Three-year changes in social correlates of physical activity, physical activity and health - related fitness among adolescents: the PAHL study

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Dedication

"This thesis is dedicated to the memory of my father, ***Mamolepo Wilson Mohlala****. I miss you every day. It breaks my heart that you could not see this process through to its completion. Your spiritual support and plenty of encouragement have made my heart warm throughout this long haul."*

Declaration

Professor MA Monyeki (promoter and co-author) and Professor GL Strydom hereby give permission to the candidate, Miss M Mohlala to include their articles as part of a doctoral thesis. The contribution of each co-author, both supervisory and supportive was kept within reasonable limits and included:

Ms M Mohlala:	Developing the proposal, writing the manuscripts, sorting of the data from the PAHL study, interpretation of the results and compilation of the thesis.
Prof MA Monyeki:	Principal investigator of the PAHL Study. Coordinated the study, providing guidance on statistical analyses and interpretation of results, reviewing the manuscript and comments on the thesis.
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Abstract

Background: Physical inactivity has been ranked the fourth leading risk factor for global mortality. Despite the health risks, physical inactivity is common. Studies to identify the correlates of physical activity to inform the design of interventions and to reduce the disease burden associated with physical inactivity, have become a public health imperative. Research evidence has been consistent in substantiating social support as significant indicators of children and adolescents' participation in physical activity (PA). The understanding of the associated social correlates of physical activity can be significantly enhanced by being examined in a longitudinal study, because physical activity behaviour is assumed to track over time. The objective of the study therefore, was to investigate the changes in social correlates of physical activity, physical activity and health-related fitness in a three-year follow-up study among learners in high schools in the Tlokwe local municipality, South Africa.

Methods: Data from a total of 206 (where boys: 73 and girls: 133) in 2012, 160 (where boys: 62 and girls: 98) in 2013 and 138 (where boys: 87 and girls: 51) in 2014 at the three measurements of 2012 to 2014 in the Physical Activity and Health Longitudinal Study (PAHLS) were used. The participants who were aged 14 years and in grade 8 were purposefully selected from class lists provided so that they could be successfully followed for the duration of the 5 year PAHL study before completing high school at the age of 18 years. The International Physical Activity Questionnaire-Short Form (IPAQ-SF) was used to determine the levels of physical activity. The cardiorespiratory endurance, muscle strength and endurance, and flexibility tests were conducted according to the standard procedures of the EUROFIT. Anthropometric measurements of height, weight, skinfold thickness and waist circumferences were determined using the standard procedures described by the International Society for the Advancement of Kinanthropometry (ISAK). Waist-to-height ratio (WHtR), body mass index (BMI) and percentage body fat (%BF) were calculated. A standardised questionnaire on the 'Social Support for Physical Activity' was used to gather information on social correlates for physical activity. Descriptive statistics including frequency, percentage, mean and standard deviations were used to explore the data. For comparing the continuous and categorical data *t*-test and chi-square were used. Non-parametric repeated-measures ANOVA with the Friedman test was used to assess changes in the correlates between

test measurement number one (T1), test measurement number two (T2) and test measurement number three (T3). Since the statistical significant found with Friedman test does not pinpoint which groups in particular differ from each other, post-hoc analyses with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied for multiple comparison, which makes it more likely to declare a results significant when there was no Type I error. To comply with the rules of Bonferroni test, we divided the p-value of 0.05 by the number of the tests (i.e. 0.05/3=0.017). As such, the new significant level used in this test was 0.017; and that means that if the p-value was larger than 0.017, we do not have a statistical significant result. Effect sizes (partial *E*ta squared (η_p^2) were used to assess the magnitude of these changes. Tracking (stability) was assessed using Spearman correlation coefficient. Attrition analysis was performed using independent sample *t*-test and chi-square of proportions to determine the difference in baseline characteristics between participants and drop-outs (n=49; 20%). No significant difference was observed between the dropouts and the actual data used in this thesis. Kolmogorov-Smirnov tests for normality was used to check if the data was normally distributed. Chi-square was calculated to determine the differences between variables. Age-adjusted Pearson correlation analysis was performed to study the development of social correlates of physical activity, physical activity and physical activity in relation with health-related fitness. Linear regression analysis with adjusted age and maturation was performed to study the relationship of changes in social correlates of physical activity, physical activity, and physical activity in relation with health-related fitness. All analyses were performed by making use of the SPSS version 21.0 (IBM SPSS Inc., Chicago III 2013) statistical programme.

Results: There were significant statistical ($p<0.05$) changes and a high correlation coefficient (ranged from r=0.to 90 r=0.97) as well as large practical developmental changes ($d\geq0.8$) (partial *Eta Square* (ηp^2))) in BMI, %BF and WHtR over a three year period. Small practical but insignificant statistical ($p>0.05$) changes in social correlates (encouragement, coactivity, transportation) were found. A significant change (p=0.04) for someone who watched you participate in PA or sport among girls, was revealed. There was strong significant differences ($p<0.001$) in mean standing broad jump (SBJ), sit-up (SUP) and sit-and-reach (SAR), stature and body mass (p=0.002) and BMI among the boys and girls. The results show an increase in stature, body mass and BMI for the entire sample. The SBJ, sit-up and sit-and-reach seemed to decrease through the three measurement points. The boys had higher body mass as compared to the girls, while the girls had higher BMI. There was a statistically significant differences in body mass (X^2(df=2) = 10.354, p=0.006) and BMI (X^2(*df*=2) = 11.400) over a period of three years. Post hoc

signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a statistical significant level set at p<0.017. There was no significant differences between BMI T1 (*Z* = -2.240, *p*=0.025) and BMI T2 or between the BMI T1 and BMI T3 (*Z*= -2.313, *p*=0.021) measurements, despite an overall decrease in the BMI measurements. However, there was a statistical decrease in BMI measured at time point 1 (T2) and BMI at measurement point 2 (T3) (*Z*= -3.034, *p*=0.002). The partial Eta square of the effect size was moderate (*d*=0.66) for SJB, small (*d*=0.36) and (*d*=0.29) for SUP and SAR respectively. Furthermore, the results revealed a significant high correlation between body mass and stature, and a moderate correlation between stature and body mass. There was also an insignificant correlation between stature and BMI (r = -0.04; p = 0.64) and (r = -0.07; p = 0.40). While the SUP, SBJ and SAR showed a significantly weak correlation with the body mass. The girls showed a significant moderate correlation between stature and SUP in T3 (r = 0.50; p = 0.00). The results also showed significant changes for vigorous and moderate exercise and minutes spend watching TV/Sitting (p<0.001) for the period of measurement. The practical effect size **(η_p^2)** of the changes was medium for vigorous activity minutes per week (*d*=0.11), medium for moderate activity minutes per week (*d*=0.07) and moderate for minutes spend watching TV/Sitting (*d*=0.61). The practical effect size of the changes was relatively small ($d \leq 0.2$) for all the variables. The results also revealed a significant relation for the questions "*has someone done a physical activity or played sports with you?"* (p<0.001), *"has someone provided transportation to a place where you can do physical activities or play sports?"*(p= 0.03) and "*has someone watched you participate in physical activities or sports?"*(p= 0.01). There were high mean values in social correlates and physical activity for the boys as compared to the girls. There was a significantly high association between *"During a typical week has someone told you that you are doing well in physical activity?"* and vigorous physical activity (r = 0.61; p = 0.03) per week. There was no statistical significance between measurement point 1 vs measurement 2 (Z=-0.929, p=0.353) and measurement points 3 and 4 (Z= -1.152, p=0.249), respectively. When ANOVA for repeated measure with Friedman test, statistical significant (p=0.017) was found for the physical activity measure of vigorous (X^2(*df*=2)=11.382, p=0.003), moderate physical activity (X^2 (*df*=2)=13.446, p=0.001) minutes spent watching TV/sitting (X^2 (*df*=2)=29.531, p=0.000) and total physical activity (X^2 (*df*=2)=29.531, p=0.000). Though no statistical significant differences (p>0.017) in TPA in all the three measurement points (T 1 vs T2, Z= -2.071, p=0.038; T2 vs T3, Z= -0.088, p=0.930 & T1 vs T3, Z= -2.367, p=0.018), total physical activity declined over a period of time. When a post-hoc followed was performed, the median (IQR) for *"During a typical week has someone watched you participate in physical activities of sports?"*, for measurement at points 2

and 3 was Z=-2.909, p=0.004. There was no statistical significance between measurement point 1 vs measurement 2 (Z= -0.929, p=0.353) and measurement points 3 and 4 (Z= -1.152, p=0.249), respectively. The results also showed a significant association between moderate physical activity and minutes spent watching TV or sitting (r = 0.67; p = 0.01) per week. A moderate significant positive correlation coefficients were observed respectively for SBJ (r = 0.31; p = 0.01) and SUP T2 (r = 0.32; p = 0.01), and total physical activity (TPA 2013). Significant positive moderate correlation coefficient was found between SUP T2 (r = 0.49; p = 0.001), and SUP T3 (r = 0.37; p = 0.05) and TPA 2013 respectively for the boys.

Conclusions: There were high correlation coefficients for the developmental changes in body mass, stature, BMI, %BF and WHtR over a period of time. The adolescents did not receive any transportation support over time. Adolescents were motivated by being watched by others for participation in physical activity. There is significant gender difference in SBJ, SUP, SAR, stature, body mass and BMI. There were some developmental changes in the health-related fitness variables and the effect size was medium for SBJ and small for SUP and SAR. The girls received less social support as compared to the boys. The girls participated less in physical activity as compared to the boys. The girls spent more minutes watching TV/Sitting in 2012 and 2014 as compared to the boys. The study also revealed that the children participated in vigorous physical activity when friends and family or someone told them that they were doing well in physical activity and sport. Explosive strength was significantly correlated with physical activity, while functional strength test was associated with physical activity in boys over a period of time.

Key words: Correlates, changes, physical activity, tracking, coactivity, modelling, health-related physical fitness, adolescents, tracing

Opsomming

Agtergrond: Fisieke onaktiwiteit word as die vierde belangrikste oorsaak vir mortaliteit, wêreldwyd bestempel. Desondanks die gesondheidsrisiko, bly fisieke onaktiwiteit steeds 'n algemene verskynsel. Studies om die konstrukte van fisieke aktiwiteit te identifiseer en te ondersoek, ten einde die gesondheidsbedreiging te bekamp, bly derhalwe 'n belangrike prioriteit. Navorsing dui ook gereeld aan dat die sosiale ondersteuning van kinders en adolessente, betekenisvolle aanduiders is van deelname aan fisieke aktiwiteit. Kennis van die sosiale konstrukte asook ander faktore, kan betekenisvol bydrae in 'n longitudinale studie, aangesien fisieke aktiwiteitgedrag oorgedra word oor tyd. Die doel van die studie was derhalwe om die veranderinge in sosiale konstrukte van fisieke aktiwiteit, fisieke aktiwiteit en gesondheidsverwante fiksheid oor 'n drie-jaar opvolgstudie by leerders in hoërskole in die Tlokwe plaaslike munisipaliteit, te ondersoek.

Metode: Inligting van 206 (seuns =73 en dogters=133) in 2012, 106 (waar seuns = 62 en dogters = 98) in 2013 en 138 (waar seuns = 87 en dogters = 51) in 2014 is oor 3 meettydperk in 2012 tot 2014 vir die *"Physical Activity and Health Longitudinal study (PAHLS)"* gebruik. Die deelnemers wat 14 jaar oud en in graad 8 was, is doelbewus gekies uit klaslyste, sodat hulle suksesvol gevolg kon word vir die duur van die 5 jaar PAHL-studie voordat hulle op die ouderdom van 18 jaar hoërskool voltooi het. Die *"International Physical Activity Questionnaire"* (IPAQ-SF) is gebruik om die aktiwiteitsvlakke te bepaal. Die kardiorespiratoriese uithouvermoë, spierkrag, spieruithou-vermoë en soepelheid is bepaal deur die prosedeer soos voorgestel deur EUROFIT te gebruik. Antropometriese metings soos lengte, gewig, velvoue en middelomtrekke is bepaal soos voorgestel deur die Internasionale Vereniging vir die Bevordering van Kinantropometrie (ISAK). Middelomtrek – tot- lengte ratio liggaamsmassa-indeks (LMI) en persentasie liggaamsvet (% vet) is ook bereken. 'n Gestandaardiseerde vraelys vir *"Social Support for Physical Activity"* is gebruik om inligting rakend die sosiale konstrukte in te samel. Beskrywende statistieke, insluitende frekwensie, persentasie, gemiddeldes en standaard afwykings is in die ontleding van die data gebruik. Om die opeenvolgende en kategoriese data te ontleed is die t-toets en die Chi-kwadraat gebruik. Vir die nie-parametriese, herhaalde metings (ANOVA) is die Friedman-toets gebruik om die veranderinge in die konstrukte in toets een (T1), toets twee (T2) en toets 3 (T3) te bepaal. Aangesien die statistiese betekenisvolle bevinding met Friedman-toets nie bepaal watter groepe in

die besonder van mekaar verskil nie, is na-hoc-ontledings met Wilcoxon onderteken-rang toetse uitgevoer met 'n Bonferroni-regstelling wat toegepas word vir veelvuldige vergelyking, wat dit meer geneig is om resultate te verklaar betekenisvol wanneer daar geen tipe I-fout was nie. Om te voldoen aan die reëls van Bonferroni toets, het ons die p-waarde van 0.05 verdeel deur die aantal toetse (dws 0.05 / 3 = 0.017). As sodanig was die nuwe beduidende vlak wat in hierdie toets gebruik is 0,017; en dit beteken dat as die p-waarde groter was as 0,017, het ons nie 'n statisties betekenisvolle resultaat nie. Effek groottes (gedeeltelike *Eta* kwadraat (η_p^2) is gebruik om die omvang van die veranderinge te bepaal. Oordraging (stabiliteit) is bepaal deur van die Spearman korrelasie koëffisiënt gebruik te maak. Die uitvalsontleding is bepaal deur die onafhanklike t-toets en Chi-kwadraat van die proporsies, ten einde die verskil in basislyn-eienskappe tussen die aktiewe deelnemers en uitvallers (n= 49; 20%) te bepaal. Geen beduidende verskille is waargeneem tussen die uitvallers (drop-outs) en die werklike data wat in hierdie proefskrif gebruik is nie. Kolmogorov-Smirnov toets vir normaliteit van data -verspreiding is gebruik. Chi-kwadraat is gebruik om die verskille tussen die veranderlikes te bepaal. Ouderdoms–aangepaste Pearson korrelasie is gedoen om die ontwikkeling van die sosiale konstrukte van fisieke aktiwiteit, fisieke aktiwiteit en fisieke aktiwiteit en gesondheidsverwante fiksheid te bepaal. Liniêre regressie-ontledings met aanpassings vir ouderdom en veroudering is gebruik om die verband tussen veranderinge in sosiale konstrukte van fisieke aktiwiteit, fisieke aktiwiteit, fisiele aktiwiteit en gesondheidsverwante fiksheid na te gaan. Alle ontledings is gedoen met behulp van die SPSS version 21.0 (1BM SPSS Inc Chicargo 111 2013) statistiese program.

