (Principal Investigator). Email;stella.eli.adrah@gmail.com. Telephone: 0233 246853085

Dr. Gillian Ferguson, Department of Health and Rehabilitation Sciences, Faculty of Health Sciences, University of Cape Town. Telephone: (027) 829743924. Email: Gillian.Ferguson@uct.ac.za

Dr. Emmanuel Bonney, School of Biomedical and Allied Health Sciences, Physiotherapy Department. Korle Bu. Telephone:(0233) 243936728. Email: ebonney10@gmail.com

To complain about participant's rights and welfare you may contact the following:

Hannah Frimpong, Administrator, Ghana Health Service Ethics Review Committee, Research Development Division, Ghana Health Service. Telephone: (0233) 507041223

Head of the University of Cape Town Human Research Ethics Committee: Prof Marc Blockman. Email: Marc.Blockman@uct.ac.za

PLEASE KEEP THIS INFORMATION SHEET FOR YOUR RECORDS

COMPLETE THE DECLARATION ON THE NEXT PAGE

H. Consent form for parents/guardians

STUDY TITLE: PHYSICAL FITNESS IN SCHOOL CHILDREN LIVING IN A LOW SOCIO-ECONOMIC AREA OF ACCRA, GHANA.

I acknowledge that I have had the purpose and contents of the Participants‟ information sheet read and satisfactorily explained to me in a language I understand.

I fully understand the contents and any potential implications as well as my right to change my mind (i.e. withdraw from the research) even after I have signed this form.

Please tick the appropriate box/boxes

□ I voluntarily agree to take part in this research by answering questions about myself and child.

□ I voluntarily agree that my child should be approached about his/her participation in the study.

□ I voluntarily agree for my child to be tested TWICE if he/she agrees to participate in the study

□ I voluntarily agree for my child to be tested only ONCE if he/ she agrees to participate in the study.

Name or initial of participant…… ID code……..

Participants‟ signature…… OR Thumb Print…….. OR Mark (please specify)

Date ……

INVESTIGATOR'S STATEMENT AND SIGNATURE

I certify that the participant has been given ample time to read and learn about the study. All questions and clarifications raised by the participant have been addressed.

Researcher's name…….

Signature…….

Date……

ALL INFORMATION PROVIDED WILL BE KEPT CONFIDENTIAL

I. Child declaration and assent form for children 6 to 8 years

STUDY TITLE: PHYSICAL FITNESS IN SCHOOL CHILDREN LIVING IN A LOW SOCIO-ECONOMIC AREA OF ACCRA, GHANA.

My name is Stella Elikplim Lawerteh. I am studying at a University in South Africa. The purpose of this research is to measure your level of physical fitness. You will be required to do simple activities like throwing, bouncing and catching a ball, throwing a sandbag, hoping, jumping and running.

DECLARATION

I agree to voluntarily perform the tests.

I understand that I do not have to do all the things, I can stop at any time and no one will be angry with me. I understand that the researcher will tell my parents how well I performed so that plans can be made to help me if necessary.

If you understand and agree to show us how you do some of these activities, please write your name in the box below.

If you understand and DO NOT want to show us how you do these activities, please write your name in the box below.

J. Informed assent form for children 9 to 12 years

STUDY TITLE: PHYSICAL FITNESS IN SCHOOL CHILDREN LIVING IN A LOW SOCIO-ECONOMIC AREA OF ACCRA, GHANA.

My name is Stella Elikplim Lawerteh, I work with children at the 37 Military Hospital and currently studying at a University in South Africa. I am doing a study on the PHYSICAL FITNESS OF SCHOOL CHILDREN IN ACCRA, GHANA.

What is the purpose of the research study?

The purpose for this study is to measure your current physical fitness level and that of other children in your school. It is very important to check how fit you are as a child so that if problems are identified, they can be solved early so that you grow to become a healthy adult. Also, this study will help to develop a new test which your PE teacher can easily use to monitor your physical fitness level.

What do I have to do?

