Physical fitness and weight status of Grade One children in Cape Town, South Africa

VAN STRYP, O., Africa, E. & Duncan, M. J.

DOI 10.36386/sajrsper.v44i2.154
ISSN 0379-9069

Publisher: North-West University, Potchefstroom

South African Journal for Research in Sport, Physical Education and Recreation, 44(2): 81-90.
ISBN: 0379-9069

PHYSICAL FITNESS AND WEIGHT STATUS OF GRADE ONE CHILDREN IN CAPE TOWN, SOUTH AFRICA

Odelia VAN STRYP[1], Eileen AFRICA[1] and Michael J. DUNCAN[2]
[1] *Sport Science Department, Stellenbosch University, Rep. of South Africa*
[2] *School of Life Sciences, Coventry University, United Kingdom*

ABSTRACT

Physical fitness and weight in young children are important indicators of health status. Literature has shown that fatness and physical fitness are highly intertwined; considering the two together is important as they influence each other. The aim of this study was to investigate the physical fitness levels and weight status of Grade 1 children (N=184) from two schools in Cape Town, South Africa, as well as differences in physical fitness and weight between boys and girls. A quantitative study design was applied. Physical fitness skills were evaluated by measuring five components: cardiorespiratory fitness, muscular strength, agility, flexibility and coordination. Children's height and mass were measured to determine their Body Mass Index (BMI) and the International Obesity Task Force (IOTF) cut-offs were used to establish under- and overweight classifications of the children. Boys performed better than girls in the standing broad jump, shuttle run and throwing, whereas girls performed better in the flexibility test. Of the children, 84% were classified as normal weight, 11% were overweight and 5% were obese. The children in this study were relatively fit compared with children in other provinces in South Africa; however, their fitness levels can still be significantly improved.

Keywords: Physical fitness; Physically active; Weight; Body mass index.

INTRODUCTION

Children with high physical fitness levels are often in good health, whereas children with low physical fitness levels are at an increased risk of cardiovascular diseases and other co-morbidities (Jaakkola et al., 2015). Physical fitness can be defined as health-related fitness comprising cardiorespiratory and muscular endurance, muscular strength, body composition and flexibility, as well as skill-related fitness, which involves agility, balance, coordination, power, reaction time and speed. Health- and skill-related fitness play a major role in children's physical activity (PA) patterns (Ruiz et al., 2009) and therefore children's physical fitness levels can be a facilitator of PA engagement from childhood through adolescence into adulthood (Fernandez-Santos et al., 2016). According to Lopes et al. (2012), a high body mass index (BMI; overweight/obese) is potentially associated with low levels of motor competence and physical fitness. However, it is vital to keep in mind that physical fitness is also dependent on genetic, anatomical, physiological and environmental factors (Malina et al., 2004). Globally, children are viewed as the most active population; however, more children are presenting with low levels of PA and physical fitness, which can potentially lead to childhood obesity (Fang et al., 2017). According to the International PA Guidelines, children's physical fitness levels are deteriorating rapidly, and children do not meet the PA guidelines for good health. According

to the Healthy Active Kids South Africa (HAKSA) report card in 2016, only 50% of South African children met the PA recommendations, and areas of concern were high amounts of screen time and poor nutrition (Draper et al., 2019). Another concern indicated by the HAKSA report card was that children were undernourished and overweight/obese, and that the prevalence of overweight is increasing drastically.

It is extremely important for children to participate in an adequate amount of moderate to vigorous physical activity (MVPA) per day (McLellan et al., 2020). Regular participation in MVPA contributes to physical fitness, body composition and bone health, while also preventing excess adiposity (Fang et al., 2017). The HAKSA report card recommends that healthy lifestyles need to be established and that children should have safe environments in which to take part in PA (Draper et al., 2019). Malina et al. (2004) contend that childhood is a critical period for developing and promoting healthy behaviours associated with physical fitness and PA.