Resultate: Statisties betekenisvolle ($p<0.05$) veranderinge, met hoë korrelasie koëffisiënt (tussen r= 0.90; r = 0.97) asook groot gedeeltelik *Eta* van die effek groottes in LMI, % liggaamsvet en middel-tot-lengte ratio is oor die drie jaar periode gevind met klein dog nie-betekenisvolle ($p>0.05$) veranderinge in sosiale konstrukte (bemoediging, mede-aktiwiteit, vervoer). ’n Betekenisvolle verandering ($p=0.04$) is by dogters gevind rakende “iemand wat jou dophou terwyl jy fisieke aktiwiteit of sport doen”. Daar was ook by seuns betekenisvolle verskil in die gemiddelde standverspring, opsitte, sit-en-reik, lengte en liggaamsmassa ($p=0.002$) en LMI by seuns en dogters. Resultate toon ’n toename in lengte, liggaamsmassa en LMI vir die totale groep. Die standverspring, opsitte en sit-en-reik blyk af te neem in die drie metings oor tyd. Die seuns het ’n hoër liggaamsmassa getoon in vergelyking met die dogters, terwyl die dogters ’n hoër LMI vertoon het. Daar was 'n statisties beduidende verskil in liggaamsmassa (X^2 (df = 2) = 10.354, p = 0.006) en BMI (X^2 (df = 2) = 11.400) oor 'n tydperk van drie jaar. Post-hoc onderteken-rang ontledings met Wilcoxon onderteken-rang toetse is uitgevoer met Bonferroni korreksie toegepas, wat lei tot

'n statisties beduidende vlak gestel op p <0,017. Daar was geen beduidende verskille tussen BMI T1 (Z = -2.240, p = 0.025) en BMI T2 of tussen BMI T1 en BMI T3 (Z = -2.313, p = 0.021), ondanks 'n algehele afname in BMI-metings. Daar was egter 'n statistiese afname in BMI gemeet op tydpunt 1 (T2) en BMI by meetpunt 2 (T3) (Z = -3.034, p = 0.002). Die gedeeltelike Eta-kwadraat van die effek grootte was van medium grootte (0.5-0.8) vir standverspring en klein (0.12-0.8 vir opsitte en sit-en-reik. Die resultate het verdere ook ‘n hoë korrelasie tussen massa en lengte getoon met ’n matige korrelasie tussen lengte en massa. Daar was verder ook ’n nie- betekenisvolle korrelasie tussen lengte en LMI (r = -0.04; p = 0.64) en (r = -0.07; p = 0.40). Die opsitte, standverspring en sit-en-reik het betekenisvolle swak korrelasies met liggaamsmassa vertoon. Die dogters het ’n matige betekenisvolle korrelasie met opsitte in T3 (r = 0.50; p = 0.00) getoon. Verder het betekenisvolle veranderinge vir strawwe en matige aktiwiteit en minute TV kyk of sit (p<0.001) oor tyd voorgekom. Die gedeeltelike *Eta*-kwadraat van effekgrootte van die veranderinge was medium vir inspannende aktiwiteite in minute per week (0.11) en medium vir matige aktiwiteit in minute per week (0.07) en groot vir minute gespandeer vir TV kyk en sit (0.61). Die *Eta*-kwadraat van die effekgrootte van veranderinge was klein (<0.02) vir al die veranderinge. Die resultate toon egter ’n betekenisvolle verband met die vraag.” Het iemand saam met jou fisieke aktiwiteit of sport beoefen (p<0.001)”. Het iemand vervoer verskaf na plekke waar jy fisieke aktiwiteit of sport kon doen (p=0.03) en “ Het iemand jou dop gehou terwyl jy fisiek aktiwiteit of sport beoefen het (p=0.01)”. Hoë gemiddelde waardes vir sosiale konstrukte en fisieke aktiwiteit het by seuns en dogters voorgekom. Daar het ook ’n betekenisvolle hoër verband tussen die vraag “Gedurende ’n tipiese week het iemand vir jou gesê jy doen goed in fisieke aktiwiteit” en matige aktiwiteit in minute per week (r = 0.61; p = 0.03) voorgekom. Daar was geen statistiese betekenisvol tussen meetpunt 1 teenoor meting 2 (Z = -0.929, p = 0.353) en meetpunte 3 en 4 (Z = -1.152, p = 0.249) onderskeidelik. Wanneer ANOVA vir herhaalde meting van Friedman-toets, is statistiese betekenisvolle (p = 0.017) gevind vir die fisiese aktiwiteitsmetode van kragtige (X^2 (*df* = 2) = 11.382, p = 0.003), matige fisiese aktiwiteit (X^2 (*df* = 2) = 13.446, p = 0.001) minute bestee aan TV / sit (X^2 (*df* = 2) = 29.531, p = 0.000) en totale fisiese aktiwiteit (X^2 (*df* = 2) = 29.531, p = 0.000). Alhoewel geen statistiese beduidende verskille (p>0,017) in TPA in al drie die meetpunte (T1 vs T2, Z = -2.071, p = 0.038, T2 teenoor T3, Z = -0.088, p = 0.930 en T1 teenoor T3, Z = -2.367, p = 0.018), het die totale fisiese aktiwiteit oor 'n tydperk gedaal. Toe 'n post-hoc gevolg is, het die mediaan (IQR) vir "tydens 'n tipiese week iemand gekyk hoe jy aan fisiese sportaktiwiteite deelgeneem het?", Vir meting by punte 2 en 3 was Z = -2.909, p = 0.004. Daar was geen statistiese betekenisvol tussen meetpunt 1 teenoor meting 2 (Z = -0.929, p = 0.353) en meetpunte 3 en 4 (Z = -1.152, p = 0.249) onderskeidelik. Resultate toon ook ’n betekenisvolle verband tussen matige

fisieke aktiwiteit en minute van TV kyk of sit (r = 0.677; p = 0.016) per week. 'n Matige beduidende positiewe korrelasie koëffisiënt is onderskeidelik waargeneem tussen standverspringe (SBJT2) (r = 0.31; p = 0.01) en op sitte (SUPT2) (r = 0.32; p = 0.01), en totale fisieke aktiwiteit (TPA2013). Betekenisvolle positiewe matige korrelasie koëffisiënte is tussen SUPT2 (r = 0.49; p = 0.001), en SUPT3 (r = 0.37; p = 0.05) en TPA2013 is onderskeidelik by die seuns.

Gevolgtrekking: Hoë korrelasie koëffisiënte vir ontwikkelings-veranderinge in liggaams-massa, lengte LMI, % liggaamsvet en middel-tot-lengte ratio het oor tyd voorgekom. Die adolessente het nie enige hulp met betrekking tot vervoer oor tyd ontvang nie, dog hulle is bemoedig deur ander wat hulle dop hou tydens deelname aan sport en fisiek aktiwiteit. Daar bestaan betekenisvolle geslagsverskille in standverspring, opsitte en sit-en-reik. Die dogters ontvang minder sosiale ondersteuning in vergelyking met seuns en toon ook ’n laer deelname aan fisieke aktiwiteit. Dogters spandeer meer minute om TV te kyk en te sit (2012 & 2014). Die studie toon ook aan dat kinders geneig is om meer aan inspannende aktiwiteit deel te neem indien vriende en familie hulle aanmoedig en sê dat hulle goed doen in fisieke aktiwiteit en sport. Eksplosiewe krag het betekenisvol gekorreleer met fisieke aktiwiteit, terwyl funksionele krag geassosieer word met fisieke aktiwiteit by seuns oor 'n tydperk van tyd.

Sleutelterme: Konstrukte, veranderinge, fisieke aktiwiteit, oordraging, mede-aktiwiteit, modelleer, gesondheidsverwante fisieke fiksheid, adolessente, opsporing.

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Article submitted for publication in the *Journal of Physical Activity and Health*

Chapter 4

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Article submitted for publication in the *BioMed Central Journal*

Chapter 5

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List of Abbreviations

ASC	Australian Sport Commission
BMI	Body Mass Index
CDC	Centre for Disease Control
IPAQ-SF	International Physical Activity Questionnaire- Short Form
ISAK	International Society for the Advancement of Kinanthropometry

MET	Metabolic Equivalent
MOD	Moderate
NCD	Non-Communicable Disease
PA	Physical Activity
PAHLS	Physical Activity and Health Longitudinal Study
PI	Principal Investigator
SAR	Sit and Reach
SBJ	Standing Broad Jump
SUP	Sit- Up
TPA	Total Physical Activity
VIG	Vigorous
WHO	World Health Organisation
WHtR	Waist-to-Height Ratio

Chapter 1
Introduction

1.1 BACKGROUND

Physical inactivity is a modifiable risk factor for non-communicable diseases such as cardiovascular disease and a widening variety of other chronic diseases, including diabetes mellitus, cancer (colon and breast), obesity, hypertension, bone and joint diseases (osteoporosis and osteoarthritis), and depression (Lee & Skerrett, 2001:459; WHO, 2018). A systemic review of articles concerning physical activity, fitness and health revealed a linear relation between physical activity and health status, such that a further increase in physical activity and fitness will lead to improvements in health status (Warburton *et al.*, 2006:803). However, there is a decline in the physical activity level and 80% of 13–15 year olds do not meet the current physical activity recommendations of 60 minutes of moderate to vigorous physical activity per day (Hallal *et al.*, 2012:247). These disturbing results highlight the need for more physical activity surveillance to explain why some people are active while others are not active. There is also a need to assess the extent to how correlates of physical activity influence participation and patterns of changes over a period of time to guide the design of an intervention programme.

1.2 PROBLEM STATEMENT

Regular physical activity has a positive influence on health during childhood, adolescence, and throughout adult life (Malina, 2001:1; Bélanger *et al.*, 2015; Maillane-Vanegas *et al.*, 2017:5). Regular physical activity in childhood and adolescence improves strength and endurance, helps build healthy bones and muscles, helps control weight, reduces anxiety and stress, increases self-esteem, and may improve blood pressure and cholesterol levels (Physical Activity Guidelines Advisory Committee, 2008:1; Institute of Medicine, 2013:17). Regular physical activity is also important in the prevention of chronic diseases later in life (Heitzler *et al.*, 2006:252). However, as children move through adolescence their participation in physical activity declines markedly, while sedentary time increases (Wilson & Dollman, 2007:146; Jago *et al.*, 2017). International data published in the Lancet Physical Activity Series (Hallal *et al.*,

2012:247) reports that 80% of 13–15 year olds do not meet the current physical activity recommendations of 60 minutes of moderate to vigorous physical activity per day, and also highlights the need for more physical activity surveillance data from Africa. In South Africa, 30% of adolescents do not meet internationally recommended amounts of moderate to vigorous physical activity (Van Biljon *et al.,* 2018:127), and it has been reported from other African countries that less than 50% of adolescents between 13 and 15 years of age are physically active for at least 60 minutes a day on at least three days a week (Peltzer, 2009:172). The decline in physical acivity during adolescence may be attributed to popularity of sedentary behaviours, such as watching television, using the internet and video games increases, adolescents may spend more time on them, as opposed to regular participation in physical activity (O'Dea, 2003: 497; Dwyer *et al.,* 2006: 75; Ruiz *et al.,* 2011: 173). Additionally, constrains such as homework and level of crime in the community, as well a physical environemnt (Muthuri *et al.,* 2014:3355; Shirinde *et al.,* 2012:238). As such, adolescents' access to physical activities may be limited by family structure and routine, parents' safety concerns, lack of support or inability to provide for travel, equipment purchases and club membership fees (Dwyer *et al.,* 2006:75; De Cocker *et al.,* 2012:2).

This observed trend of inactivity is worrisome, given that physical activity can help develop the physical fitness of these adolescents. "Physical fitness" refers to a set of attributes that people have or achieve that relates to the ability to perform physical activity; while "physical activity" refers to any body movement produced by skeletal muscles that results in energy expenditure (Caspersen *et al.,* 1985: 126; ACSM, 2018:5). Physical fitness can then also be described in terms of the skill and health related components. As implied by the name, health-related fitness is an important component of overall health. Children who are unfit are at increased risk for cardiovascular and metabolic disease (Andersen *et al.,* 2008:58). Physical inactivity is also an important contributor to non-communicable diseases (Bauman *et al.,* 2012:258). Physical inactivity is defined as doing no or very little physical activity at work, at home, for transport or during discretionary time. Physical activity habits developed early in life may continue into adulthood (Telama *et al.,* 2005:268).

Research carried out in Ellisras (Mantsena *et al.,* 2003:225; Monyeki *et al.,* 2005:877) and the Tshannda longitudinal study (Amusa *et al.,* 2010:221) has consistently reported body weight disorders and incidents of health-risk behaviours in school children and adolescents. In a study among 259 boys and girls in the Tlokwe Municipality, it was found that there is a strong and

significant positive association between physical fitness and BMI for the underweight and overweight girls with high physical fitness scores (OR, 10.69 [95%CI: 2.81-40.73], and (OR, 0.11 [95%CI: 0.03-0.50]) respectively (Monyeki *et al.,* 2012:374). In addition, it was found that there was a non-significant weaker positive relationship between physical fitness and BMI for the underweight boys with high physical fitness scores (OR, 1.80 [95%CI: 0.63-5.09]), and the overweight boys with high physical fitness scores (OR, 0.18 [95%CI: 0.02-1.78]) (Monyeki *et al.,* 2012: 374).

Healthy levels of HRPF allow individuals to perform physical activities with vigour and promote resistance to fatigue (Cattuzzo *et al.,* 2014:123). A review on the association of fundamental movement skills with health-related variables, including HRPF, reported a consistent positive association between cardiorespiratory fitness and motor competence (MC) and an inverse association between MC and weight status (Lubans *et al.,* 2010:1019). Therefore, improving HRPF levels across childhood and adolescence, is important from a public health perspective (Lubans *et al.,* 2010:1019), specifically from an intervention standpoint, as this will further promote lifelong physical activity and health (Morgan *et al.,* 2013: e1361).

Public health efforts directed at promoting physical activity and preventing this age-related decline have been done with limited success (Van Sluijs *et al.,* 2007:703; Pate *et al.,* 2016:47). Physical activity (PA) behavior is influenced by a complex interaction of factors in different domains (Stanley *et al.,* 2012:50). Studies identified correlates such as demographic, biological, environmental, social and psychological; which have been investigated as being influential in a young person's level of physical activity (Sallis *et al.,* 2000:963; Strauss *et al.,* 2001:897; Stanley *et al.,* 2012:50). Because physical activity is affected by diverse factors, behavioural theories and models are used to guide the selection of variables for study (Bauman *et al.,* 2002:5; Stanley *et al.,* 2012:50). In this thesis therefore, an ecological model in determining the social correlates of physical activity among adolescents with emphasis on the factors that influence participation in physical activity such as intrapersonal, interpersonal, organisational, community and policy was used (Sallis *et al.,* 2008:465). This approach uses a comprehensive framework to explain physical activity, proposing that determinants at all levels namely individual, social, environmental, and policy are contributors (Bauman *et al.,* 2012:258). A key principle is that understanding of all levels of influence, can inform the

development of multilevel interventions that offer the best chance for success (Sallis *et al.,* 2008:465).

Conducting studies during the adolescent stage in life may help to understand to what extent the social correlates of physical activity affect individual participation in physical activity. Adolescence is a time when independence is established, and dietary and activity patterns may be adopted that are followed for many years (Berkey *et al.,* 2003:386). The period of adolescence can be looked upon as a time of more struggle and turmoil than childhood. Adolescents have long been regarded as a group of people who are searching for themselves to find some form of identity and meaning in their lives (Rathi & Rastogi, 2007:32).