You will perform a few activities that test your physical fitness. You would be asked to:

1. Throw and catch a ball

2. Throw a sand bag

3. Run

4. Jump

5. Hop

These tests will only take 30 to 40 minutes and it will be done during PE time so you will not miss class because of it.

What are the benefits of participating?

When you are physically fit, will be able to engage in play with other children which helps your brain, bones, heart and muscles to develop well. Feedback will be given to you if your child performed below standard and you will be advised on to improve your physical fitness.

What are the challenges involved in doing the tests?

There are no major challenges involved except for the daily minimal risk that you face by playing and running on the school's playground. First aid kit will however be on site in case of minor bruises. Also, because the tests require you to be active, you may feel tired during or after the tests. You will be allowed to rest after each test. Water will be made available if you need something to drink. A researcher will be present at all times, obey his/her instructions to stay safe.

Can I refuse to take part in the study?

You have the right to refuse to participate. Your participation depends entirely on your consent. Your consent is voluntary. If you change your mind about your participation in the study, you may withdraw your consent at any time.

Will I be paid for taking part?

There will be no payment for taking part in this study.

DECLARATION

I agree to voluntarily perform the tests.

I understand that I do not have to do all the things, I can stop at any time and no one will be angry with me. I understand that the researcher will tell my parents how well I performed so that plans can be made to help me if necessary.

If you understand and agree to show us how you do some of these activities please write your name in the box below.

If you understand and DO NOT want to show us how you do these activities, please write your name in the box below.

K. Demographic and health information

Please try to answer all questions and circle the answer that is most applicable for the child

All information given in this questionnaire will be kept confidential.

Child's full name …….

Child's date of birth ……..

Child's Grade ……

Where do you live …….

Father's highest level of education JHS□ SHS□ Tertiary□

Father's occupation …….

Mother's highest level of education JHS□ SHS□ Tertiary□

Mother's occupation ……

Telephone number ……...

Email address …….

The Child's Development and Health

1. Were there any complications during the mother's pregnancy or at the birth of your child?

□Yes

□No

If yes, please explain:

……

…….……

2. Was your child born underweight or premature at birth (born early)?

□Yes

□No

3. Does your child struggle with motor activities at home?

If yes, please explain:

□Yes

□ No

4. Does your child participate in any sport outside school?

□ Yes

□ No

If yes which sport activity and how often per week

……

……..

5. Did your child struggle to learn motor activities or /active games (e.g. how catch or kick a ball skip rope or climb play structures)?

□ Yes

□No

If yes which activity was hard?

……

6. Does your child struggle to pay attention (easily distracted) at home?

□Yes

□No

7. Has your child ever failed a grade a school?

□Yes

□No

8. Do you think your child has a problem with movement?

□Maybe

□Yes

□No

9. How does your child get to school every day? (Tick one)

□Private Transport

□Public Transport

□Walking

□Ride a Bike

L. Children's PAR-Q screening form

Childs name:

Parent/guardian name:

Does your child have or has he or she ever experienced any of the following? Please Circle

High or Low Blood Pressure Y /N

Elevated blood cholesterol Y /N

Diabetes Y /N

Chest pains brought on by physical exertion Y /N

Childhood epilepsy Y /N

Dizziness or fainting Y /N

A bone, joint or muscular problems with arthritis Y /N

Asthma or respiratory Problems Y /N

Any sustained injuries or illness Y /N

Any allergies Y /N

Is your child taking any medication Y /N

Has your doctor ever advised your child to exercise Y /N

Is there any reason not mentioned above why any type or physical activity may not be suitable for your child

Y /N

If answered "YES" to any of the above questions please give full details here:

M. Two item physical activity questionnaire

Physical activity; any activity that make you (break a) sweat or get out of breath.

Physical activity can be done in sports, playing with friends or walking to school.

Some examples of physical activities are, running, jogging, skipping rope, football, biking

Add up all the time you spend in physical activity each day (don't include your Physical Education class)

P1. Over the last past 7 days, on how many days were you physically active for a total of 60 minutes per day?