Around the world, the weight status of children is escalating, which may lead to numerous associated diseases such as hypertension, type 2 diabetes, high blood pressure and cardiovascular diseases (Negash et al., 2017; Klingberg et al., 2019; Rad et al., 2019). A recent survey across 195 countries concluded that roughly 107.7 million children were obese, and according to the Non-communicable Disease Risk Factor Collaboration, the prevalence of obesity between 1975 and 2016 increased from 0.7% to 5.6% among girls and from 0.9% to 7.8% among boys (Rad et al., 2019). In 2016, the South African Department of Health indicated that one in every four girls and one in every five boys between the ages of 2 and 14 years were either overweight or obese. According to Kirsten et al. (2013), South African studies tend to emphasise childhood undernutrition as a concern in the country, rather than other important factors such as physical fitness. Although slightly dated, the research by Kirsten et al. (2013) found that 9% of children aged between 6 and 13 years old in the Western Cape were overweight and 4% obese. The recent study of Mkhize and Sibanda (2020) concluded that many children in South Africa are undernourished due to the high poverty rate – in 2018 an estimated 59% of children lived below the poverty line.

Although studies performed in South Africa (North-West, Limpopo and Gauteng provinces) have investigated the physical fitness levels and weight status or BMI of children, the majority of these studies are relatively dated. Furthermore, to the knowledge of the researcher, only one similar study has been conducted in Cape Town (Western Cape Province), by Sloan (1966). No studies that similarly investigated physical fitness levels and weight status or BMI of children specifically in the Western Cape can be found, with only studies done in other regions or across South Africa available (Truter et al., 2010; Amusa et al., 2011; Armstrong et al., 2011; Du Toit et al., 2011). Sloan's study (1966) compared physical fitness test results of South African boys and girls with those of British and American children. More studies in this field, including studies that specifically focus on the Western Cape Province, are needed. This is necessary to gain a better understanding of South African children's physical fitness levels and weight status, in order to develop age- and sex-specific intervention programmes (Klingberg et al., 2019). The researchers conducted this study with the aim of gaining a better understanding of the physical fitness levels and weight status of children by collecting data and determining the physical fitness levels and weight status of Grade 1 children in Cape Town. A secondary aim was to determine whether there were any differences in physical fitness and weight status between boys and girls.

METHODS

Following approval from the Research Ethics Committee of the Institution involved (#8456) and the Western Cape Education Department, the researcher approached specific schools to request them to take part in the study. The regulations of the Helsinki declaration were followed. The Grade 1 classes from two schools in Cape Town (N=191; 106 boys, 85 girls, mean age 6.1 years) were a convenience sample and participated in the study voluntarily. A quantitative descriptive study design was used. Written consent from the parents and/or legal guardians and assent from the participants were obtained prior to participation. The participants were free from any neuromuscular disorders or special education needs that could impede movement. Participants were included in the study if they were in Grade 1 and attended the selected schools, they had signed the assent form, and their parents had completed the informed consent form. Participants were excluded if they had a hearing or sight impairment, were unwilling to participate in the measurements, had severe medical conditions, for example, a heart or ear defect, or if they were unable to run or jump.