Potential correlates of physical activity were found to track moderately in the transition between childhood and adolescence (Gebremariam, 2012:1). Previous reviews have concluded that social influences, especially parental influences on children's activity, are strong (Pyper *et al.,* 2016:568; Schoeppe *et al.,* 2016:152). According to Beets and colleagues, parental support "represents the functional characteristics associated with the interactions between a parent and his or her children in the context of intentionally participating in, prompting, discussing, and/or providing activity-related opportunities" (Beets *et al.,* 2010:624). A study by Heitzler *et al.* (2006:253) found that children's perception of parental support and parents' reports of direct support were strongly related to organised physical activity. The findings were supported by Wilk *et al.* (2018:79) who found that a child's perception of parental support for PA had a positive effect on boys and girls. In a study among 475 adolescents (233 males and 242 females) and their biological parents and peers, it was revealed that, weekly high intensity and very high intensity physical activity by the father, older brother, and best friend of the subject were associated with higher activity levels of the subjects (Raudsepp & Viira, 2000:51). Gebremariam (2012:1) revealed that small but significant higher levels of enjoyment and teacher support for physical activity, and friends' support for physical activity were detected among learners who are active.

The social cognitive theory of Bandura (1986) suggests that the relationship between determinants and behaviour is reciprocal. That is, changes in the social correlates are likely to co-vary with changes in physical activity (De Bourdeaudhuij *et al.,* 2002:376). Furthermore, it was found that the suggested theory was further supported by De Bourdeaudhuij *et al.*

(2002:376) who documented that psychosocial variables at baseline (e.g. self-efficacy) were poorer correlates of PA change than changes in these psychosocial correlates.

However, previously identified correlates mostly relate to cross-sectional difference in levels of physical activity (Craggs *et al.*, 2011:645). This type of studies only provides statistical association, rather than providing evidence of a causal relationship between factors and physical activity (Bauman *et al.*, 2012: 258; Martin *et al.*, 2014:142). The estimates in a cross-sectional study tend to assume a homogenous development (Monyeki *et al.*, 2007:552). Longitudinal observational studies and experimental data could identify factors that have strong causal associations with physical activity (Miettinen, 2010:25). Tracking and stability are inherent in longitudinal studies (Malina, 2001:1). Tracking refers to the tendency of individuals to maintain their rank or position within a group over time (Malina, 2001:1; Gebremariam, 2012:2). Understanding of these associated correlates of physical activity would be significantly enhanced by examination of these correlates, and other factors in a longitudinal study. Intervention programmes are based on the assumptions that physical active behaviour tracks over time (Gebremariam, 2012:2).

As physical activity appears to track over time, one would thus also assume that some of its psychological and social-environmental correlates would display that pattern, although stability in physical activity behaviour might also be related to other factors such as the behaviour becoming habitual or hereditary (Gebremariam *et al.*, 2012). Investigating the changes in social correlates of physical activity is important as it can reveal the patterns of change in these correlates and can indicate the proper timing for intervention (Gebremariam, 2012:2). Longitudinal studies investigating the changes of these social correlates of physical activity and physical activity in relation with health-related fitness among adolescents in South Africa, especially in the Tlokwe local municipality, are lacking. Available related studies which were cross-sectional in nature from the Tlokwe area, indicated a high level of TV viewing (Toriola & Monyeki, 2011:796), and a low level of physical activity among children (Mamabolo *et al.*, 2007:1047) as well as a high level of both overweight and underweight (Monyeki *et al.*, 2012:374).

It is clear from the reviewed literature (i.e. from databases and search engines: Science direct, Pubmed, Ebsco, Jstor, SportDiscuss, Medline, Eric database, Plos One with the following

keywords; health-related fitness, tracking, changes in social correlates of physical activity and physical activity and sport participation, family and friends, correlates of physical activity) that changes in correlates of physical activity and physical activity in relation with health-related physical fitness need to be tracked in longitudinal studies. This is essential for the proper timing of intervention and thus the reduction of physical inactivity among adolescents. Improvement of the research base, with a stronger focus on determinants, that is with improved causal inference rather than repetition of cross-sectional correlates studies. This will further provide an understanding of physical activity in populations and will assist with interventions designed to increase physical activity levels.

It is against this background information that the following research questions are posed:

- What are the three-year developmental changes of social correlates of physical activity for girls and boys in selected schools within the Tlokwe local municipality?
- What are the three-year relationship between changes of physical activity and selected health-related fitness in girls and boys from selected schools within the Tlokwe local municipality?
- What are the three-year longitudinal relationship between changes in social correlates of physical activity and physical activity among boys and girls in the Tlokwe local municipality?

The present study on the longitudinal analyses of the changes in social correlates of physical activity and physical activity in relation with health-related fitness among adolescents is set to provide a unique contribution to the literature. The data collected relating to ages 14, 15, 16, 17 and 18 provided an opportunity to determine how social correlates of physical activity and physical activity in relation with health-related fitness change over a significant period of time among adolescent boys and girls in the Tlokwe local municipality. The data used in the thesis are obtained from the PAHL study which started in 2010 and ended in 2014 as a multiple longitudinal study, which implies the repeated measurements on more than one birth cohort (Kemper, 1985; Monyeki, 2006:10) that follows a group of adolescents boys and girls who were 14 years at the beginning of the study and 18 years at the end of the study (Monyeki *et al.,* 2012). The goal of PAHLS was to obtain information on the physical activity and health health determinants of adolescents in the Tlokwe municipality followed for a period of 5 years.

Most of the study already been published in PAHL study was based on cross-sectional or baseline measurements. As such, the interest of my thesis was to analyse the secondary longitudinal data on the variables of social correlates of physical activity, physical activity and health-related physical fitness. From the big data file with the guidance of the PI, I have sorted data analysed for this thesis with the following objectives and hypotheses.

1.3 OBJECTIVES

The objectives of this study were to determine:

1. the three-year developmental changes of social correlates of physical activity for girls and boys from selected schools in the Tlokwe local municipality;

2. the three-year relationship between changes of physical activity and selected health-related fitness for girls and boys from selected schools in the Tlokwe local municipality; and

3. the three-year longitudinal relationship between changes in social correlates of physical activity and physical activity in girls and boys from selected schools in the Tlokwe local municipality.

1.4 HYPOTHESES

This study was based on the following hypotheses:

1. Significant developmental changes of social correlates of physical activity in girls and boys over a period of three-years from selected high schools in the Tlokwe local municipality will be found.

2. There will be three-year significant positive relationship between changes in the physical activity and selected health-related fitness for girls and boys from selected schools in the Tlokwe local municipality.

3. There will be three-year significant positive longitudinal relationship between changes in the social correlates of physical activity and physical activity in girls and boys from selected schools in the Tlokwe local municipality.

1.5 THESIS STRUCTURE

The thesis is submitted in an article format as approved by the North-West University senate, and the structure is as follows:

Chapter 1: Introduction. The NWU Harvard guidelines was used for referencing.

Chapter 2: Literature review: Social correlates of physical activity, physical activity and health-related fitness in children and adolescents. The NWU Harvard guidelines was used for referencing.

Chapter 3: **Article 1**: The three-year developmental changes in the social correlates of physical activity in girls and boys: the PAHL study. A manuscript has been prepared for publication in the *Journal of Physical Activity and Health.* The references are prepared in accordance with the guidelines proposed by the *Journal of Physical Activity and Health.*

Chapter 4: **Article 2**: The three-year developmental changes of physical activity and selected health-related fitness in girls and boys: the PAHL study. A manuscript has been prepared for publication in the *BioMed central.* The references are prepared in accordance with the guidelines proposed by the *BioMed Central Journal.*

Chapter 5: **Article 3**: The three year longitudinal relationship between changes in social correlates of physical activity and physical activity in girls and boys: the PAHL study. A manuscript has been prepared for publication in the *Journal of Physical Activity and Health.* The references are prepared in accordance with the guidelines proposed by the *Journal of Physical Activity and Health.*

Chapter 6: Summary, conclusions, limitations and recommendations. The NWU Harvard guidelines was used for referencing.

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Chapter 2
Social correlates of physical activity, physical activity and health-related fitness among adolescents over a period of time: a Literature review

2.1 INTRODUCTION

Globally, many adults, adolescents and children do insufficient physical activity to maintain good health (Hallal *et al.,* 2012:247; WHO, 2018). To cite an example, it was reported in the WHO 2018 report that more than 81% of adolescents aged 11-17 years were insufficiently physically active in 2010 with girls being less active than adolescent boys, and with 84% vs. 78% not meeting WHO recommendations (WHO, 2018). Physical inactivity has been ranked among the ten major causes of mortality and disability in developed countries, and nearly two million deaths world-wide can be attributable to physical inactivity (Sattelmair *et al.,* 2011:789; WHO, 2002; WHO, 2018). Physical inactivity also causes 6% of the burden of disease, from coronary heart disease, 7% of type 2 diabetes, 10% of breast cancer, and 10% of colon cancer (Lee *et al.,* 2012:184). The burden of physical inactivity, therefore, has become unacceptably high (Lee *et al.,* 2012:184).

There is strong evidence suggesting that regular physical activity improves body composition, cardiorespiratory and muscular fitness, bone health, and levels of metabolic health biomarkers among children and adolescents (PAGAC, 2008:1; Loprinzi *et al.,* 2012:597; Hervás *et al.,* 2018:61). The benefits of physical activity on health are widely recognised in the literature, which also suggests that the promotion of physical activity should begin already in early life (Hallal *et al.,* 2006:1019; Janssen & Leblanc, 2010:40; Timmons *et al.,* 2012:773). However, as children move through adolescence, their participation in physical activity declines markedly (Corder *et al.,* 2010:926; Dumith *et al.,* 2011:685). In African countries, only 50% of adolescents between 13 and 15 years of age are physically active for at least 60 minutes a day on at least three days a week (Peltzer, 2009:173; Wushe *et al.,* 2014:471). This non-

compliance with the recommended 60 minutes of daily physical activity is found to be associated with a number of barriers or physical activity correlates (Shirinde *et al.,* 2012:228; Monyeki, 2013:323).

Physical activity is influenced by several correlates. Studies have identified correlates such as demographic, biological, environmental, social and psychological factors, which may be identified to be influential in a young person's level of physical activity (Stanley *et al.,* 2012:50; Sterdt *et al.,* 2014:72; Macniven *et al.,* 2017:187). Understanding why some people are physically active and others not, will contribute to developing evidence-based interventions focusing on causes of physical inactivity.

To develop effective physical activity interventions in adolescents, influences on, and determinants of activity levels need to be well understood. Therefore, this chapter will focus on reviewing the literature on the changes in the social correlates of physical activity and physical activity in relation with health-related fitness. In the write-up of this chapter information was gathered following databases and search engines namely; Science direct, Pubmed, Ebsco, Jstor, SportDiscuss, Medline, Eric database, Plos One with the following keywords; health-related fitness, tracking, changes in social correlates of physical activity and physical activity and sport participation, family and friends, correlates of physical activity were used to obtain the relevant information in the write-up of the literature review in the thesis.

This chapter presents the literature review under the following headings:

- Social correlates of physical activity;
- Assessment of social correlates of physical activity;
- Health-related fitness components among adolescents;
- Assessment of health related fitness components;
- Physical activity;
- Assessment of physical activity;
- Theories for determining social correlates of physical activity;
- Studies in developed countries on social correlates of PA, health-related PA; and physical activity; and
- Studies in developing countries on social correlates of PA, health-related PA and physical activity;

- Chapter summary.

2.2. SOCIAL CORRELATES OF PHYSICAL ACTIVITY

The positive effects of PA among the adolescents include improvement in health outcomes such as aerobic fitness, blood lipids, blood pressure, body composition, glucose metabolism, skeletal health, and psychological health (Kohl, 2013:15). Given these health benefits, adolescents still do not meet the recommendations to be physically active daily, or accumulate 30 to 60 min ranging up to several hours per day (Armstrong, 2012:131), and this warrant investigation into what causes adolescents to be physically inactive.

Studies have identified several social correlates which affect physical activity among adolescents including; gender (Al-Hazza *et al.,* 2011:140), age (Al-Hazza *et al.,* 2011: 140; Craggs *et al.,* 2011:645), support received from family (Craggs *et al.,* 2011:645; Bauer *et al.,* 2011:25), friends, teachers and coaches (Humbert *et al.,* 2006:467). Social support is a construct contained in a number of theories (Social Cognitive and Planned Behaviour Theory) and models (Health Belief and Social Ecological Model), used to explain physical activity behavior (Glanz *et al.,* 2008:15). Social support therefore, is described as an action that helps a person adopt and/or maintain a particular practice that can occur in different ways, such as instrumental/direct (characterised by acquisition or sports equipment sharing, facilitating transport to local practices and engaging in physical activities together), psychological/emotional (transmitted through incentives, words of motivation and encouragement for practices) and instructional/informative support (characterised by acts of orientation, counselling and talks about the importance and appropriate ways of engaging in physical activities) (Duncan *et al.,* 2005:3; Beets *et al.,* 2006:278; Beets *et al.,* 2010:621; Barr-Anderson *et al.,* 2010: 364).

The behavioural epidemiology framework used to determine correlates of physical activity proposes five phases in the research process concerning physical activity and health (Buchan *et al.,* 2012:5). It suggests that it is necessary to assess the behaviour, which is physical activity, and then establish whether there are links between physical activity and health in adolescents (Biddle *et al.,* 2011:26). It also proposes that, before interventions can be planned, the key variables that are correlated with behaviour, need to be identified. It is believed that physical

activity is not changed by the intervention per se; however, some personal, social or environmental variables influence the physical activity behaviour. The social cognitive theory (Bandura, 1986:15; Buchan *et al.,* 2012:5) is a widely accepted framework for understanding and explaining the influences of variables on adolescents' physical activity. The variables are explained below.

2.2.1 Psychological factors

Several psychological factors including self-efficacy and attitude are associated with levels of physical activity (Bandura, 1986:15; Malina *et al.,* 2004:472). Self-efficacy refers to confidence in one's physical ability. An individual's perception of barriers to activity (e.g. lack of facilities, limited access to facilities) correlates with the level of physical activity (Malina *et al.,* 2004:472).

Social-cognitive variables (i.e. beliefs that are formed by social learning and reinforcement history) are putative influences on self-initiated change in health behaviours such as physical activity (Bandura, 2004:143). They may be especially important during early adolescence, when participation in physical activity increasingly becomes a leisure choice. According to self-efficacy theory (Bandura, 1997:30), a belief in personal capabilities to plan and execute the courses of action required to attain a behavioural goal is the proximal influence on physical activity.

Though some studies do not show an association between self-efficacy and physical activity, it is argued that self-efficacy may affect adolescents' physical activity (Shokrvash *et al.,* 2013:5). Reports of longitudinal, cohort studies of adolescent girls suggest that declines in physical activity through high school are mitigated by self-efficacy for overcoming barriers to physical activity and by perceived social support (Dishman *et al.,* 2009:3), especially from family (Dowda *et al.,* 2007:153) and friends (Duncan *et al.,* 2007:80). Social Cognitive Theory (Bandura, 1989) suggests that strong social support networks increase an individual's self-efficacy (SE) to overcome barriers to being physically active. Parents, family members (brothers, sisters, uncles and grandparents), friends and teachers can increase an adolescent's self-efficacy directly by acquisition or sports equipment sharing, facilitating transport to local practices and engaging in physical activities together or indirectly (Dishman *et al.,* 2009:2;

Lubans & Sylva, 2009:134) through incentives, words of motivation and encouragement for practices.