□ 0 days

□ 1 day

□ 2 days

□ 3 days

□ 4 days

□ 5 days

□ 6 days

□ 7 days

P2. Over a typical or usual week, how many days are you physically active for a total of 60 minutes per day?

□ 0 days

□ 1 day

□ 2 days

□ 3 days

□ 4 days

□ 5 days

□ 6 days

□ 7 days

N. Confidentiality agreement between student researcher and research assistants

I, …… having been recruited as an assistant on the study titled PHYSICAL FITNESS IN SCHOOL CHILDREN LIVING IN A LOW SOCIO- ECONOMIC AREA OF ACCRA, GHANA, by appending my signature to this document pledges to keep all information obtained from children and their parents confidential.

SIGNATURE……..

DATE……

O. PERF-FIT score sheet

Score form Power and Agility PERF-FIT©					
Name:		ID:		Remarks	
Tester:		Test date:			
Agility ladder Running (0.01 s) *Always 2 trials*	Trial 1 Time (0.01 s)	#Mistakes	Rest 15s Trial 2 Time (0.01 s)	#Mistakes	Extra trial Running Needed? 3 mistakes or more
					Yes/No
Agility ladder Stepping (0.01 s) *Always 2 trials*	Trial 1 Time (0.01 s)	#Mistakes	Rest 15s Trial 2 Time (0.01 s)	#Mistakes	Extra Trial Needed? 3 mistakes or more
					Yes/No
Extra trial Running Only if needed	Time (0.01 s)	#Mistakes	**Extra trial Stepping Only if needed**	Time (0.01 s)	#Mistakes
Side Jump *Always 2 trials*	Trial 1 (# in 15 s)	Rest 15s Trial 2	**Long jump** Distance cm *Always 2 trials*	Trial 1 distance cm	Rest 15s Trial 2 cm
Throw sandbag 2Kg Kneeling *Always 2 trials*	Trial 1 Kneeling distance cm	Trial 2 Kneeling distance cm	**Throw Tennis Ball**	Trial 1 distance cm	Trial 2 distance cm

Score form SIS Bouncing and Throwing PERF-FIT©

P. Alpha-fit score sheet

ALPHA SCORE SHEET

ALPHA FITNESS BATTERY SCORE SHEET			
NAME	ID	TESTER	
STANDING LONG JUMP	TEST 1	TEST 2	TEST 3
4X 10M SHUTTLE	TEST 1	TEST 2	TEST3
20M MSFB TEST	NO. OF LAPS	LEVEL	