The tests took place in each school's hall, where stations were allocated to the various physical fitness tests. The children's measurements were taken in a standardised order that included height, weight and the various physical fitness tests. Physical fitness levels were assessed using five valid and reliable tests as a modified European Physical Fitness Test Battery (EUROFIT; adapted from the original EUROFIT), and which have been widely employed in previous studies (Fernandez-Santos et al., 2016). They included the Leger test for cardiorespiratory fitness (endurance) (Ruiz et al., 2009); standing broad jump for muscular strength (explosiveness) (Ruiz et al., 2011); the 4- × 5-metre shuttle run for agility (speed) (Milosevic et al., 2015); the sit-and-reach test for flexibility (Milosevic et al., 2015); and throwing a ball for coordination (Fernandez-Santos et al., 2016). A clear demonstration of each test was given before a participant performed the assessment trials. The Leger test (20-metre shuttle run endurance test) was assessed at different stages and the total running time was added. For this test, learners received only one formal trial, which was conducted at the beginning of the day. The distance of the standing broad jump was measured in centimetres; participants received three trials and the best score was used. For the 4- × 5-metre shuttle run, the participants received one familiarisation trial and two formal trials. Their time was recorded in seconds and the best time was used. For the sit-and-reach test, participants sat with their backs against a wall, a bench (25 cm high and 60 cm long) was placed at their feet and they had to stretch forward, while their legs remained in a straight position. The metric scale was moved to the tip of their fingers. The maximum distance was measured, and participants performed two trials. The overhand throwing technique was used in the throwing test and each participant received three trials with both arms. These measurements were used in previous South African studies (Amusa et al., 2011; Armstrong et al., 2011; Monyeki et al., 2005).

Participants' anthropometric measurements were taken while children were barefooted and dressed in their physical education kit (t-shirt and shorts). Body mass (kg) and height (cm) were assessed before the physical fitness data collection started, using a calibrated Trystom (P375) scale (TPLZ1T46CLNDBI300; Co. TRYSTOM, spol. s. r.o./1993-2015 www.trystom.cz) and portable anthropometer (P375). The measurements were taken to the nearest 0.1 kg and cm.

Statistical analysis

Data were analysed using Excel (Microsoft) and Statistica version 13.5 (TIBCO Software Inc., Palo Alto, California, USA). The level of statistical significance was set at $p<0.05$. Differences in the various physical fitness test results between boys and girls were investigated using one-way analysis of variance (ANOVA). Normal probability plots were inspected to check for normality and in cases where it was suspected to be a problem non-parametric Mann-Whitney U tests were calculated. The latter results were mostly similar to the ANOVA F-test outcomes, and therefore, only the ANOVA results were reported. Levene's test was used to test for homogeneity of variance, which was, in all cases, not significant. The Cohen's D effect sizes were determined to see if there were any practical differences.

RESULTS

Table 1 presents the mean and standard deviation of the physical fitness test components.

Table 1. **MEANS AND STANDARD DEVIATIONS OF THE PHYSICAL FITNESS TESTS (BOYS AND GIRLS)**

Physical fitness tests	Mean	Standard deviation (SD)
Standing jump (cm)	112.46	18.81
Shuttle run (4 m × 5 m) (seconds)	14.04	1.17
Flexibility (sit-and-reach) (cm)	18.35	5.41
Throwing right arm (m)	11.23	5.04
Throwing left arm (m)	6.62	2.52
20m shuttle run endurance test (laps)	3.8	2.04

Table 2 depicts the differences between boys and girls for each physical fitness skill. An ANOVA test (F-test) was used to analyse the sex differences to determine statistically significant differences, and Cohen's D effect sizes were calculated.

Table 2. **SEX DIFFERENCES IN THE PHYSICAL FITNESS TEST RESULTS**

Physical fitness skills	Sex	Mean	SD	F-test (p value)	Cohen's D effect sizes
Standing broad jump (cm)	Boys Girls	115.71 108.25	17.55 19.64	p=0.04	0.40 (medium)
Shuttle run (4 m × 5 m) (seconds)	Boys Girls	13.86 14.28	1.23 1.07	p=0.03	0.36 (small)
Flexibility (sit-and-reach) (cm)	Boys Girls	17.67 19.35	5.74 4.89	p=0.03	0.31 (small)
Throwing: right arm (m)	Boys Girls	12.15 10.03	5.26 4.54	p=0.01	0.43 (medium)
Throwing: left arm (m)	Boys Girls	6.88 6.25	2.73 2.19	p=0.07	0.25 (small)
20-m shuttle run endurance (cardiorespiratory endurance: VO2 max)	Boys Girls	23.1 22.4	3.37 2.74	p=0.17	0.1 (negligible)