The other psychological factor associated with adolescent physical activity is *Attitude*. Attitude has been defined as a predisposition or a tendency to respond positively or negatively towards a certain idea, object, person, or situation. Attitude influences an individual's choice of action, and responses to challenges, incentives, and rewards (together called stimuli). The Theory of Reasoned Action / Planned Behaviour (Ajzen, 1991:179) suggests that health behaviour, including PA, is determined by intentions individuals form based on their attitudes toward the behaviour. An active lifestyle is attended by a higher value of training and competition, plus social experiences in sports (Kopczynski *et al.*, 2014:139). Adolescents holding more-positive attitudes toward sports, exercise and fitness are more active, and this suggests that youth activity-promotion efforts may benefit from targeting PA-related attitudes in addition to behaviour itself (Graham *et al.*, 2011:132).

2.2.2 Environmental

The environmental correlates include variables clustered around the concepts of access, opportunities, and availability of facilities to be active, and are associated with higher levels of physical activity. To get children off the couch and participating in more active free-time play, it will be extremely important to ensure the provision of a safe and accessible environment for such activities (Heitzler *et al.*, 2006:254). Walkability, traffic speed, and volume (inversely), land-use mix (proximity of homes and destinations such as shops), residential density, and access or proximity to recreation facilities are found to be robust correlates of physical activity among children and adolescents (Ding *et al.*, 2011:442). Studies on environmental correlates have revealed access to programme and facilities, parental transport to physical activity, season, urban/rural environment, neighbourhood safety, and time spent out as being associated with physical activity participation (Sallis *et al.*, 2000:963; Hinkley *et al.*, 2008:435; Biddle *et al.*, 2009:278).

2.2.3 Socio-cultural

This correlate relates to the society to which the adolescents interact with amongst others, including peers and parents. Evidence suggests various ways in which parents can influence physical activity (Wilson & Dollman, 2007:148; Solomon-Moore *et al.,* 2018). In a study by Shokrvash and colleagues among 402 adolescents, it was revealed that parental support was associated with physical activity participation (Shokrvash *et al.,* 2013:5). Parental support could either be direct or indirect, and was associated with physical activity (Dishman *et al.,* 2009:3). The direct social support includes encouraging, stimulating, practising together and providing transportation for the adolescents to the practice sites, and indirect support would be through behaviour modelling (Wu & Pender, 2002:25; Beets *et al.,* 2006:278). Parents can strongly influence children's physical activity through role modelling (Dishman *et al.,* 2009:2; Bauer *et.al.,* 2011:25), providing practical and emotional support, which may include watching or encouraging them to be active (Duncan *et al.,* 2005:3; Dishman *et al.,* 2009:2; Bauer *et al.,* 2011:25). Children's perceptions of parental support include acknowledging verbal encouragement by their parents and feeling confident that their parents would sign them up for an activity. This is strongly related to their participation in organised physical activity (Heitzler *et al.,* 2006:254).

Evidence suggests that family support is a frequent source of the active lifestyle (Bauer *et al.,* 2008:12; Dishman *et al.,* 2009:2; Deforche *et al.,* 2010:S24). Low perceived support for boys and low practical and emotional support for girls were found to be significant predictors of lower levels of physical activity (Shokrvash *et al.,* 2013:5). Studies have confirmed practical and emotional support as being an important type of family support that were associated with adolescents' physical activity (Wright *et al.,* 2010: 224; Craggs *et al.,* 2011:645). These may include watching them and encouraging them to be active (Bauer *et al.,* 2009:12; Dishman *et al.,* 2009:2). Electronic devices, amusing games, family conflicts, low knowledge, insufficient parenthood skills to manage adolescents, and negative role modelling are possible factors argued to be related to increased sedentary behaviour among adolescents (Bauer *et al.,* 2008:10).

A study exploring the role of personal, familial, and cultural attitudes and social norms for physical activity (PA) on actual PA behavior among female indian adolescents, has found that religion and spirituality influences PA among participants with strong affinities for Indian

cultures (Ramanathan & Crocker, 2009:500). Cultural heritage impacts PA norms, attitudes, and patterns, and must be considered when evaluating adolescent PA participation in multicultural societies.

2.2.4 Socio-economic status

Socio-economic status (SES) is an important determinant of health and well-being because it influences people's attitudes, experiences, and their exposure to several health risk factors (Huure *et al.,* 2003:249) and studies have shown a connection between low SES to a variety of chronic diseases and all-cause mortality (e.g. health disparity) (Borrell *et al.,* 2004:398; Pollitt *et al.,* 2007:55). Children and adolescents who grow up in a low SES family have a higher risk of an unhealthier lifestyle and cardiovascular disease (CVD) compared to children from higher SES (Lee & Ryff, 2016:58:249; Pollitt *et al.,* 2007:55). For an example, studies associating SES and physical activity behaviour have shown that obesity is more prevalent in low SES children as compared to higher SES (Janssen *et al.,* 2006:139; Lioret *et al.,* 2007:509). A study examining the difference in physical activity and sedentary behaviour in adolescents according to socio-economic status (SES) independent of body mass index, revealed that adolescents from a low SES show a trend of lower PA levels and spend more time in sedentary behaviour than high SES adolescents; however, the difference in PA was influenced by BMI (Drenowatz *et al.,* 2010: 214).

Contrary to the findings above, a study in rural South African adolescents have revealed that higher SES is associated with more time spent in sedentary behavior's such as watching television and reading, less time walking as a means of transport, and more time participating in MVPA involved in school and club sports (Mickelsfield *et al.,* 2014:40); and *McVeigh et al.* (2009:1006) have found that lower SES is associated with less leisure-time activity in a younger South African cohort, further more that lower SES status was associated with more television time.

The SES correlates include the parental education and father's occupation in adolescents (Ferreira *et al.,* 2007:129; Hinkley *et al.,* 2008:435). Positive associations between physical activity and family income (Wang & Beydoun, 2007:6; Kim & So, 2014:1887) has also been found.

2.2.5 Biological factors

Biological factors can change the pattern of PA in children and adolescents (Malina *et al.,* 2004; Smart *et al.,* 2012:89). Biological factors as quoted by Bacil *et al.* (2015:114) in their systematic review, is defined as the progression toward the state of maturity, and that it can be analysed by two components: timing and time, where "Timing" is considered to be the moment when a given maturation event occurs (for instance, the age of menarche, the growth spurt period, the appearance of secondary sexual characteristics, among others) and the timing of the biological maturation of an individual. It is possible to classify this individual as early-maturing, on time or late-maturing. "Time" is the rate at which this event is expressed, in essence, how fast or slow these changes manifest themselves (Smart *et al.,* 2012:86). As individuals progress toward the state of maturity, their physical activity reduces regardless of their chronological age (Sherar *et al.,* 2010:333) and this may be due to difference in timing of sexual maturation and growth spurt related to gender and age (Summers-Effler, 2004:29). Secondary sexual characteristics, such as breast development, may contribute to perceptions of discomfort and lower self-esteem and in addition, hormonal changes and changes in body composition, such as increased body fat among girls, may contribute to decreased physical activity participation (Summers-Effler, 2004:29). In boys, the age of the early peak height velocity (PHV) can positively influence the behaviour of PA due to increased muscle mass and strength, which tends to occur after the peak height velocity (PHV) point (Rauch *et al.,* 2004:772). The PHV is simply the period of time in which an adolescent experiences his/her fastest upward growth in stature. This positively influences the behaviour of physical activity due to increased muscle mass and strength among boys (Rauch *et al.,* 2004:772).

2.2.6 Policy correlates

Policy is described in many ecological models (Sallis *et al.,* 2008:465) as being a factor that can influence physical activity participation. Policy intervention if instituted can provide guidance for collective and individual behaviour and can be informal or formal legislative or regulatory actions taken by government or non-governmental organisations (Bellew *et al.,* 2011:340), that is local (schools or workplace), regional government, or national levels. Usually, policy intervention requires partnerships and actions outside the health sector to improve those conditions, support services, and environments that enable physical activity planning (Daugbjerg *et al.,* 2009:209). Such policies can mandate investments in resources

(e.g. bike paths, parks, and sports programme) or develop relevant public health regulations (e.g. pavement specifications, stair design standards, and payment for physical activity counselling in health) (Sallis *et al.,* 2006:297). Pucher and Buehler (2008:495) identified policies and environmental supports in Germany, Denmark, and the Netherlands that explain the high levels for cycling in those countries.

2.2.7 Genes correlates

Genetics is a possible determinant of physical activity (Kelly & Pomp, 2013:348). Evidence from human and animal studies indicates that physical activity is regulated by intrinsic biological process, similar to other behaviours such as eating (Niermann *et al.,* 2015). Twin and family studies have shown that genetic factors contribute to the variation in reported daily physical activity, with heredity estimates ranging from small [heritability (h^2) <30%] to moderate [heritability (h^2) =30- 50%] and even high [heritability (h^2) = 78%] levels (Franks *et al.,* 2005:901; Fisher *et al.,* 2010).

2.3 ASSESSMENT OF SOCIAL CORRELATES OF PHYSICAL ACTIVITY

Assessment of correlates of adolescent physical activity is important because they can answer basic questions about likely influences on the behaviour and this can inform the design and timing of the intervention. Tools for assessing social correlates of physical activity among the youth are discussed below.

2.3.1 Social support scale/ Peer norm

The Health Promotion Model emphasises the multidimensional influences on health behaviours by integrating constructs from Social Cognitive Theory (SCT) (Bandura, 1986:30). According to the Health Promotion Model (Pender *et al.,* 2011:31), interpersonal influences, such as social support and peer norm, are related to PA participation. The model defines social support as instrumental assistance and emotional encouragement, and peer norms as individuals' perceptions of their peers' prevalence, beliefs, attitudes, and values related to a behaviour. The social support scale was first developed by Zimet *et al.* (1988:30).

A 5-item ***Social Support/ Peer Norm*** **Scale** was developed to assess the instrumental assistance and emotional encouragement received from others. The scales are used to evaluate the psychometric properties of a **Social Support and Peer Norm Scale**. Ling *et al.* (2014:888) added three items to the original 5-item scale to increase its comprehensiveness and construct validity. The scale showed adequate internal consistency and test-retest reliability (Ling *et al.,* 2014:888).

2.3.2 Youth physical activity survey for specific settings

Two physical activity contexts receiving much attention in recent years are the lunchtime and after-school contexts (Stanley *et al.,* 2014:412) and these have been identified as the most critical windows for physical activity promotion during a school day (Mota *et al.,* 2003:547; Beighle *et al.,* 2006:516). This is because lunchtime and after school are considered discretionary periods, when children are able to make some choices about their participation in physical activity (Beighle *et al.,* 2006:516). The Y-PASS questionnaire was designed to assess the potential intrapersonal, sociocultural and physical environment/policy correlates of children's lunchtime and after-school physical activity.

The ***Y-PASS*** was based on the social ecological theoretical framework (i.e. intrapersonal, sociocultural environment and physical environment/policy domains) (Sallis *et al.,* 2008:465) following processes identified by Frazer and Lawley (2000:45), DeVellis (2003:15) and Streiner and Norman (2008:25). A 5-point Likert scale (i.e. disagree a lot, disagree a little, neither disagree nor agree, agree a little and agree a lot) was developed for the Y-PASS questionnaires as this is deemed appropriate for children (Borgers & Hox, 2001:321) and has been used and tested in other questionnaires administered to children of a similar age to participants in this study (Sallis *et al.,* 2002:30; Jago *et al.,* 2009:67). The factors and items demonstrated fair to very high test-retest reliability (ICC = 0.26 – 0.93).

2.3.3 Attitude scale

The scale was developed by Kenyon (1968:566) based on a conceptual model characterising physical activity as a multidimensional phenomenon (Kenyon, 1968:566). The six subsets or dimensions identified were physical activity as a social experience, as health and fitness, as the

pursuit of vertigo, as an aesthetic experience, as catharsis, and as an ascetic experience**.** In a study among Greek prisoner (Konstantinakos *et al.,* 2010:39) exploring three factors including: a) need for physical activity (7 items); b) physical activity before and during imprisonment (2 items); and c) non-participation in physical activity (2 items). The internal consistency for the whole scale was 0.70, while reliability indexes ranged from 0.88 to 0.58 for the three factors. The results underscored the need for physical activity and sport during imprisonment and thus showed overall reliability and validity of the named Attitudes towards Physical Activity of Greek Prisoners (ATPA-GP) and the attitudes toward physical activity (ATPA).

2.3.4 Self-efficacy

For almost two decades the Physical Self-Efficacy Scale (PSES) (Ryckman *et al.,* 1982) has been employed as a measure of physical self-efficacy. It is composed of two subscales; the Perceived Physical Ability (PPA) and Physical Self-Presentational Confidence (PSPC) subscales. The PSES has been demonstrated to have acceptable validity and reliability, and has been widely accepted as a measure of perceived competence in the physical domain (McAuley *et al.,* 2005:268).

2.3.5 Neighbourhood scale

The scale assesses the availability of sports facilities, safety concerns, and the social environment. The safety scale and the social environment scale showed good internal consistency (Huang *et al.,* 2011:16) and this was consistent with previous studies (Hume *et al.,* 2006:16; McMinn *et al.,* 2009:81) and emphasises that a range of questions should be included in order to assess the different aspects of the local environment. This strongly supported the test–retest reliability and validity of a new self-report measure of neighborhood environment characteristics hypothesised to be related to lifestyle physical activity, particularly walking for transport.

The scales or instruments to measure social support for adolescents' physical activity described above consider social support from different social groups simultaneously (Motl *et al.,* 2007: 6), others measure the support from parents, from friends (Lubans & Morgan, 2009:141) and there are those that measure the social support of two or more groups, but with specific items for each one (Dishman *et al.,* 2010:72; Taymoori, Rhodes & Berry, 2010:257). These

instruments also show variations in the kind of social support measured (Duncan, Duncan & Strycker, 2005:3; Dowda *et al.*, 2007:153; Kirby, Levin & Inchley, 2011:785; Morrisssey *et al.*, 2012:333). The selection of any instrument should depend on what needs to be achieved in the study, and may further be adapted to meet the conditions of the preferred settings or targeted population.

2.4 HEALTH-RELATED FITNESS AMONG ADOLESCENTS

According to Pescatello *et al.* (2014:2), physical fitness is a set of attributes or characteristics that an individual has or achieve that relates to an ability to perform physical activity, and these are usually separated into the skill-related components and the health-related components. Skill- or performance-related physical fitness involves skills that will enhance one's performance in athletic or sports events (Pescatello *et al.*, 2014:2). The SRPF includes agility, balance, coordination, speed, power, and reaction time. While the health-related physical fitness consists of those components of physical fitness that have a relationship with good health (Pescatello *et al.*, 2014:2). According to Andreasi *et al*. (2010:497), the HRPF is a set of constructs that has a link with the ability to perform physical and daily functional activities and also displays salutogenic characteristics. The basic parameters of health-related fitness are body composition, cardiorespiratory fitness, flexibility, muscular endurance and muscular strength and also optimal metabolic functioning (Toriola & Monyeki, 2012:797; ACSM 2018:2).

Assessing HRPF identifies the status of an individual's physical fitness and health for developing an appropriate, individualised exercise training programme, and also screening for risk of heart disease and other chronic diseases. The assessment should include tests that can measure the five different components of health-related physical fitness including: body composition, cardiorespiratory fitness, flexibility, muscular strength and muscular endurance. These components, as well as their evaluation protocols, are discussed and analysed below.