Q. Alpha-fit test battery norms compiled by Kolimechkov et al., 2019

Percentiles for the standing long jump test (cm) in girls

	Percentiles															
Age	1	3	10	20	25	30	40	50	60	70	75	80	90	97	99	100
5.0	*37.9*	*47.8*	*60.1*	*68.0*	*71.9*	*74.4*	*79.3*	*84.2*	*89.0*	*93.7*	*96.1*	*99.5*	*106.3*	*116.4*	*123.4*	*126.9*
6.0	46.7	56.6	69.1	*77.1*	81.1	*83.6*	*88.7*	93.8	*98.7*	*103.6*	106.1	*109.6*	116.7	127.0	134.4	*138.1*
6.5	51.1	61.0	73.6	*81.7*	85.7	*88.3*	*93.4*	98.6	*103.6*	*108.6*	111.1	*114.7*	121.9	132.3	139.9	*143.7*
7.0	55.6	65.5	78.2	*86.3*	90.4	*93.0*	*98.3*	103.5	*108.5*	*113.5*	116.0	*119.7*	127.0	137.6	145.2	*149.0*
7.5	60.2	70.1	82.8	*91.1*	95.2	*97.8*	*103.1*	108.3	*113.4*	*118.5*	121.0	*124.7*	132.1	142.7	150.5	*154.4*
8.0	64.9	74.8	87.5	*95.8*	99.9	*102.5*	*107.8*	113.1	*118.2*	*123.3*	125.9	*129.6*	137.1	147.9	155.7	*159.6*
8.5	69.6	79.5	92.3	*100.6*	104.7	*107.4*	*112.7*	118.0	*123.1*	*128.2*	130.8	*134.6*	142.1	152.9	160.8	*164.8*
9.0	*72.6*	*81.7*	*93.9*	*102.5*	*106.6*	*109.5*	*115.0*	*120.5*	*125.8*	*131.2*	*134.0*	*137.8*	*145.9*	*158.0*	*165.7*	*169.5*
10.0	*78.7*	*86.1*	*97.2*	*106.4*	*110.5*	*113.7*	*119.6*	*125.4*	*131.1*	*137.1*	*140.3*	*144.3*	*153.5*	*168.1*	*175.4*	*179.1*
11.0	*84.8*	*90.5*	*100.5*	*110.3*	*114.4*	*117.9*	*124.2*	*130.4*	*136.5*	*143.0*	*146.6*	*150.8*	*161.2*	*178.2*	*185.2*	*188.7*
12.0	*90.9*	*94.8*	*103.7*	*114.2*	*118.3*	*122.1*	*128.9*	*135.3*	*141.8*	*148.9*	*152.9*	*157.2*	*168.8*	*188.3*	*194.9*	*198.2*
13.0	*97.0*	*99.2*	107.0	118.1	*122.2*	126.3	133.5	140.3	147.2	154.8	*159.3*	163.7	176.4	*198.4*	*204.7*	207.8
14.0	*100.1*	*102.4*	110.4	121.8	*126.0*	130.2	137.4	144.2	151.1	158.5	*162.9*	167.3	179.6	*200.4*	*206.3*	209.3
15.0	*101.3*	*103.6*	111.6	123.0	*127.2*	131.3	138.3	145.0	151.7	158.8	*163.0*	167.2	179.0	*198.7*	*204.3*	207.1
16.0	*104.7*	*107.0*	114.8	126.0	*130.1*	134.1	141.0	147.5	154.0	160.9	*165.0*	169.1	180.4	*199.4*	*204.8*	207.5
17.0	*108.8*	*111.0*	118.6	129.5	*133.5*	137.4	144.2	150.6	157.0	163.9	*168.0*	172.0	183.4	*202.5*	*208.0*	210.7
18.0	*112.9*	*115.0*	*122.4*	*133.0*	*136.9*	*140.7*	*147.4*	*153.7*	*160.0*	*166.9*	*170.9*	*174.9*	*186.4*	*205.7*	*211.2*	*213.9*