There was a statistically significant difference (p=0.04) for the standing broad jump, for which boys had a higher mean score compared with girls (115.71±17.55 m vs. 108.25±19.64 m). Boys achieved a higher mean score in throwing with the right arm compared with girls (12.15±5.26 m vs. 10.03±4.54 m; p=0.01). Boys also performed statistically significantly better in the 4 m × 5 m shuttle run compared with the girls (13.86±1.23 seconds vs. 14.28±1.07 seconds; p=0.03). Flexibility was the only skill for which girls performed better than boys, also demonstrating a statistically significant difference (p=0.03). The Cohen's D effect size showed a medium practical difference of 0.43 between boys and girls for throwing with the right arm. There were no differences between boys and girls for the 20-m shuttle run endurance test (cardiorespiratory endurance [VO2 max]).

Height and weight were measured to calculate BMI. Table 3 displays the mean height, weight and BMI for boys and girls.

***Table 3*. SEX DIFFERENCES FOR ANTHROPOMETRIC MEASUREMENTS**

Anthropometry measurements	Sex	M	SD	F-test (p value)	Cohen's D effect sizes
Height (cm)	Boys	119.99	6.13	p=0.11	0.24 (small)
	Girls	118.52	6.35		
Weight (kg)	Boys	23.30	5.30	p=0.06	0.21 (small)
	Girls	22.14	5.58		
BMI (kg/m^2)	Boys	16.00	2.48	p=0.06	0.2 (small)
	Girls	15.50	2.52		

There were no statistically significant differences in weight, height or BMI between the boys and girls. The International Obesity Task Force (IOTF) norms developed by Cole et al. (2000) were used to determine the proportion of normal weight, overweight and obese participants. According to these norms, 84.23% of participants (boys 45.65%; girls 38.58%) in the current study were of normal weight, 10.86% (boys 7.06%; girls 3.80%) were overweight and 4.89% (boys 3.26%; girls 1.63%) were obese.

DISCUSSION

Overall, the performance of the participants in the current study was 'average' in the physical fitness tests compared with norms of other countries. However, in the South African context, the participants performed 'well', and therefore, the researcher could speculate that the participants were relatively fit and had a normal weight status.

Compared with girls, the boys performed better overall in the physical fitness tests. According to the European norms of Tomkinson et al. (2017), the performance of South African children of this age cohort was poor to moderate, except in the sit-and-reach test. The differences between boys and girls may have been because of restrictions that are described in the Newell's constraints model, where one can be restricted due to a task or the environment. Therefore, when children take part in physical fitness skills their ability to perform the task can be

influenced by the environment, as well as the type of skill and complexity of the movements and the structural and functional nature of the child (Nazario et al., 2013).

The results are comparable to the findings of Monyeki et al. (2005), who assessed South African primary school children's body composition and physical fitness. The mean scores for the standing broad jump, shuttle run and flexibility were slightly higher in the current study than for the 7-year-olds in Monyeki's study, indicated that the participants in the current study had better physical fitness levels. Although the current study found differences between boys and girls for the standing broad jump and throw, the boys performed better in the shuttle run and girls performed better in flexibility. Monyeki found no statistically significant differences between boys and girls for these tests. Armstrong et al. (2011) investigated the physical fitness levels of 6- to 13-year-old South African children and focused on differences in various ethnic groups. The mean scores for Grade 1 children in the standing broad jump and flexibility tests were slightly higher than those of the current study. A possible reason for this is that children came from different socio-economic environments, and the type of activities they were exposed to daily may have been a contributing factor; however, this is speculation that could be investigated in the future (Armstrong et al., 2011). Another South African study conducted by Amusa et al. (2011) investigated the physical fitness levels of rural Grade 1 children. Amusa (2011) found that boys had a higher mean score for flexibility than girls; however, higher mean values for the standing broad jump and lower mean values for the flexibility test were found in the current study. The study of Sloan (1966) used the American Alliance for Health, Physical Education, and Recreation (AAHPER) physical fitness test and compared South African children with British and American children. The study concluded that the South African children were mostly taller and heavier, and most children were fitter than the British and American children. This is the only study that has been conducted in Cape Town and is very outdated. The above-mentioned studies (Monyeki et al., 2005; Amusa et al., 2011; Armstrong et al., 2011) are all South African studies, but were not conducted in Cape Town, and thus are not directly comparable with the current study as the provinces in South Africa differ in terms of population groups, socio-economic status and environmental factors. Our findings may indicate that the participants in the current study were fitter and stronger in muscular strength than children in other areas of South Africa.