2.4.1 Body composition

Body composition refers to relative amount of muscle, fat, bone and other vital parts of the body (Malina *et al.*, 2004:101; ACSM, 2018:3). Excess fat particularly that which is located centrally around the belly (visceral adiposity), is associated with hypertension, metabolic

syndrome, type 2 diabetic mellitus, stroke, cardiovascular diseases and dyslipidemia (Roger *et al.,* 2012). Increasing adiposity among children and adolescents has become a global health concern in both developed and developing countries (Senbanjo *et al.,* 2013:648). It was already estimated in 2010 that 43 million children worldwide were considered to be overweight and obese and that the global prevalence of overweight and obesity among children had increased from 4.2% in 1990 to 6.7% in 2010 and this is expected to reach 9.1% by 2020 (De Onis *et al.,* 2010:1257). The prevalence of overweight and obesity in South Africa is on par with developed countries and among the highest among African countries (Reddy *et al.,* 2008:203; Rossouw *et al.,* 2012:2).

Childhood obesity impacts the overall state of health of the individual by increasing the risk of developing diabetes mellitus, hypertension, coronary artery diseases, and metabolic syndrome (Lee *et al.,* 2012:184-189) later in a child's life. Furthermore, increased adiposity levels have been linked to depression, indicating that psychological morbidities are also important consequences (Murabito *et al.,* 2012:1713). Studies suggest that youth of both sexes who participate in relatively high levels of physical activity have less adiposity than less active youth (Barbeau & Litaker, 2003:S28; Moore *et al.,* 2003:10; Janssen & Leblanc, 2010:40; Kohll & Cook, 2013).

Studies examining the relationship between weight status and health-related physical fitness among youths revealed that physical fitness decreased consistently with increasing BMI (Prista *et al.*, 2003: 952; Haerens *et al.,* 2007:258; Huang & Malina, 2007:707), although the primary influence of fat mass and fat-free mass is still not clear (Artero *et al.,* 2010:418). A study among 6929 Chinese children aged between six to twelve years, showed an inverse association of obesity with cardiorespiratory fitness, muscle explosive strength, and speed (Shang *et al.,* 2010:515414). With the accumulation of body fat, explosive strength, cardiorespiratory fitness, speed, and agility of children declines continuously (Bovet *et al.,* 2007:479; Mak *et al.,* 2010:10).

The disturbing data on overweight and obesity prevalence among paediatric populations and its health implications have precipitated an awareness of the value of identifying and treating individuals with excess body fat (Donnelly *et al.,* 2009:495; US Preventive Task Force & Barton, 2010:361). Body composition can be estimated with laboratory techniques and field

techniques that vary in terms of complexity, cost and accuracy (Duren *et al.*, 2008:1139; Lee & Gallagher, 2008:566). These techniques include inter alia, those listed below.

Anthropometric, can be used to estimate ***Body Mass Index*** (BMI) by dividing the weight in kilograms by height in metres squared. This is the quick and easy method for determining if body weight is appropriate for body height. It however, does not differentiate between fat and fat-free weight. ***Girth Measurements*** are used to either estimate body composition or describe body proportions. The Waist-to-hip ratio (WHR) is a frequently used clinical application of girth measurements. This value is often used to reflect the degree of abdominal, or android-type, obesity. They are sometimes used in equations to predict body composition and may also be used to track changes in body shape and size during weight loss. The major disadvantage is that they provide little information about the fat and fat-free components of the body. ***Skinfold Measurements*** are used to estimate %BF. This method can provide a fairly accurate assessment of percentage body fat (%BF). The value obtained by skinfold measurement is typically within 3.5% of the value measured with underwater weighing (Glaner, 2005). Skinfold measurement is based on the assumption that, as a person gains adipose tissue, the increase in skinfold thickness is proportional to the additional fat weight.

Densitometry (Siri, 1961:223)**,** two common procedures that estimate body composition based on densitometry are *hydrostatic weighing* and *air displacement plethysmography*. The foundation of these techniques is that various types of tissues in the body have different and consistent densities. Fat tissue has a density far less than that of either muscle or bone. Each of these techniques results in the assessment of total body volume and subsequently the calculation of body density.

Hydrostatic *(underwater)* ***weighing*** is one of the most common means for estimating body composition in research settings and is often used as the **criterion method** for assessing %BF. In this procedure, the participant is submerged in a tank of warm water and then exhales fully while technicians record the body mass. The body mass while submerged and the body mass on land are used to calculate %BF. Hydrostatic weighing is based on Archimedes' principle, which states that a submerged object is buoyed up by a force equal to the volume of water it displaces. The disadvantage of hydrostatic weighing is that it is highly reliant upon the subject (Duren *et al.,* 2008:1139). It is problematic particularly among children and obese participants as it is difficult for them to submerge completely under water.

Air displacement plethysmography (McCrory *et al.,* 1995:1686), the body volume is determined by monitoring changes in pressure within a closed chamber. These pressure changes are achieved by oscillating a speaker mounted between the front testing chamber and a rear reference chamber, which causes complementary pressure changes in each chamber. The pressure changes are very small and are not noticed by the individual being tested. The advantage of this method is that it has a high level of accuracy, ease-of-use, and a fast test time. Compared to underwater weighing, the Bod Pod does not require getting wet, and is well suited for special populations such as children, obese, elderly, and disabled persons. The BodPod unit is however, very expensive and only a few fitness institutions have it.

2.4.2 Cardiorespiratory fitness

Cardiorespiratory fitness (CRF) is related to the ability to perform large muscle, dynamic, moderate to vigorous intensity exercise for prolonged periods of time (ACSM, 2010:72). This involves the integration of the physiologic and functional state of the respiratory, cardiovascular, and muscular systems. The CRF is an essential component, because it has been found that low levels of CRF have been associated with increased risk of premature death from all cause and specifically from cardiovascular disease (CVD). Increases in CRF are associated with a reduction in death from all cause; and lastly, high levels of CRF are associated with higher levels of habitual physical activity, which in turn are associated with many health benefits (Kodama *et al.,* 2009:2024; Sesso *et al.,* 2010:975). The benefits of CRF extend to patients with established cardiovascular disease (Wannamethee *et al.,* 2000:1358; Agarwal, 2012:541). A systematic review and meta-analysis of 48 clinical trials (Tylor *et al.,* 2004:682) revealed that, compared with usual care, cardiac rehabilitation significantly reduced the incidence of premature death from any cause and from cardiovascular disease in particular.

In a study among adolescents in the USA, it was revealed that 33.6% of adolescents (approximately 7.5 million US adolescents) had low CRF; it further revealed that the prevalence is higher among females (34.4%) than in males (32.9%) (Carnethon *et al.,* 2005:2981). This observation is similar to the results of a study conducted in South Africa, where girls were found to be less fit than the boys as shown by their performances in all the health-related physical fitness tests (Toriola & Monyeki, 2012:795). Girls' aerobic capacity does not differ from that of boys in the prepubertal period, but from the age of 14 years their

aerobic power is significantly lower by about 15% (Hayes *et al.,* 2013:205). The maximal aerobic performance capacity in girls reaches a plateau from 14 years onwards, while in boys it increases up to the age of 18 years (Rowland, 1994:147; Hayes *et al.*, 2013:205). In a study (Pate *et al.,* 2006:1005) among youths aged 12 to 19 years in the United States, it is suggested that one third had low levels of cardiorespiratory fitness. Furthermore, adolescents who have high BMI, low levels of physical activity and high levels of sedentary behaviour, are likely to have low cardiorespiratory fitness (Pate *et al.,* 2006:1005). The results also showed an inverse relationship between age and CRF (Pate *et al.,* 2006:1005). The decline, however, is higher among the girls as compared with the boys. The fitness increased with age in males, but decreased with age in females, and these changes may be explained by physical developmental factors, such as sex-related changes in lean weight and fat weight during puberty.

Another study in South Africa, assessing the relationship between CRF and resting blood pressure among adolescents revealed that the adolescents who were overweight had poor predicted maximal oxygen consumption ($\dot{V}O_{2max}$) (Mean=26.66 $ml.kg^{-1}.min^{-1}$ ±6.44) and the highest prevalence of elevated SBP and DBP (4.9% and 6.5% respectively) compared with underweight and normal weight adolescents (Awotidebe *et al.,* 2016:245); and fatness and poor cardiorespiratory fitness were positively associated with elevated SBP and DBP, respectively.

Cardiorespiratory endurance (aerobic capacity) is described as the ability to perform large-muscle dynamic, moderate-to-high intensity exercise for prolonged periods. Maximal oxygen consumption ($\dot{V}O_{2max}$), is the maximal amount of oxygen one is able to use during exercise or physical activity (Pescatello *et al.,* 2014:20). The most precise way to determine $\dot{V}O_{2max}$ is direct gas analysis. The individual is required to exercise to the point of exhaustion, on a treadmill or cycle ergometer. Throughout the test, oxygen consumption, carbon dioxide production and volume of air are measured with special equipment. Due to advances in technology, today a portable gas analyser can be worn during a field-based graded maximal exercise test (Castagna *et al.,* 2010: 1488; Silva *et al.,* 2012:145). However, this sophisticated and expensive equipment requires qualified personnel and time for these tests, thus, the use of such equipment is limited to several settings such as in sports clubs, schools, or in large scale research studies (Pescatello *et al.,* 2014:20). Alternative methods, field tests are often used for measuring $\dot{V}O_{2max}$. The main advantages of field tests is that they have a low operating cost,

ease of administration, the possibility of mass assessment of a large number of subjects simultaneously, and administration of the test in the specific setting of the subject's daily routine. Some of these techniques are described below.

The ***Cooper's test*** (Cooper, 1968:135) involves running or walking continuously for 12 minutes while maintaining a constant pace or speed throughout. The total distance covered will be used in a formula to predict the $\dot{V}O_{2max}$. The ***9-minute run/walk test*** (Farias *et al.,* 2010:98) has been used as an adapted version of the Cooper's 12 minute walk-run test. The 9-minute test has been found to be a valid indicator of CRF in adolescents (Paludo *et al.,* 2012:401)

The multistage shuttle test such as the ***20 metre shuttles run test*** is the most frequently used field test (Castro-Piñero *et al.,* 2010:934; Mayorga-Vega *et al.,* 2015:536). The test is split into a series of one minute levels (Léger *et al.,* 1984:64). Each level consists of a number of bleeps and this dictates the pace at which each 20 metre shuttle must be run. As the levels progress, the bleeps become quicker and more frequent so a greater number of shuttles have to be completed inside one minute. The starting speed (level 1) is 8.5km/hr and increases by 0.5km/hr for each level. The test ends when the athlete(s) can no longer maintain the pace of the bleeps. The test is valid for estimating $\dot{V}O_{2max}$ among children and adolescents, provided performance scores are combined with other variables such as sex, age or body mass (Mayorga-Vega *et al.,* 2015:536).

2.4.3 Flexibility

Flexibility is defined as the ability of the muscle to lengthen to the end of the range of motion (ROM) (Thakur & Motimath, 2014:653). The lengthening is influenced by muscles, tendons, ligaments, bones, and bony structures. Adequate flexibility prevents soft tissue injuries (Gleim & McHugh, 2001:289). At all ages, girls demonstrate greater flexibility than boys, and the difference is greatest during adolescence (IOM, 2012:20). However, flexibility in both males and females tends to decline after age 17, in part as a result of a decline in physical activity and normal aging.

Direct flexibility methods measure angular displacements between adjacent segments or from an external reference. Tests are done using a Goniometer and a Flexometer. ***Indirect flexibility***

tests usually involve the linear measurement of distances between segments or from an external object. These include the sit and reach, the V-sit and the floor touch tests. The modified SAR is an appropriate and valid test for assessing hip and low back flexibility in children and adolescents (Chillon *et al.,* 2010:646).

2.4.4 Muscular strength and endurance

Muscular strength and endurance are components of health-related fitness. Optimal levels of muscular strength and endurance among the adolescents may help improve motor development and these relates to a lower incidence of physical activity and sport-related injuries (Behringer *et al.,* 2011:186; Myer *et al.,* 2011:74). Some studies have linked higher levels of muscular strength and endurance to a lower prevalence of cardio-metabolic disease risk factors (Peterson *et al.,* 2014:896; Cohen *et al.,* 2014:15). Strength in children increases linearly, with boys having a slight advantage over girls. The boys show marked development of muscle mass while girls develop fat mass (Malina *et al.,* 2009:45). These may have an impact on the muscular strength of the adolescence. Differences in muscle strength between boys and girls become magnified during adolescence, primarily as a result of the maturation (production of sex steroid hormones) (Kohl & Cook, 2013:15; Minatto *et al.,* 2013:45).

Muscular endurance is assessed through the ***sit-up*** **(SUP)** which is a measure of abdominal strength and endurance assessed through the number of correctly performed sit-ups in 60 seconds. This field test is valid, reliable, feasible and safe for the assessment of health-related physical fitness in children and adolescents (Ruiz *et al.*, 2011:520). Muscular strength is assessed through the ***standing broad jump*** **(SBJ)** which measures the explosive strength of leg extensors (in centimetres) and the ***bent arm hang*** **(BAH)** which is used to assess the functional arm and shoulder muscular endurance to the point of exhaustion (in seconds). Castro-Pinero *et al.* (2010:939) found that the SBJ showed the strongest association with the vertical jump, squat jump, countermovement jump, throw basketball, push-ups and isometric strength/muscular strength tests. The test was also found to be valid and reliable. The ***bent arm hang*** was also found to be valid and reliable (Ortega *et al.,* 2008:3).

2.5 PHYSICAL ACTIVITY

Physical activity is defined as any bodily movement produced by the skeletal muscles that results in energy expenditure (ACSM, 2018:2). Malina *et al.* (2004:458) explained physical activity as having three components which are mechanical, physiological and behavioral components. The biomechanical view is that physical activity is measured in terms of force, velocity, acceleration, mechanical power, or mechanical work produced. Physiological describes physical activity in terms of energy expenditure, using measures such as O_2 uptake, metabolic energy, metabolic power or metabolic equivalents (METs). Behaviourally physical activity is described as the type of activity (e.g. running, calisthenics) and the context of activity, that is the home, school, with friends or family (Malina *et al.,* 2004:458). The major contributors are everyday activities that involve moving the body around, such as walking, cycling, climbing stairs, housework, and shopping, with much of this occurring as an incidental part of our routines (WHO, 2010:10).

Regular engagement in moderate to high-intensity physical activity has been shown to protect the individual from chronic diseases and conditions such as obesity, diabetes and coronary heart diseases (Spengler & Woll, 2013:3), to promote bone development and bone strength (Spengler & Woll, 2013:3), to provide psychological advantages such as self-confidence and self-image (Davies *et al.,* 2011:708), and to prevent breast and colon cancer (WHO, 2015:35).

Physically active adolescents display healthier cardiovascular profiles (normal BMIs, and develop higher peak bone masses) than their less active counterparts. However, most adolescents fail to engage in vigorous- or moderate-intensity physical activity for the recommended 60 minutes or more each day, with as many as one-third reporting no physical activity in the preceding five days (CDC, 2012:1). The decrease in physical activity among adolescents may be amongst others, due to easy access to transport, because of unsafe circumstances and the distance between schools, and living areas, which prevents children from walking long distances to school (Monyeki, 2013:323), and increased sedentariness (Toriola & Monyeki, 2012:795; Van der Merwe, 2013:348). This lack of participation in physical activity has contributed to a greater prevalence of obesity, a decrease in fitness (e.g., flexibility, muscular strength, cardiorespiratory capacity), and a greater risk of disease (non-communicable diseases) (Malina, 2007:67; Steele *et al.,* 2008:342).

To understand why some people are physically active and others inactive, researchers have studied correlates including demographic/biological, psychological correlates, behavioural correlates, social/cultural and environmental correlates which influence an adolescent's participation in physical activity. Examining the characteristics of those less likely to be physically active has important implications for developing and understanding the initiation and adoption of this behaviour.