Percentiles for the standing long jump test (cm) in boys

	Percentiles															
Age	1	3	10	20	25	30	40	50	60	70	75	80	90	97	99	100
5.0	*42.8*	*54.3*	*67.7*	*76.0*	*80.2*	*82.8*	*87.9*	*93.0*	*97.6*	*102.1*	*104.4*	*107.8*	*114.5*	*123.5*	*130.2*	*133.6*
6.0	52.0	63.5	77.3	*85.8*	90.0	*92.6*	*97.8*	103.0	*107.8*	*112.6*	115.0	*118.4*	125.3	134.9	141.8	*145.3*
6.5	56.6	68.1	82.1	*90.6*	94.9	*97.5*	*102.8*	108.0	*112.9*	*117.8*	120.3	*123.8*	130.7	140.6	147.6	*151.1*
7.0	61.3	72.8	86.8	*95.5*	99.8	*102.5*	*107.8*	113.1	*118.1*	*123.1*	125.6	*129.1*	136.2	146.2	153.4	*157.0*
7.5	66.1	77.6	91.7	*100.4*	104.7	*107.4*	*112.8*	118.2	*123.2*	*128.3*	130.8	*134.4*	141.6	151.7	159.0	*162.7*
8.0	71.0	82.4	96.5	*105.3*	109.7	*112.4*	*117.9*	123.3	*128.4*	*133.5*	136.0	*139.6*	146.9	157.2	164.6	*168.3*
8.5	75.9	87.3	101.5	*110.2*	114.6	*117.3*	*122.8*	128.3	*133.5*	*138.6*	141.2	*144.9*	152.2	162.6	170.1	*173.9*
9.0	*79.9*	*90.3*	*103.9*	*113.0*	*117.4*	*120.4*	*126.1*	*131.8*	*137.2*	*142.7*	*145.5*	*149.2*	*157.2*	*168.9*	*176.2*	*179.9*
10.0	*87.8*	*96.2*	*108.6*	*118.6*	*123.1*	*126.4*	*132.7*	*138.8*	*144.7*	*150.7*	*154.0*	*158.0*	*167.2*	*181.4*	*188.4*	*192.0*
11.0	*95.7*	*102.1*	*113.3*	*124.2*	*128.7*	*132.5*	*139.3*	*145.8*	*152.1*	*158.8*	*162.6*	*166.8*	*177.3*	*193.9*	*200.7*	*204.0*
12.0	*103.6*	*108.1*	*118.1*	*129.8*	*134.4*	*138.5*	*145.8*	*152.8*	*159.6*	*166.9*	*171.1*	*175.5*	*187.3*	*206.4*	*212.9*	*216.1*
13.0	*111.5*	*114.0*	122.8	135.4	*140.0*	144.6	152.4	159.8	167.1	175.0	*179.7*	184.3	197.3	*218.9*	*225.1*	228.2
14.0	*126.0*	*128.7*	138.1	151.5	*156.2*	160.9	169.0	176.4	183.8	191.7	*196.3*	200.8	213.3	*233.7*	*239.6*	242.5
15.0	*139.8*	*142.5*	151.9	165.4	*170.1*	174.8	182.7	189.8	196.9	204.3	*208.6*	212.8	224.4	*242.8*	*248.1*	250.7
16.0	*149.9*	*152.6*	162.2	175.9	*180.6*	185.2	192.8	199.7	206.4	213.4	*217.4*	221.3	231.8	*248.3*	*253.0*	255.3
17.0	*156.1*	*159.0*	169.4	184.2	*189.1*	193.9	201.7	208.5	215.1	221.7	*225.5*	229.2	239.0	*253.7*	*257.9*	260.0
18.0	*162.3*	*165.5*	*176.6*	*192.5*	*197.6*	*202.6*	*210.6*	*217.3*	*223.8*	*230.0*	*233.6*	*237.1*	*246.2*	*259.2*	*262.9*	*264.7*