Tomkinson et al. (2017) conducted the EUROFIT in over 30 countries and classified the mean fitness score for boys and girls (age 9 to 17 years) using a normative quantile-based framework (5th to 80th and above percentiles). The percentiles give an indication of the fitness levels of children. Table 4 shows comparable normative values for the standing broad jump, sit-and-reach and the 20-metre shuttle run, but not for the 4- × 5-metre shuttle run because Tomkinson used a 10- × 4-metre shuttle run and there were no norms for throwing.

When comparing the standing broad jump results of the 9-year-old learners of the current study, the boys and girls were placed between the 10th and 20th percentile, which is low. For the sit-and-reach assessment, the boys were on the 60th percentile and the girls between the 50th and 60th percentile, which is considered good. For the 20-metre shuttle run endurance test, the boys and girls were placed below the 5th percentile, which indicates that their levels of cardiorespiratory fitness were poor.

Table 4. **NORMATIVE PERCENTILES FOR PHYSICAL FITNESS SKILLS OF BOYS AND GIRLS**

Physical fitness skill	Boys' percentile	Girls' percentile
Standing broad jump	10th to 20th	10th to 20th
Sit-and-reach	60th	50th to 60th
20-m shuttle run (VO2 max, mL/kg/min)	5th	5th
20-m shuttle run (laps)	5th	5th

Therefore, it is suggested that children need to improve their aerobic endurance levels. The results show that according to international norms set by the World Health Organization (WHO), the population of the current study performed 'average' overall in the standing broad jump, although they performed 'well' in terms of South African studies (Monyeki et al., 2005; Amusa et al., 2011). According to the percentiles (Tomkinson et al., 2017), boys performed better in flexibility than girls and for the 20-metre shuttle run endurance test, boys and girls had very low scores. Overall, the performance of the participants in the current study was average, but in comparison with other South African studies, the participants performed quite well. The results indicate that Grade 1 children have potential to improve their physical fitness skills, especially cardiorespiratory endurance, and should be encouraged to be more physically active by adopting good PA behaviours. A potential way for children to intensify their PA levels at school would be to increase opportunities for PA during the school day. This could certainly be an avenue for future research. It is crucial that more studies are performed in South Africa to determine children's physical fitness levels, especially in different socio-economic environments and regions, and to have a better understanding of how physically fit South African children of all ages are.

The findings of the current study are in line with the outcomes of Kemp and Pienaar (2013), who conducted a study on Grade 1 learners in North West Province, South Africa. In the current study, participants had similar means for height, weight and BMI. Although Armstrong et al. (2011) compared ethnic groups, there are comparable results that are in line with the height and weight scores of the current study. Amusa et al. (2011) also found no difference between boys and girls in height and weight. Comparing the results of height, weight and BMI of the current study with the growth standards set by the WHO in 2007, the height of the boys and girls is on the 50th percentile, the weight of boys is between the 85th and 97th percentile and the weight of girls between the 50th and 85th percentile. Therefore, the participants' BMI and height were in line with their age according to the growth standards (Turck et al., 2013). Armstrong et al. (2011) investigated the physical fitness and anthropometry measurements of 6- to 13-year-old children in South Africa and found that 15.4% were overweight or obese, which corresponds to the findings of the current study. Another South African study conducted by Symington et al. (2016) explored the relationship between stunted and overweight children aged between 3 and 9 years in two provinces (Gauteng and Mpumalanga). Symington concluded that 12% of the children were overweight or obese. The growth standards percentiles of the children's