2.6 ASSESSMENT OF PHYSICAL ACTIVITY AMONG ADOLESCENTS

There are various techniques for assessing physical activity. These can be grouped into two broad categories: subjective, which includes observation and questionnaires (including activity diaries, recall questionnaire, interview) and objective, which includes physiological indices such as heart rate (HR), calorimetry, the doubly-labelled water (DLW) method and electronic motion sensors (Westerterp, 2017:1277). Each of these methods has its strengths and limitations in assessing leisure-time physical activity. The assessment technique applied must be socially acceptable, should not be a burden to the participant and should influence the individual's physical activity pattern minimally (Armstrong & Welsman, 2006:1067).

The frequency, intensity, duration and the mode of activity are monitored to be able to quantify physical activity level as accurately as possible (Armstrong & Welsman, 2006:1067). According to Kruger *et al.* (2006:1143), physical activity is assessed from the tasks performed during identifiable segments of daily life or measurement of the occurrence of the activity during non-working hours. The physical activity behaviours are assessed to monitor the status of important health-related behaviours, to determine trends and appropriately allocates resources and to evaluate programme or policy effectiveness (Tudor-Locke *et al.*, 2003:194). A short description of the various methods follows.

2.6.1 Subjective methods

2.6.1.1 Questionnaires

The questionnaire is a most useful method to estimate physical activity and is reliable during large epidemiological studies (Mota *et al.*, 2002:111). There are various questionnaires to record physical activity, inter alia World Health Organisation (WHO) questionnaires, self-reported activity log books, and other lesser known questionnaires (Mota *et al.*, 2002:111). In

particular, they are probably most effective for assessing easily-recalled, structured and time-delineated activities such as participation in sport, and routine activities such as walking to work (Warms, 2006:80). This method is inexpensive, simple and brief (Martinez-Gonzalez *et al.*, 2005:921).

Participants report about the intensity of the physical activity, the frequency of vigorous physical activity, the hours spent on vigorous physical activity, the average duration of a physical activity session and the participation in an organised physical activity (Yang *et al.*, 2010:370). The information in the previous mentioned questions is then coded for inactivity or very low activity (= 1), moderate activity (=2) to regular or vigorous activity (= 3) and then computed to form a physical activity index with a total score ranging from 5 to 15 (Yang *et al.*, 2010:370). In a study by Halldin *et al.* (2007:349-357) participants were instructed to classify themselves into one of the four groups, where group one was those with low physical activity suggesting a sedentary lifestyle with less than two hours of light physical activity per week (e.g. walking, cycling), group two were light physical activity (generally without sweating) at least two hour per week (e.g. walking to and from work, cycling, gardening), group three suggesting moderate physical activity viz., regular activity one to two times per week, at least 30 minutes each time (e.g. jogging swimming, tennis, badminton). The last group were those with a high physical activity level, indulging in intensive regular activity more than twice per week, at least 30 minutes each time (e.g. running, swimming, tennis, aerobics, or other strain exercises). Work-related physical activity was classified in the questionnaire as mainly sedentary/ physically very light, half work day sedentary/ physically light, less than half work day sedentary/ physically intense, and active/ physically strenuous (Halldin *et al.*, 2007:351).

The disadvantage of these techniques is that they are less robust in determining whether it is light or moderate physical activity (Sylvia *et al.*, 2014:199) and also energy expenditure (Shephard, 2003:197). They may also be limited by written language (questions) (Lassenius *et al.*, 2013:82) and social influences such as social desirability, complexity of the questionnaire, age, and seasonal variations (Sylvia *et al.*, 2014:199; Vanhees *et al.*, 2005:102). The recall bias may be noted when using self report questionnaires. If not given proper consideration, self reported questionnaire can either underestimate or overestimate the true effect or association. For an example, the over or under reporting of physical activity. Recall bias was found to be related to a number of factors, including length of the recall period (ie, short or long times of clinical assessment), characteristics of the disease under investigation (eg, acute, chronic),

patient/sample characteristics (eg, age, accessibility), and study design (eg, duration of study) (Coughlin, 1990: 87; Monyeki *et al.*, 2018: 71).

2.6.1.1.1 Examples of questionnaires

The International Physical Activity Questionnaire (IPAQ) is interested in finding out about the kind of physical activities that people do as part of their everyday lives. The questions will ask a person about the time he/she spent being physically active in the last seven days and will say: *Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. Think about all the vigorous and moderate activities that you did in the last seven days.* Vigorous physical activities refer to activities that take hard physical effort and make a person breathe much harder than normal. Moderate activities refer to activities that take moderate physical effort and make a person breathe somewhat harder than normal (Craig *et al.,* 2003:1381; Lee *et al.,* 2011:115). The activity is measured in metabolic equivalent (METs), which is simply the energy it takes to sit quietly (PAGAC, 2008). For the average adult, this is about one calorie per every one kilogram of body weight per hour. Moderate-intensity activities are those that get a person moving fast enough or strenuously enough to burn off three to six times as much energy per minute as one does when sitting quietly, or exercises that clock in at 3 to 6 METs (Lee *et al.,* 2011:115) and vigorous-intensity activities burn more than 6 METs (PAGAC, 2008). One limitation to this way of measuring exercise intensity is that it does not consider the fact that some people have a higher level of fitness than others, whereby IPAQ-SF has been found to overestimate intensity of physical activity participation among the adolescents (Monyeki *et al.*, 2018:71).

The reliability and validity of the IPAQ instrument were tested in 12 countries and were found to be reliable and valid for testing physical activity (Craig *et al.,* 2003:1381). The questionnaire was found to have acceptable measurement properties as good as other established self-reports and as being capable of monitoring population levels of physical activity among 18 to 65 years old adults in diverse settings (Craig *et al.,* 2003:1381). As such, IPAQ with its advantages and the purpose of the PAHLS (Monyeki *et al.,* 2018) was preferred for use in the current thesis.

The Physical Activity Questionnaire for Adolescents is a nine-item, seven day self-report recall questionnaire designed and extensively used for surveillance and monitoring. The PAQ-A is self-administered. It was developed to assess general levels of physical activity for high schools students in grades 9 to 12 and approximately 14 to 19 years of age. The PAQ-A can be administered in a classroom setting and provides a summary physical activity score derived from eight items (the ninth item does not factor into the overall score), each scored on a 5-point scale. Once you have a value from 1 to 5 for each of the 8 items (items 1 to 8) used in the Physical Activity composite score, you simply take the mean of these 8 items, which results in the final PAQ-A activity summary score. A score of 1 indicates low physical activity, whereas a score of 5 indicates high physical activity. Estimated completion time is 20 minutes (Bervoets *et al.,* 2014:47).

The Physical Activity Questionnaire for Adolescents (PAQ-A) is regarded as one of the most suitable self-report tools (Biddle *et al.,* 2011:1) and objective measure (Trost, 2007:299) for examining PA among adolescents. It was developed and tested for reliability and validity in various countries including African countries, such as Nigeria and Ghana (Adeniyi *et al.,* 2011:16; Asare & Danquah, 2015:11), in Europe, including Holland and the UK (Vos *et al.,* 2013: 55; Bervoets *et al.,* 2014:47). Acceptable test-retest reliability and internal consistency have also been demonstrated for the Physical activity Questionnaire for Children (PAQ-C) and PAQ-A (Martinez-Gomez *et al.,* 2009:427; Aggio *et al.,* 2016:3).

2.6.1.2 Interviews

Interviews have higher reliability and validity than self-administered questionnaires, however, the major drawback with interviews is the high cost in terms of observer time (Malina *et al*., 2004:461). They are therefore not used in large scale surveys. Interviewer-administered surveys are probably needed with low-literacy participants, but they are more expensive to use and require training of interviewers (Sallis, 2010:404).

2.6.1.3 Activity diaries

Diaries have been used successfully among children and adolescents. The major disadvantage of the diary method is its high degree of reactivity, which is the fact that there is a need to repeatedly record activities and this may create change in a person's spontaneous activities and

affect performance of tasks (Malina *et al.,* 2004:461; Sylvia *et al.,* 2014:199). In addition, questionnaires not completed in real time could be subject to memory bias as well as participant reactivity, the phenomenon of behavior change due to awareness of being observed (Lindamer *et al.,* 2008:294; Ling *et al.,* 2010:261; Hardy *et al.,* 2013:10).

2.6.2 Objective techniques

2.6.2.1 Doubly Labelled Water

This has been found to be the most precise method to measure energy expenditure and is regarded as the "golden standard" for the validation of other instruments measuring physical activity (Westerterp, 2017:1277). This method involves the administration of an oral dose of water containing specific isotopes of hydrogen and oxygen per kilogram body mass. The amount of isotopes measured in excreted urine after a twenty-four hour period is equivalent to the amount of metabolic carbon dioxide removed by the body. The metabolic carbon dioxide is then used to estimate the energy expenditure (Warms, 2006:80; Westerterp, 2017:1277). The doubly labelled water method is expensive and has limited applicability, does not provide the type, pattern, frequency, intensity and duration of physical activity carried out during the day and is not feasible for large populations due to financial costs.

2.6.2.2 Electronic Motion Sensors

These include devices such as pedometers and accelerometers (Bassett & John, 2010:135; Feito *et al.,* 2012:733). These devices are developed in response to the lack of reliability of self-report measures, intrusiveness of direct observation and the complexity of heart rate monitoring (Puyau *et al.,* 2002:152, Kowalski *et al.,* 2012:148). Pedometers and accelerometers are affordable and good enough to measure physical activity, specifically ambulatory habitual physical activity (Feito *et al.,* 2012:733; Hills *et al.,* 2014:5). These are usually worn on the waist where vertical motion occurs (Coleman *et al.,* 1999:9; Tudor-Locke & Meyers, 2001:92; Hills *et al.,* 2014:5). The disadvantage of this method is that insecurely fitted motion sensors cause vibration and displacement of the wearable systems, and this is liable to produce extraneous signal artefacts and to degrade sensing accuracy. However, the accelerometers or motion sensors should be securely fitted and attached to the human body in order to prevent relative motion between the sensors and the parts of the human body.

The selection of the assessment method (whether objective or subjective) to determine physical activity should be based on careful consideration of the advantages and disadvantages of the instrument, as well as indications for application and evidence to support that the instrument is reliable and valid (Trueth *et al.,* 2005:488; Haskell, Blair & Hill, 2009:280). Assessing physical activity may be filled with difficulties as it is multidimensional, and no single method can capture all subcomponents and domains in the activity of interest (Monyeki *et al.*, 2018:71).

2.7 LEVELS OF PHYSICAL ACTIVITY AMONG ADOLESCENTS

Physical activity is a crucial habit for adolescent health, normal growth and development. Given that PA habits formed early in life and may continue into adulthood, regular participation in PA during childhood and adolescence is of critical importance (Heitzler *et al.,* 2011:457). International data published in the Lancet Physical Activity Series (Hallal *et al.,* 2012:247) reports that 80% of 13-15 year olds do not meet the current physical activity recommendations of 60 minutes of moderate to vigorous physical activity per day.

In USA, only 27.9% of learners ages between six to seventeen years had participated in at least 60 minutes per day of physical activity on all seven days before the survey, and only 29% attended physical education class daily (CDC, 2013:SS4). In another study by Butcher *et al.* (2008: 360), it has been found that between 40% and 57% of adolescents in 100 cities in the USA did not conform to the guidelines of being active.

In Germany, Bös (2003:85) showed that among young people the amount of time being physically active decreased from three to four h/day in the 1970s to about one hour per day. In adolescents aged 11 to 17 years only 28.2% of the boys and about 17.3% of the girls are physically active on most days of the week (Graf *et al.,* 2014:178).

In China, a total of 35.6% students spent ≥1 h/day performing moderate to vigorous physical activity (MVPA) during school, and 34.9% spent ≥1 h/day in MVPA outside school time (Duan *et al.,* 2015: e0133544); there were 42.9% who reported screen time for ≥2 h/day. Although boys spent more time engaged in physical activity than girls did, they also spent more time exhibiting sedentary behaviour.

In Africa, although adolescents may engage in large volumes of light and incidental moderate-intensity physical activity during domestic activities and active transportation (Gibson *et al.,* 2013:e66552; Muthuri *et al.,* 2014:3327), multiple studies have consistently reported majority of adolescents in Africa as being insufficiently active to meet the MVPA recommendations (McVeigh & Meiring, 2014:371; Muthuri *et al.,* 2014:3327). Wushe *et al.* (2014:471) has reported an average MVPA (50.9 ± 40.3 minutes/day) for the study sample. Only 8% to 35% of African adolescents engaged in sufficient levels of physical activity for 60 minutes per day on at least five days per week (Guthold *et al.,* 2010:43). In Nigeria, about 72% of school going adolescents reported engaging in physical activity at least once a month (Senbanjo & Oshikoya, 2010:217), 59% engaged at moderate levels (Odunaiya *et al.,* 2010:529), and more than 50% engaged in low levels of physical activity (Adeniyi *et al.,* 2011:16). In a study among Zimbabwean adolescents concerning physical activity, it was revealed that the majority of children used active transport, played organised sports and engaged in acceptable levels of PA. However, most of them did not meet the recommended hours of unstructured/unorganised play per day (Manyanga *et al.,* 2016:S337). There is over 72% of Kenyan children and youth who use active transportation to and from school and in their daily lives. Although majority have normal body weight and acceptable sedentary time, but are not doing as well in attaining the World Health Organisation (WHO) recommendation on PA (Wachira *et al.* 2014:S69; Onywera *et al.,* 2016: S195).

In South Africa, data from the 2008 National Youth Risk Behaviour Survey found that 41% of the respondents (46% of females and 37% of males) had insufficient or no physical activity in the week prior to the survey (Joubert *et al.,* 2007:725; Peltzer, 2009:172; Reddy *et al.,* 2010: 176, Kinsman *et al.,* 2015:28790). The study by De Vos *et al.* (2016:372) revealed between 70.7% and 71.9% of the adolescents who did not meet the recommended health-based guidelines. This is slightly lower than the 80% of the world's adolescent population who do not comply with the guidelines according to WHO (2015). They further revealed that higher activity levels were shown during weekends, where the boys were significantly more active than girls ($p < 0.001$; ES between 0.21 and 0.56), and girls showed more sedentary behaviours than the boys (ES between 0.18 and 0.20) (De Vos *et al.,* 2016:372). However, the findings by Wushe *et al.* (2014:471) among adolescents in the Tlokwe Municipality of the North-West province revealed that girls were significantly more active than boys, expending more time in MVPA (61.13 ± 52.2 minutes/day; $p < 0.05$) compared to boys (35.0 ± 32.9 minutes/day). The

results further revealed that white adolescents spent more time in MVPA than black adolescents. However there was no significant difference in MVPA between black (47.87 ± 39.6 minutes/day; p = 0.58) and white adolescents (59.5 ± 41.8 minutes/day) (Wushe *et al.,* 2014).

The literature has consistently suggested that PA declines during adolescence (Dumith *et al.,* 2011:685), with a mean decline of 7% per year. It can therefore be estimated that the global PA change throughout adolescence would be ~60% to 70% (Dumith *et al.,* 2011:685). These results concurs with previous studies with the largest follow-up duration (9–10 to 18–19 years) that found an overall decrease of 83% (9.2% per year) considering the habitual PA (MET-time/week), although results were obtained only among girls (Kimm *et al.,* 2000:1445). One study revealed a significant increase among boys compared to girls (Janz *et al.,* 2000:1250). The increase among boys may be due to the stage of adolescence (Dumith *et al.,* 2011:685). Physical activity seems to show a greater decline after discernible physical maturation (Duncan *et al.,* 2007:80).