Percentiles for the 4 x10m m shuttle run test (sec.) in girls

Percentiles															
Age	1	3	10	20	25	30	40	50	60	70	75	80	90	97	99	100
5.0	*21.1*	*20.7*	*19.4*	*18.6*	*18.2*	*17.9*	*17.4*	*16.8*	*16.3*	*15.8*	*15.6*	*15.2*	*14.4*	*13.0*	*12.6*	*12.4*
6.0	*20.0*	19.6	18.3	*17.5*	17.1	*16.9*	*16.4*	15.9	*15.5*	*15.0*	14.8	*14.4*	13.7	12.6	*12.3*	*12.1*
7.0	*18.9*	18.5	17.2	*16.4*	16.0	*15.8*	*15.4*	15.0	*14.6*	*14.2*	14.0	*13.7*	13.0	12.2	*12.0*	*11.9*
8.0	*17.8*	17.4	16.1	*15.4*	15.0	*14.8*	*14.4*	14.0	*13.6*	*13.3*	13.1	*12.9*	12.4	11.7	*11.5*	*11.4*
9.0	*17.0*	16.7	15.5	*15.1*	14.5	*14.5*	*14.1*	13.6	*13.4*	*13.1*	12.8	*12.7*	12.1	11.4	*11.2*	*11.1*
10.0	*16.4*	16.1	15.1	*14.8*	14.1	*14.2*	*13.9*	13.3	*13.2*	*12.8*	12.6	*12.5*	11.9	11.3	*11.1*	*10.8*
11.0	*16.2*	*16.0*	*15.2*	*14.5*	*14.2*	*14.0*	*13.6*	*13.3*	*13.0*	*12.6*	*12.5*	*12.3*	*11.9*	*10.9*	*10.6*	*10.5*
12.0	*15.7*	*15.6*	*14.9*	*14.2*	*13.9*	*13.7*	*13.4*	*13.0*	*12.7*	*12.4*	*12.3*	*12.1*	*11.7*	*10.6*	*10.3*	*10.2*
13.0	*15.2*	*15.1*	14.6	13.9	*13.7*	13.4	13.1	12.8	12.5	12.2	*12.1*	11.9	11.5	*10.4*	*10.1*	9.9
14.0	*15.1*	*15.0*	14.5	13.8	*13.6*	13.4	13.0	12.7	12.4	12.1	*12.0*	11.8	11.4	*10.3*	*10.0*	9.8
15.0	*15.0*	*14.9*	14.4	13.7	*13.5*	13.3	13.0	12.7	12.4	12.1	*12.0*	11.8	11.4	*10.1*	*9.8*	9.6
16.0	*14.7*	*14.6*	14.2	13.6	*13.4*	13.2	12.9	12.6	12.3	12.1	*11.9*	11.7	11.3	*10.0*	*9.7*	9.5
17.0	*14.5*	*14.4*	14.0	13.5	*13.4*	13.2	12.9	12.6	12.4	12.1	*12.0*	11.8	11.4	*10.1*	*9.8*	9.6
18.0	*14.2*	*14.1*	*13.8*	*13.4*	*13.3*	*13.2*	*12.9*	*12.6*	*12.5*	*12.1*	*12.0*	*11.9*	*11.5*	*10.2*	*9.9*	*9.7*

Percentiles for the 4 x10m m shuttle run test (sec.) in boys

Percentiles																
Age	1	3	10	20	25	30	40	50	60	70	75	80	90	97	99	100
5.0	*19.8*	*19.4*	*18.1*	*17.3*	*16.9*	*16.7*	*16.2*	*15.8*	*15.3*	*14.8*	*14.5*	*14.1*	*13.2*	*12.0*	*11.7*	*11.5*
6.0	*18.9*	18.5	17.2	*16.4*	16.0	*15.8*	*15.3*	14.9	*14.5*	*14.0*	13.8	*13.4*	12.7	11.7	*11.4*	*11.3*
7.0	*18.0*	17.6	16.3	*15.5*	15.1	*14.9*	*14.4*	14.0	*13.6*	*13.3*	13.1	*12.8*	12.2	11.4	*11.2*	*11.1*
8.0	*17.0*	16.6	15.3	*14.6*	14.3	*14.1*	*13.7*	13.3	*13.0*	*12.7*	12.5	*12.3*	11.8	11.1	*10.9*	*10.8*
9.0	*16.2*	15.9	14.8	*14.3*	13.8	*13.8*	*13.4*	13.0	*12.7*	*12.4*	12.2	*12.1*	11.6	11.0	*10.8*	*10.5*
10.0	*15.4*	15.1	14.1	*14.0*	13.3	*13.5*	*13.1*	12.5	*12.5*	*12.2*	11.9	*11.8*	11.3	10.7	*10.5*	*10.2*
11.0	*15.3*	*15.1*	*14.3*	*13.7*	*13.4*	*13.2*	*12.9*	*12.5*	*12.3*	*12.0*	*11.8*	*11.6*	*11.3*	*10.3*	*10.0*	*9.9*
12.0	*14.7*	*14.5*	*13.9*	*13.3*	*13.1*	*12.9*	*12.6*	*12.3*	*12.0*	*11.7*	*11.6*	*11.4*	*11.1*	*10.0*	*9.7*	*9.6*
13.0	*14.1*	*14.0*	13.6	13.0	*12.8*	12.6	12.3	12.0	11.8	11.5	*11.4*	11.2	10.9	*9.8*	*9.5*	9.3
14.0	*13.7*	*13.6*	13.2	12.6	*12.4*	12.2	11.9	11.7	11.4	11.2	*11.1*	10.9	10.6	*9.6*	*9.3*	9.1
15.0	*13.2*	*13.1*	12.7	12.1	*12.0*	11.8	11.5	11.2	11.0	10.8	*10.7*	10.5	10.2	*9.2*	*8.9*	8.8
16.0	*12.8*	*12.7*	12.3	11.8	*11.6*	11.4	11.1	10.9	10.7	10.5	*10.4*	10.2	9.9	*9.0*	*8.7*	8.6
17.0	*12.9*	*12.8*	12.4	11.8	*11.6*	11.4	11.1	10.9	10.7	10.4	*10.3*	10.2	9.9	*9.1*	*8.8*	8.7
18.0	*13.1*	*13.0*	*12.5*	*11.8*	*11.6*	*11.4*	*11.1*	*10.9*	*10.7*	*10.3*	*10.3*	*10.2*	*9.9*	*9.1*	*8.9*	*8.8*