weight possibly indicate overweight or obesity and there may be multiple factors influencing this high prevalence, such as poor dietary habits and lifestyles, as well as physical inactivity. More studies are needed to establish the BMI of children and the contributing factors that lead to overweight or obesity, in order to prevent childhood obesity. This would greatly assist in the development of appropriate intervention programmes and the promotion of healthy lifestyles and being physically active.

Limitations

The sample size of the current study is a limitation because the results cannot be generalised as the sample is not representative of the South African population; therefore it is recommended that future studies include more participants. There was no control over the cause and effect of the results and no clarity on whether the weight of the children had an effect on their physical fitness. Furthermore, there was no concrete evidence that their lower physical fitness levels could lead to overweight and obesity.

Recommendations

More research in this field is imperative. The study only explored the results of Grade 1 children, and therefore it is recommended that children in other grades are also studied. Children should be encouraged specifically to focus more on aerobic endurance and lower body muscular power.

CONCLUSIONS

To conclude, in this study boys exhibited better physical fitness than girls, especially in the standing broad jump, shuttle run and throwing tests. However, girls performed better than boys in flexibility. With reference to the South African context, the population under study demonstrated higher physical fitness levels compared with previous South African studies, but compared with international norms, their physical fitness levels were low. Therefore, it is recommended that children of this age cohort should specifically focus on aerobic endurance as well as lower body muscular power. Boys need to focus on flexibility and girls on muscular strength, agility and coordination skills. To improve these children's physical fitness levels, it is recommended that they should be more physically active during the day, to enhance their physical fitness levels. These results can be used to encourage schools to create more awareness through their curriculum that children should be physically active during the day, as well as to motivate them. Being more active could potentially assist children in their physical fitness. In terms of weight status, according to the growth percentile charts, the participants had normal weight status but a slight tendency towards being overweight was seen. This study offers updated and relevant data for Cape Town and has practical applications for teachers, parents and therapists. The data presented in the current study demonstrate the physical fitness profile of children from a specific age cohort in Cape Town; this can be used as a reference point to target future interventions to enhance the fitness and health of children in Cape Town, Western Cape.

Conflict of interest

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

No funding was applicable to this study. The study underwent all the necessary ethical approvals, as well as consent and assent.

Acknowledgments

The authors would like to express their gratitude to the Grade 1 learners who participated in the study; without the children this study would not have been possible. The assistants with the data collection are also thanked.

REFERENCES

AMUSA, L.O.; GOON, D.T.; AMEY, A.K. & TORIOLA, A.L. (2011). Health-related physical fitness among young rural primary school children in Tshannda, South Africa. *Science Research Essays*, 6(22): 4665-4680. doi.10.5897/SRE10.522

ARMSTRONG, M.E.G.; LAMBERT, E.V. & LAMBERT, M.I. (2011). Physical fitness of South African primary school children, 6 to 13 years of age: Discovery Vitality health of Nation study. *Perceptual Motor Skills*, 113(3): 999-1016. doi: 10.2466/06.10.13.PMS.113.6.999-1016

COLE, T.J.; BELLIZZI, M.C.; FLEGAL, K.M. & DIETZ, W.H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal*, 320: 1240-1246. doi: 10.1136/bmj.320.7244.1240

DU TOIT, D.; PIENAAR, A.E. & TRUTER, L. (2011). Relationship between physical fitness and academic performance in South African children. *South African Journal for Research in Sport, Physical Education and Recreation*, 33(3): 23-35. doi: 10520/EJC108966

DRAPER, C.E.; TOMAZ, S.A.; BASSETT, S.H.; HARBRON, J.; KRUGER, H.S.; MICKLESFIELD, L.K.; MONYEKI, A. & LAMBERT, E.V. (2019). Results from the Healthy Active Kids South Africa 2018 Report Card. *South Africa Journal of Child Health,* 13(3):130-136. doi: 10520/EJC-18aafc6eeb

FANG, H.; QUAN, M.; ZHOU, T.; SUN, S.; ZHANG, J.; ZHANG, H.; CAO, Z .; ZHAO, G .; WANG, R.; CHEN, P. (2017). Relationship between Physical Activity and Physical Fitness in Preschool Children: A Cross-Sectional Study. *BioMedical Research International*, 1-8.