2.8 THEORIES FOR DETERMINING SOCIAL CORRELATES OF PHYSICAL ACTIVITY

Physical inactivity is a significant risk factor for numerous chronic diseases such as diabetes, cancer and cardiovascular diseases (Booth *et al.,* 2012:1143). Less than 50% of adolescents in Africa were found to be physically inactive (Guthold *et al.,* 2010:43), of these, in South Africa there were 31% who do not meet the recommended 60 minute three days per week of physical activity (Van Biljon *et al.,* 2018:126). The intrapersonal theories of health behaviour change are used as a guiding framework for understanding the extent to which psychological, social, and environmental factors predict health behaviour (Glanz, 2002:545; Lewis *et al.,* 2002:26). These theories differ in the conceptions of human nature they adopt, and in what they regard as being the basic causes and mechanisms of human motivation and behaviour.

2.8.1 Social cognitive theory (SCT) (Bandura, 1986)

The social cognitive theory (Bandura, 1986:15) is a widely accepted framework for understanding and explaining the influences of variables in adolescents' physical activity. The theory suggests that behaviour is primarily determined by two beliefs, namely self–efficacy

and outcome (Brassington & King, 2004:324). Self-efficacy refers to a person's confidence that they can successfully engage in a particular behaviour, while outcome expectations refers to a person's belief about how they would benefit from engaging in the behaviour. These are further influenced by personal factors, including past experience of success or failure doing the behaviour, secondary experience such as modelling by credible others, verbal persuasion from credible others and physiological states such as emotions and physical sensations related to performing the behaviour (Brassington & King, 2004:324). Behaviour can influence one's environment, and it is determined by that environment. These processes occur through observational learning and reinforcement (Dunton *et al.,* 2010:S92).

The model suggests that a person will only take health-related action (e.g. exercise) if he/she feels at risk of a negative health outcome (e.g. perceived severity of disease) and expects that by taking an action he/she will prevent negative health outcomes (Dunton *et al.,* 2010:S92). The model is based on four health beliefs, which are: perceived severity of a potential illness; perceived susceptibility to a disease; perceived benefits of engaging in a health promoting behaviour; and perceived barriers to participation in a health promoting behaviour (Brassington & King, 2004:323).

LaMorte (2016:15) highlighted the limitations to the social cognitive theory which should be considered when using this theory in public health as follows:

- The theory assumes that changes in the environment will automatically lead to changes in the person, which may not always be true.
- The theory is loosely organised, based solely on the dynamic interplay between person, behaviour, and environment. It is not clear the extent to which each affect actual behaviour and if one is more influential than another.
- The theory heavily focuses on the processes of learning and in doing so, disregards biological and hormonal predispositions that may influence behaviours, regardless of past experience and expectations.
- The theory does not focus on emotion or motivation, other than through reference to past experience. There is minimal attention paid to these factors.
- The theory can be broad-reaching and can be difficult to operationalise in entirety.

As with other theories, applicability of all the constructs of SCT to one public health problem may be difficult, especially in developing focused public health programmes (LaMorte, 2016:15).

2.8.3 Self-determination model (SDT) (Ryan & Deci, 2000:68)

The self-determination model suggests that people have three innate psychological needs that are considered to be universal necessities (Ryan & Deci, 2000:68). The theory further asserts that there are different approaches to motivation, and differentiates between different types of motivation.

- First, the need for **competence** means the desire to control and master the environment and outcome. We want to know how things will turn out and what the results of our actions are.

- Second, the need for **relatedness** deals with the desire to "interact with, be connected to, and experience caring for other people". Our actions and daily activities involve other people and through this, we seek the feeling of belongingness.

- Thirdly, the need for **autonomy** is concerned with the urge to be causal agents and to act in harmony with our integrated self. Deci and Ryan (2000:68) stated that, to be autonomous does not mean to be independent. It means having a sense of free will, when doing something, or acting out of our own interests and values.

Action vary in the degree to which they are volitional, without any external influence. Motivation to take action occurs along a continuum from external regulation (i.e. rewards, other demands), followed by introjection regulation (i.e. moral reasons), to identified regulation (i.e. useful outcomes), to integrated regulation (i.e. important for personal growth), to intrinsic motivation (i.e. mastery, enjoyment).

2.8.4 Trans-theoretical model (TTM) (Prochaska & DiClemente, 1984)

The model suggests that people progress through five stages of change towards permanently adopting a behaviour (Dunton *et al.*, 2010:S92). The stages are pre-contemplation, contemplation, preparation, action and maintenance. This model proposed that people move through the stages using a series of processes of change (e.g. conscious raising, stimulus control, etc.). The cognitive processes of change are more important in promoting behavioural

change at the earlier stages of change, and behavioural process are more effective in the later stage of change (Brassington & King, 2004:324). The Trans-theoretical Model provides suggested strategies for public health interventions to address people at various stages of the decision-making process. This can result in interventions that are tailored (i.e. a message or programme component has been specifically created for a target population's level of knowledge and motivation) and effective. The TTM encourages an assessment of an individual's current stage of change and accounts for any relapse in people's decision-making processes.

2.8.5 Theories of reasoned action/ theory of planned behaviour

Theory of reasoned action (Davis et al., 1989:984)

This theory state that people's participation in physical activity is primarily due to their intention to perform the behaviour, and that this intension is determined by one's attitude towards the behaviour and subjective norms (Brassington & King, 2004:323).

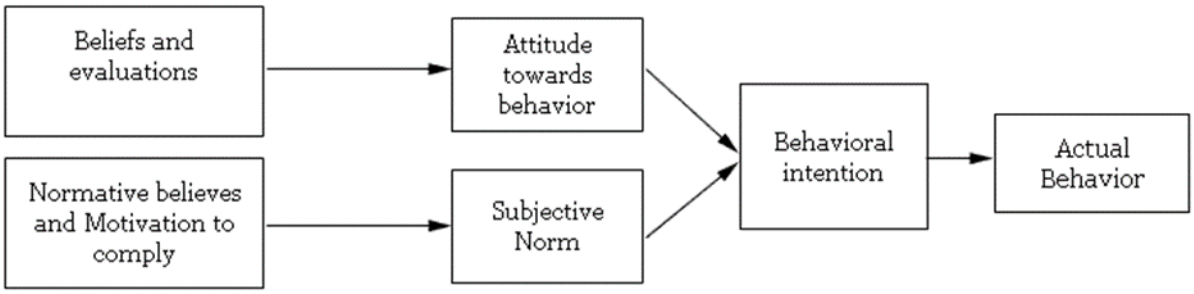

Figure 2.1*: Theory of Reasonned Action from Davis et al. (1989; pg. 984)*

The theory of reasoned actions suggests that the attitude of a person towards a behaviour is determined by his/her beliefs on the consequences of this behaviour, multiplied by his/her evaluation of these consequences. It further suggests that external stimuli influence attitudes by modifying the structure of the person's beliefs. Moreover, behavioural intention is also determined by the subjective norms that are themselves determined by the normative beliefs of an individual and by his/her motivation to comply with the norms.

Theory of planned behaviour (Ajzen, 1991:179)

This theory evolved from the Theory of reasoned action by adding the notion of perceived control to its model. This concept is similar to self-efficacy, which is concerned with one's perception about the level of physical activity. The behaviour is weighted by the belief of other people, the value attributed to these opinions and his/her perceived ease or difficulty of taking that action (i.e. behavioural control) (Dunton *et al.,* 2010:S92). Generally, if a person intends to take an action, then it is likely that he/she will do it.

2.8.6 Ecological model

Ecological model of physical activity have been developed that suggest correlates are specific to domains (Sallis *et al.,* 2006:297). The ecological model is the integration of ideas from several theories including inter-relations between individuals and their social environment. This model is now common in used (Sallis *et al.,* 2008:465). The approach uses a comprehensive framework to explain physical activity, proposing that determinants at all levels whether individual, social, environmental, and policy are contributors to physical activity. The model suggests that all domains are important for understanding worldwide physical activity, and that frequency in each domain varies greatly between countries (Bull *et al.,* 2009:790; Macniven *et al.,* 2012:41). For example, occupational, household, and transport domains are the most common types of physical activity in low-income and middle-income countries, whereas leisure-time activities contribute more to total physical activity in high-income countries than elsewhere (Macniven *et al.,* 2012:41). The key principle is that knowledge about all types of influence can inform the development of multilevel interventions to offer the best chance of success.

Social Cognitive Theory (SCT) is a learning theory based on the idea that people learn by observing others. People learn by observing others, with the environment, behaviour, and cognition, all as the chief factors influencing development in a reciprocal triadic relationship. In this model, Bandura (1999:4) explains the reciprocal causality, internal personal factors in the form of cognitive, affective and biological events; behavioural patterns; and environmental events all operate as interacting determinants that influence one another bidirectionally.

2.9. CHANGES IN SOCIAL CORRELATES OF PHYSICAL ACTIVITY

Many factors contribute to the decline in physical activity (PA) during adolescence. These factors are, and not limited to gender, socioeconomic status, psychological characteristics, friends, family, and physical environment all relate to different activity levels (Sallis, Prochaska & Taylor, 2000:963; Van Der Horst *et al.,* 2007:1241; Lubans, Foster & Biddle, 2008: 463).This decline contributes to increased mortality rate and burden of diseases (Derby *et al.,* 2011:396; Sanderson *et al.,* 2010:556; Zhao *et al.,* 2011:132). Intervention programmes also fail to increase the level of physical activity among adolescents. Ecologic frameworks account for factors beyond the individual, including intrapersonal factors, interpersonal relationships, and the physical environment, and how they influence health behaviours (Martinez *et al.,* 2009:22; McNiell *et al.,* 2006:36; Sallis & Owen 2008:465). Spence and Lee (2003:7) broadly divided the ecological model into intra-individual factors related to physical activity (including an individual's weight, attitude, and exercise self-efficacy) and extra-individual factors (including social factors, like neighbourhood cohesion and social support) (Anderson *et al.,* 2010:21). For physical activity interventions to be successful, it is important to target ecological domains beyond the individual level. The interventions should be theory-based and should include analysis of mediators across ecological domains in order to identify the most effective combination of factors to promote physical activity among adolescents (Perry *et al.,* 2012:2).

Correlates studies mostly relate to cross-sectional differences in levels of physical activity, and few to longitudinal studies. Findings are, therefore limited, to hypothesis generation concerning potential causal factors and mediators (Lubans *et al.,* 2008:463; Craggs *et al.,* 2011:645). Cross-sectional studies make it difficult to distinguish a determinant from a correlate (Atkin *et al.,* 2016:167). The characteristics inherent in longitudinal studies assist in identifying determinants, that is potential causal factors (Bauman *et al.,* 2002:23) and mediators of change in child and adolescent physical activity which should strengthen the evidence base to inform the development and targeting of effective interventions (Corder *et al.,* 2009:1078).

Determinants are defined as a preceding, causal predictor of change in physical activity (Bauman *et al.,* 2002:5). Several determinants can influence physical activity behaviour (Cavill *et al.,* 2006:2). These can be non-modifiable, such as age, gender, and social class, or modifiable. Modifiable determinants include personal factors (e.g. attitudes, motivation, self-

efficacy), the social environment (e.g. family, peers, social support), and the physical environment (e.g. access to sport facilities, urban development, transport infrastructure, green spaces). Other factors exhibiting similar associations to previously established cross-sectional results were: perceived behavioural control, parental role modelling, parental activity, and barriers for physical activity (Van Der Horst *et al.*, 2007:1241). Evidence has been consistent in supporting family social support (Hsu *et al.*, 2011:210; Siceloff *et al.*, 2013:1) and peer social support, (Beets *et al.*, 2006:278; Salvy *et al.*, 2012:369) as significant indicators of adolescents' moderate to vigorous physical activity (MVPA).

Identifying determinants, that are potential causal factors (Bauman *et al.*, 2002:5) and mediators of change in child and adolescent physical activity, would strengthen the evidence base to inform the development and targeting of effective interventions (Corder *et al.*, 2009:1078).

A study by Van Der Horst *et al.* (2000:963) on social correlates among children and adolescents, revealed that girls consistently reported larger declines in physical activity than did boys. In children aged 10 to13 years, no consistent results were evident for the association between physical activity and gender, whereas results consistently showed no association between gender and change in physical activity in adolescents. It may be possible that the gender differences in children decline with increasing age or maturity. Despite the unclear picture of its association with change in physical activity, maturation may be an important factor to consider when investigating age-related declines in physical activity (Sherar *et al.*, 2010:332; Bacil *et al.*, 2015:114). However, due to inter-individual variation in the timing and tempo of physical maturation, maturity may directly or indirectly explain inter-individual differences in physical activity decline (Drenowatz *et al.*, 2010:18). Zimmermann-Sloutskis *et al.* (2010:11) have found that the prevalence of inactivity, "no sport", complete inactivity, and non-membership in a sport club were all increasing with age. They further discovered that age higher than 16 years was a significant predictor for "no sport" in both genders and for "inactive" in women.

A change in family support was strongly associated with total PA, and these associations were positive. Girls who experienced more family support either little or higher had showed positive changes in total physical activity (Graham *et al.*, 2014:51). It has been further found that parent support, support from others, and opportunities to exercise, were positively associated with adolescents' PA participation (Sallis *et al.*, 2000:963; Graham *et al.*, 2014:51).

Parents appear to be a strong influence on physical activity behaviour. The mechanisms can be either direct (by providing a supportive, nurturing environment), indirect (through modelling), or, more likely, an interaction of the two (Cheng *et al.,* 2014:35). Other studies further hypothesised that there could be a significant genetic transmission of factors that predispose the child to increased levels of physical activity (Moore-Harrison & Lightfoot, 2010:271). Explicit modelling, through which the parents behaviour encourages the physical activities of children, or of logistical support, such as transporting children to and from activities may influence adolescents participation in physical activity (Griffith *et al.,* 2007:265). These findings suggest the need for additional research on parental influences to design more effective family-focused interventions.

Children whose parents are physically active have been reported to be nearly 6 times as likely to be active than children whose parents are both inactive (Cantell *et al.,* 2012:e20), and there appears to be reasonable evidence of a dose-response between number of active parents (0, 1, 2) and activity levels of children. Hesketh *et al.* (2017:987) demonstrated that parental inactivity was a strong positive predictor of children's inactivity, but, the parental activity scores were weaker predictors of the children's time spent in vigorous activity and their level of total physical activity. Similar findings emerged in a study by Griffith *et al.* (2007:265). Other results revealed that when both parents were active, the children were 5.8 times more likely to be active than were children of two inactive parents.

Peer influences appeared to be quite important with respect to participation in organised sports (Fitzgerald *et al.,* 2012:941), a large and growing source of physical activity among children and adolescents. Fitzgerald *et al.* (2012:941) identified six processes through which peers and/or friends may have an influence on physical activity including: peer and/or friend support, presence of peers and friends, peer norms, friendship quality and acceptance, peer crowds, and peer victimisation. Among high socialisers, odds of being active were over three times higher than low socialisers (Kirby *et al.,* 2011:785). Boys receive more parental and peer support for physical activity than girls (Raudsepp, 2006:79; Gustafson & Rhodes, 2006:93), thus pushing boys to be more active than girls as they move into adolescence. Another study by Grebremariam (2012:4) among 885 adolescents, revealed a small but a significant change in perceived social support from friends at baseline (BL), test measurement 1 (T1) and test measurement 2 (T2), with boys perceiving more social support for PA from friends than girls do.