Percentiles for the 20 m shuttle run test (VO_2 max ml/kg/min) in girls

Percentiles															
Age	1	3	10	20	25	30	40	50	60	70	75	80	90	97	99
5.0	*44.5*	*45.1*	*46.3*	*46.8*	*47.0*	*47.2*	*47.7*	*48.2*	*48.6*	*48.9*	*49.1*	*49.5*	*50.2*	*51.3*	*52.1*
6.0	42.9	43.7	44.9	*45.6*	46.0	*46.3*	*46.8*	47.4	*47.9*	*48.4*	48.7	*49.1*	50.0	51.3	52.3
6.5	42.1	43.0	44.2	*45.1*	45.5	*45.8*	*46.4*	47.0	*47.6*	*48.2*	48.5	*49.0*	49.9	51.3	52.4
7.0	41.2	42.2	43.5	*44.5*	45.0	*45.3*	*46.0*	46.6	*47.3*	*48.0*	48.3	*48.8*	49.8	51.4	52.7
7.5	40.3	41.4	42.8	*43.9*	44.4	*44.8*	*45.5*	46.2	*47.0*	*47.7*	48.1	*48.7*	49.8	51.6	53.0
8.0	39.3	40.5	42.1	*43.2*	43.8	*44.2*	*45.0*	45.8	*46.6*	*47.5*	47.9	*48.5*	49.8	51.8	53.4
8.5	38.6	39.6	41.3	*42.6*	43.2	*43.6*	*44.5*	45.4	*46.3*	*47.2*	47.7	*48.4*	49.9	52.1	53.5
9.0	*38.4*	*39.2*	*41.0*	*42.4*	*43.0*	*43.5*	*44.4*	*45.3*	*46.2*	*47.2*	*47.7*	*48.4*	*49.9*	*51.9*	*53.0*
10.0	*37.9*	*38.4*	40.4	42.0	*42.6*	43.2	44.2	45.1	46.0	47.0	*47.6*	48.2	49.8	*51.6*	*52.1*
11.0	*35.6*	*36.2*	38.3	40.1	*40.8*	41.4	42.5	43.5	44.5	45.7	*46.4*	47.0	48.7	*50.8*	*51.4*
12.0	*33.3*	*34.0*	36.2	38.2	*38.9*	39.6	40.8	42.0	43.1	44.3	*45.0*	45.7	47.7	*49.9*	*50.6*
13.0	*31.2*	*31.9*	34.3	36.4	*37.2*	37.9	39.2	40.4	41.6	42.9	*43.7*	44.4	46.5	*48.9*	*49.6*
14.0	*29.2*	*29.9*	32.4	34.6	*35.4*	36.2	37.6	38.8	40.1	41.4	*42.2*	43.0	45.2	*47.7*	*48.4*
15.0	*27.3*	*28.0*	30.5	32.8	*33.7*	34.5	35.9	37.2	38.5	39.9	*40.8*	41.6	43.9	*46.4*	*47.1*
16.0	*25.1*	*25.9*	28.7	31.1	*32.0*	32.8	34.2	35.6	37.0	38.4	*39.3*	40.2	42.5	*45.3*	*46.1*
17.0	*23.0*	*23.9*	26.8	29.3	*30.2*	31.1	32.6	34.1	35.5	37.0	*37.9*	38.8	41.3	*44.1*	*44.9*
18.0	*20.9*	*21.8*	*24.9*	*27.5*	*28.5*	*29.4*	*31.0*	*32.6*	*34.0*	*35.6*	*36.5*	*37.4*	*40.1*	*42.9*	*43.7*