FERNANDEZ-SANTOS, J.R.; RUIZ, J.R., GONZALEZ-MONTESINOS, J.L. & CASTRO-PINEOR, J. (2016). Reliability and Validity of Field-Based Tests to Assess Upper-Body Muscular Strength in Children aged 6-12 Years. *Pediatric Exercise Science*, 28(2): 331-340.

JAAKKOLA, T.; YLI-PIIPARI, S.; HUOTARI, P.; WATT, A. & LIUKKONEN, J. (2015). Fundamental movement skills and physical fitness as predictors of physical activity: A 6-year follow-up study. *Scandinavian Journal of Medicine, Science and Sports,*1-8. doi: 10.1111/sms.12407

KEMP, C. & PIENAAR, A.E. (2013). Relationship between the body composition and motor and physical competence of Grade 1 learners in South Africa. *Journal of Sports Medicine and Physical Fitness*, 53(6): 635-643.

KLINGBERG, S.; DRAPER, C.E.; MICKLESFIELD, L.K.; BENJAMIN-NEELON, S.E. & Van SLUIJS, E.M.F. (2019). Childhood Obesity Prevention in Africa: A Systematic Review of Intervention Effectiveness and Implementation. *International Journal of Environmental Research and Public Health*, 16: 1212-1230. doi: 10.3390/ijerph16071212

KIRSTEN, A.P.; MARAIS, D. & SCHUBL, C. (2013). The influence of socio-demographic factors on the nutritional status of children in the Stellenbosch area, Western Cape. *South African Journal of Clinical Nutrition*, 26(3): 124-131. doi: 10.1080/16070658.2013.11734456

LOPES, V.P.; MAIA, J.A.R.; RODRIGUES, L.P. & MALINA, R. (2012). Motor coordination, physical activity and fitness as predictors of longitudinal change in adiposity during childhood. *European Journal of Sport Science*, 12(4): 384-391. doi: 10.1080/17461391.2011.566368

MALINA, R.; BOUCHARD C. & BAR-OR O. (2004). Growth, Maturation and Physical Activity. Champaign, IL, USA: Human Kinetics.

MCLELLAN, G.; ARTHUR, R.; DONNELLY, S. & BUCHAN, D.S. (2020). Segmented sedentary time and physical activity patterns throughout the week from wrist-worn ActiGraph GT3X accelerometers among children 7-12 years old. *Journal of Sport and Health Sciences*, 9: 179-188. doi: 10.1016/j.jshs.2019.02.005

MILOSEVIC, V. & PETROVIC, A. (2015). Reliability of field-based tests for monitoring and assessing physical fitness in preschool children. *Serbian Journal of Sports Sciences*, 9(1): 20-26.

MKHIZE, M. & SIBANDA, M. (2020). A review of selected studies on the factors associated with the nutrition status of children under the age of five years in South Africa. *International Journal of Environmental Research and Public Health,* 17: 1-26. doi: 10.3390/ijerph17217973

MONYEKI, M.A.; KOPPES, L.L.J.; KEMPER, H.C.G.; MONYEKI, K.D.; TORIOLA, A.L.; PIENAAR, A.E. & TWISK, J.W.R. (2005). Body composition and physical fitness of undernourished South African rural primary school children. *European Journal of Clinical Nutrition*, 59: 877-883.