Percentiles for the 20 m shuttle run test (VO_2max ml/kg/min) in boys

Percentiles															
Age	1	3	10	20	25	30	40	50	60	70	75	80	90	97	99
5.0	*44.2*	*45.2*	*46.1*	*46.9*	*47.3*	*47.6*	*48.1*	*48.7*	*49.5*	*50.2*	*50.6*	*50.7*	*51.0*	*52.1*	*53.1*
6.0	42.8	43.8	45.1	*46.0*	46.5	*46.8*	*47.5*	48.1	*49.1*	*50.1*	50.6	*50.8*	51.2	52.7	53.9
6.5	42.1	43.1	44.6	*45.6*	46.1	*46.4*	*47.1*	47.8	*48.9*	*50.0*	50.6	*50.8*	51.3	53.0	54.3
7.0	41.3	42.4	44.0	*45.1*	45.6	*46.0*	*46.7*	47.5	*48.7*	*50.0*	50.6	*50.9*	51.4	53.3	54.7
7.5	40.4	41.7	43.4	*44.6*	45.2	*45.6*	*46.5*	47.3	*48.7*	*50.0*	50.7	*51.0*	51.5	53.6	55.2
8.0	39.5	40.9	42.7	*44.0*	44.7	*45.2*	*46.1*	47.0	*48.5*	*50.0*	50.8	*51.1*	51.7	54.0	55.6
8.5	39.1	40.0	42.0	*43.5*	44.2	*44.7*	*45.7*	46.7	*48.4*	*50.1*	50.9	*51.2*	51.9	54.5	55.5
9.0	*38.9*	*39.7*	*41.8*	*43.4*	*44.1*	*44.7*	*45.7*	*46.8*	*48.3*	*49.8*	*50.6*	*51.0*	*52.1*	*54.6*	*55.5*
10.0	*38.4*	*39.1*	41.3	43.2	*43.9*	44.6	45.8	46.9	48.0	49.2	*49.9*	50.6	52.5	*54.7*	*55.4*
11.0	*36.3*	*37.0*	39.5	41.7	*42.5*	43.2	44.6	45.8	47.0	48.4	*49.2*	49.9	52.1	*54.6*	*55.3*
12.0	*34.4*	*35.2*	38.0	40.5	*41.4*	42.3	43.8	45.2	46.7	48.2	*49.1*	50.0	52.4	*55.3*	*56.2*
13.0	*32.8*	*33.7*	36.9	39.7	*40.7*	41.7	43.4	45.0	46.6	48.3	*49.3*	50.3	53.1	*56.3*	*57.2*
14.0	*31.3*	*32.3*	35.8	38.8	*39.9*	41.0	42.9	44.6	46.4	48.3	*49.4*	50.5	53.5	*57.0*	*58.0*
15.0	*29.6*	*30.7*	34.5	37.8	*39.0*	40.1	42.1	44.0	45.9	47.9	*49.1*	50.2	53.4	*57.2*	*58.3*
16.0	*28.2*	*29.3*	33.2	36.6	*37.9*	39.1	41.3	43.2	45.2	47.3	*48.6*	49.8	53.3	*57.2*	*58.3*
17.0	*26.4*	*27.7*	32.0	35.6	*36.9*	38.2	40.5	42.6	44.7	46.9	*48.2*	49.5	53.2	*57.4*	*58.6*
18.0	*24.7*	*26.0*	*30.8*	*34.6*	*36.0*	*37.3*	*39.7*	*42.0*	*44.2*	*46.5*	*47.9*	*49.2*	*53.1*	*57.6*	*58.9*