NAZARIO, P.F. & VIEIRA, J.L.P. (2013). Sport context and the motor development of children. *Revista Brasileira de Crescimento e Desenvolvimento Humano*, 1-10. doi: 10.5007/1980-0037.2014v16n1p86

NEGASH, S.; AGYEMANG, C.; MATSHA, T.E.; PEER, N.; ERASMUS, R.T. & KENGNE, A.P. (2017). Differential prevalence and associations of overweight and obesity by gender and population group among school learners in South Africa: A cross-sectional study. *BMC Obesity*, 4: 29-37. doi: 10.1186/s40608-017-0165-1

RAD, S.A.; MOKHTAR, N. & KIWANUKA, F. (2019). Effect of a Four Weeks Aerobic Training Intervention on Body Fat Percentage and Physical Fitness Indices among 5- to 6-year-old Obese, Overweight and Normal Weight Children: A Quasi-experimental Study. *International Journal of Kinesiology & Sports Science*, 7(1): 12-17. doi: 10.7575/aiac.ijkss.v.7n.1p.12

RUIZ, J.R., SILVA, G., OLIVEIRA, N., RIBEIRO, J.C., OLIVEIRA, J.F. & MOTA, J. (2009). Criterion-related validity of the 20-m shuttle run test in youths aged 13-19 years. *Journal of Sports Science*, 27(9): 899-906. doi: 10.1080/02640410902902835

RUIZ, J.R.; CASTO-PINERO, J.; ESPANA-ROMERO, V.; ARTERO, E.G.; ORTEGA, F.B.; CUENCA, M.M.; JIMENEZ-PAVÓN, D.; CHILLÓN, P.; GIRELA-REJÓN, M.J.; MORA, J.; GUTIÉRREZ, A.; SUNI, J.; SJÖSTRÖM, M.; CASTILLO, M.J. (2011). Field-based fitness assessment in young people: The ALPHA health-related fitness test battery for children and adolescents. *British Journal of Sports Medicine*, 45: 518-524.

SLOAN, A.W. (1966). Physical fitness of South African compared with British and American High school children. *South African Journal of Medicine,* 53: 688-690.

SYMINGTON, E.A.; GERICKE, G.J.; NEL, J.H.; & LABADARIOS, D. (2016). The relationship between stunting and overweight among children from South Africa: Secondary analysis of the National Food Consumption Survey-Fortification Baseline I. *South African Medical Journal*, 106(1): 65-69. doi: 10520/EJC182763

TURCK, D.; MICHAELSEN, K.F.; SHAMIR, R.; BRAEGGER, C.; CAMPOY, C.; COLOMB, V.; DECSI, T.; DOMELLÖF, M.; FEWTRELL, M.; KOLACEK, S.; MIHATSCH, W.; MORENO, L.A.; VAN GOUDOEVER, J. (2013). World Health Organization 2006 Child Growth Standards and 2007 Growth Reference Charts: A Discussion Paper by the Committee on Nutrition of the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition. *Journal of Pediatric Gastroenterology and Nutrition,* 57(2): 258-264. doi: 10.1097/MPG.0b013e318298003f

TRUTER, L.; PIENAAR, A.E. & DU TOIT, D. (2010). Relationships between overweight, obesity and physical fitness of nine- to twelve-year-old South African children. *South African Family Practice,* 52(3): 227-233. doi: 10.1080/20786204.2010.10873979

TOMKINSON, G.R.; LANG, J.J.; TREMBLAY, M.S.; DALE, M.; LEBLANC, A.G.; BELANGER, K.; ORTEGA, F.B.; LEGER, L. (2017). International normative 20 m shuttle run values from 1 142 026 children and youth representing 50 countries. *British Journal of Sports Medicine,* 51: 1545-1554. doi: 10.1136/bjsports-2016-095987

Corresponding author: Dr O Van Stryp; **Email:** odeliavs@sun.ac.za

(Subject Editor: Prof Andries Monyeki)