A systemic review by Maturo and Cunningham (2013) of 106 studies published since 2000, investigating the influence of friends on children's physical activity, found a positive association between physical activity and positive communication about it from friends, the friends' own physical activity participation levels, and the friends' presence during participation in physical activity. Perceived peer support for physical activity was also positively associated with a percentage of daily MVPA (Bergh *et al.,* 2011:e315).

2.10. STUDIES IN DEVELOPED COUNTRIES ON SOCIAL CORRELATES OF PA, HEALTH-RELATED PHYSICAL FITNESS AND PHYSICAL ACTIVITY

Developed countries are associated with changes in behavioural and environmental factors (Stein & Coltiz, 2004:2522) which affect the health of adolescents. With advances in technology, there has been a greatly reduced dependence on walking and cycling for transportation. Household physical activity has most likely decreased due to labour-saving devices. Occupational energy requirements have also dropped as mechanised labour aids have become available and in general, jobs have become more sedentary. The decreasing energy expenditure accompanied by increasing energy consumption, has led to a positive energy balance and a marked increase in weight in society generally.

In the USA, data from a national study show that the vast majority of U.S. teenagers fail to meet the recommended one hour per day of moderate-to-vigorous physical activity (Troriano *et al.,* 2008:181). In 2013, only 29% percent of high school students reported that they had participated in at least 60 minutes per day of physical activity on each of the seven days before the Youth Risk Behavior Surveillance (CDC, 2013). Studies of Latino youth revealed that physical activity levels decrease markedly with increasing age and showing that physical activity is consistently lower among Latino girls than boys (Butte *et al.,* 2007:1257; Stovitz *et al.,* 2008:19; Belcher *et al.,* 2010:2211). A review study from 1993 reported a decline of 2.7% per year among boys and 7.4% per year among girls (Sallis, 1993:403). Another study among 398 high school girls in South Carolina, has revealed that vigorous physical activity declined from 45.4% in 8th Grade to 34.1% in 12th Grade (Pate *et al.,* 2007:1). They also asserted that the probability of participating in several forms of vigorous physical activity in 12th Grade was strongly associated with participation in those activities in 8th grade (Pate *et al.,* 2007:1). In

the same study it was revealed that girls who reported lower family support at the 8th Grade measure showed more rapid declines in PA (Dowda *et al.,* 2007:153).

In Europe, the HELENA study in 10 cities from nine European countries: Athens (Greece), Dortmund (Germany), Ghent (Belgium), Heraklion (Greece), Lille (France), Pécs (Hungary), Rome (Italy), Stockholm (Sweden), Vienna (Austria) and Zaragoza (Spain) among 3528 adolescents (52.3% girls) aged 12.5 to17.5 years revealed that peer, siblings and parental physical activity was associated with adolescent physical activity engagement and level of physical activity (Martin-Matillas *et al.,* 2010:705). It has further been revealed that low parent and low peer support were associated with reduced odds of being regularly active after school (Hohepa *et al.,* 2007:54). In a study concerning the longitudinal changes with chronological age and differences between boys and girls (Kemper *et al.,* 2013:524), it was revealed that boys and girls increased their peak VO_2 (ml/min) significantly (p <0.001) until age 14 in girls and until age 17 in boys. Their results also revealed that the peak VO_2 relative to bodyweight (peak VO_2/BW) had significantly ($p < 0.001$) decreased over the whole age range from 12 to 36 years in both sexes (Kemper *et al.,* 2013:524) and vigorous physical activity (VPA) also showed a decrease and was significantly ($p < 0.001$) related to lower peak VO_2/BW (Beta = 0.001). This relation was stronger in boys than in girls.

2.11. STUDIES IN DEVELOPING COUNTRIES ON SOCIAL CORRELATES OF PA, HEALTH-RELATED PHYSICAL FITNESS AND PHYSICAL ACTIVITY

An era of what is termed "Nutritional transition" has brought with it increased risk of non-communicable diseases (Vorster *et al.,* 2011:429). The change in diet has been significant in terms of more fat, more meat, added sugars and bigger portion sizes. "Nutrition transition," termed as a combination of improved access to food (Vorster *et al.,* 2011:429), and decreased physical activity level (PAL) have been identified to be the prime risk factors for increasing the prevalence of overweight and chronic metabolic diseases in the developing countries (Hoffman, 2004:610s). Such alterations dietary patterns are often the manifestations of societal and environmental changes that emerge as a result of a lack of supportive policies in health, agricultural, transport, urban planning, food processing, distribution, marketing, and educational sectors (WHO, 2013).

In Brazil, a study (Dumith *et al.*, 2010:642) among 519 Brazilian adolescents aged 7 to 15 years assessing overweight, obesity and physical fitness, revealed that the prevalence of overweight and obesity was 24% and 12%, among boys and girls respectively. The results also showed that normal weight students performed better than did overweight and obese students in all physical fitness tests, while those with higher BMI value were associated with declines in physical fitness (Dumith *et al.*, 2010:642). Additionally, cardiorespiratory fitness had the strongest association with BMI status (Dumith *et al.*, 2010:642).

In China, the study by Wang *et al.* (2016:397) revealed that 30.1% boys and 43.0% girls did not engage in sufficient physical activity. The study further revealed that gender, obesity, high family income, and low family support were positively associated with higher physical activity levels among boys and girls (Wang *et al.*, 2016:397).

Family support has been found to be significantly associated with low level physical activity. In a study among 402 adolescents in **Iran,** the results revealed that poor family support (OR=1.10, 95% CI=1.03–1.20, p=0.038) was the most significant contributing factor to low level physical activity in adolescents (Shokrvash *et al.*, 2013:1). Low perceived informational support for males and low practical and emotional support for females were found to be significant predictors of lower level of physical activity (Craggs *et al.*, 2011:645; Kelishadi, 2010:131).

A study among **Korean** adolescents between the ages of 13 and 14 revealed that 66% of adolescents were physically active. Females were less active than males. Social support has been shown to be a positive correlation with physical activity (Hwang & Kim, 2011:19).

Similar results were seen among 519 adolescents (14-16 yrs) **in Malaysia**. Females were found to be less active as compared to their male counterparts. The study also revealed that personal barriers such as time constrains, such as burden of homework, tuition and weather factors were associated with physical activity (Aniza & Fairuz, 2009:228). In Malaysia, less than 2% of children (mean age of 12.9 years) achieved the required MVPA (Su *et al.*, 2014:67), and spend an average of 4.69 hours per day on media-based recreation such as TV viewing and electronic games (Cheuh *et al.*, 2011:33).

In the **African region**, only 8% to 35% of African adolescents engaged in sufficient levels of physical activity for 60 minutes a day on at least five days per week (Guthold *et al.*, 2010:43). In Nigeria, about 59% of adolescents engaged at moderate levels, and more than 50% engaged

in low levels of physical activity (Adeniyi *et al.,* 2011:16). Physical activity among adolescents in Nigeria varies according to the adolescents' age, gender, weight status and SES (Oyeyemi *et al.,* 2016:e150142).

In South Africa, the national youth risk behaviour study revealed that girls had a higher prevalence of overweight increasing from 24% to 29% between 2002 and 2008, and obesity rates in the same group rising from 5% to 7.5% (Reddy *et al.,* 2012:262). Further, data from the 2008 National Youth Risk Behaviour Survey found that 41% of the respondents (46% of females and 37% of males) had insufficient or no physical activity in the week prior to the survey (Reddy *et al.,* 2010:176). A study by Toriola and Monyeki (2012:795) revealed that 80(30%) of the adolescents had low physical activity levels, and 78(27.5%) were moderately active while 88(31.1%) were highly active. Studies by Amusa *et al.* (2010:221), Mantsena *et al.* (2003:225) and Monyeki *et al.* (2005:877) in rural areas in Limpopo Province of South Africa have consistently reported body weight disorders and incidence of health-risk behaviours in adolescents. A longitudinal study by Toriola and Monyeki (2012:796) focusing on the health-related fitness, body composition and physical activity status among adolescent learners, revealed that girls were more overweight (32.4%) compared to the boys (17.1%). Additionally, the girls (%body fat 26.01±8.51) were substantially ($p<0.000$) fatter than the boys (13.19±8.56). Girls were consistently showing low physical activity and more overweight and obese.

The lack of social support for participation in PA remains a challenge in South African children (Uys *et al.,* 2016:s268), and 11% to 54% adolescent girls reported this as a barrier for their participation in physical activity (Skaal *et al.,* 2015:1337). The lack of parental support in rural communities is due to the old cultural perception that sport participation was not ideal for girls, because this took them away from their household chores (Kubayi *et al.,* 2014:1305). However, the strongest predictors were when parents participated in PA with their children, (Cozett, 2014:13), provided transport (Uys *et al.,* 2016:462), or gave them encouragement and support. Peer influence, PA self-efficacy and perceived PA competence have been found to be strong predictors of PA participation in South African senior primary school learners (Cozett, 2014:13).

2.12. CHAPTER SUMMARY

The literature review presented has revealed that the physical activity levels of adolescent are generally low and below the recommendation of 60 minutes on most days of the week. It has also demonstrated that lack of physical activity predisposes adolescents to the development of chronic diseases of lifestyle.

The review demonstrated that physical activity leads to the improvement of the health-related components of fitness. The health-related physical fitness components consist of body composition, cardiorespiratory fitness, flexibility, muscular endurance and muscular strength, and are related to health outcomes and/or health markers in adolescents. The review also demonstrated that healthy levels of health-related fitness components allow individuals to perform physical activities with vigour and promote resistance to fatigue.

The different methods for measuring the variables in study were reviewed and discussed extensively, looking at how they are administered, the conditions for administering, the advantages and disadvantages were discussed. Each technique has its shortcomings, and a careful review of each may improve the reliability of the tests conducted. However, the use of common measures and protocols across large studies enhances the capacity to combine or compare data across studies to benefit both the experts and non-experts of physical activity or fitness. Use of these common measures by the research community should increase statistical power and enhance the ability to answer scientific questions that may have previously gone unanswered.

Correlates such as demographic, biological, environmental, social and psychological; have been investigated to be influential in a young person's level of physical activity. The literature has demonstrated how social correlates such as gender, age, and support received from family, friends, teachers, and coaches, influence physical activity participation among adolescents. The patterns of changes in social correlates of PA over a longitudinal study were demonstrated.

The prevalence of PA, social correlates and HRFC in developed and developing countries were demonstrated. Various assessment procedures for PA, social correlates and HRFC were also reviewed.

From the literature review, the levels of physical activity among adolescents, the correlates associated with physical activity have been discussed. It has been noted that most of the

previous studies were cross-sectional in nature with little or no causal inference as found in longitudinal studies. While physical activity tracks over time, therefore, one would assume that these factors (correlates associated with physical activity) should also change over time. The World Health Oganisation (WHO) recommends that adolescents should accumulate at least 60 minutes of moderate- to vigorous-intensity physical activity daily in most days of the week. As seen from the literature adolescents do not meet the recommendations. Studying the reasons why physical activity declines during adolescents, studying the patterns of these changes through the adolescence stage should be done in a longitudinal study. The longitudinal studies can reveal the pattern of these changes and indicate proper timing for intervention.

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Chapter 3
The three-year developmental changes in social correlates of physical activity in girls and boys: the PAHL study

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The three-year developmental changes in social correlates of physical activity in girls and boys: the PAHL study.

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Abstract

Background: Cross-sectional evidence has been consistent in supporting family social and peer social support, as significant indicators of adolescents' participation in Moderate to Vigorous Physical Activity (MVPA). The objective of this study was to investigate the changes in social correlates of physical activity in a three-year follow-up study of learners from selected schools in the Tlokwe local municipality, South Africa.

Methods: Data from a total of 206 (where boys: 73 and girls: 133) in 2012, 160 (where boys: 62 and girls: 98) in 2013 and 138 (where boys: 87 and girls: 51) in 2014 at the three measurements of 2012 to 2014 in the Physical Activity and Health Longitudinal Study (PAHLS) were used. The fourteen year olds in grade 8 were purposefully selected as participants in the study. Anthropometric measurements of height, weight, skinfolds thickness and waist circumferences were determined using the standard procedures described by the International Society for the Advancement of Kinanthropometry (ISAK). Waist-to-height ratio (WHtR), body mass index (BMI) and percentage body fat (%BF) were calculated. A standardised questionnaire on the 'Social Support for Physical Activity' was used to gather information on social correlates for physical activity.

Results: There were significant statistical ($p<0.05$) changes and a high correlation coefficient (ranging from r=0.90 to r=0.97) as well as large partial ($d>0.08$) effect sizes in BMI, %BF and WHtR over a three year period. However, there was a statistical significant increases between body mass measured at time points 1 (T1) vs 2 (T2) ($Z= 1.820$, p=0.014) and between body mass at time points 2 (T2) vs 3 (T3)($Z= 1.620$, p=0.000). In addition, a statistical increase in BMI measured at time point 1 (T2) and BMI at measurement point 2 (T3) ($Z= 1.010$, p=0.002). Insignificant practical small and not significant statistical ($p>0.05$) changes in social correlates

(i.e. encouragement, coactivity, transportation) were found. A practical small significant change (*d*=0.007; p=0.04) for someone who watched you participate in PA, or sport among girls (i.e. changes from mean 2.14(0.60), to 2.02(0.58), was revealed. When a post-hoc followed was performed, the median (IQR) for *"During a typical week has someone watched you participate in physical activities of sports?"*, for measurement at points 2 and 3 was Z=-2.909, p=0.004. Additionally, in both boys and girls there was a change in the construct of transportation to do physical activities or sports, which decreased from a mean of 1.88 to 1.71.

Conclusions: Significantly high correlation coefficients exists for the developmental changes in body mass, stature, BMI, %BF and WHtR over a period of time. Additionally, the results showed an increase in BMI over a period of time. The adolescents experienced a decrease in transportation support to physical activity or sport facilities over time. Adolescents were motivated when watched by others when participating in physical activity. Based on the findings, the study recommend the following: Clear policies on school physical education, focusing on creation of extracurricular activities including entertainment programmes in the form of games, holding regular competitions and summer camps where teachers and even parents can participate in. Government to provide appropriate facilities in schools and communities to promote physical activity. To develop programmes in communities that will promote cohesion between the adolescents, parents and the community at large.

Key words: Correlates, changes, physical activity, tracking, coactivity, modelling

Background

Physical inactivity has been ranked among the ten major causes of mortality and disability in the developed world.[1] Salutogenic benefits of physical activity are widely recognised in literature, which also suggests that the promotion of physical activity should begin already in early life.[2] The positive effects of PA among the adolescents (i.e. a period during which major events such as the growth spurt and sexual maturation occur) [3,4] include health outcomes such as improved aerobic fitness, blood lipids, blood pressure, body composition, glucose metabolism, skeletal health, and psychological health.[5] Given these health benefits, adolescents still do not meet the recommendations to be physically active for 60 minutes or accumulate 30 to 60 minutes ranging up to several hours per day.[6,7]

International data published in the "Lancet Physical Activity Series" reported that 80% of 13 to15 year olds do not meet the current physical activity recommendations of 60 minutes of moderate to vigorous physical activity per day.[8] In the USA, only 27.9% of learners, age between 6 and 17 years had participated in at least 60 minutes per day of physical activity on all seven days before the survey. [9] In Africa, only 8% to 35% of African adolescents engaged in sufficient levels of physical activity for 60 minutes per day on at least five days per week[10] and reports in South Africa reveal that 41% of the respondents (46% of females and 37% of males) had insufficient or no physical activity in the week prior to the survey.[11-14]

Public health efforts directed at promoting physical activity and preventing this age related decline globally have been done with limited success.[15] Numerous studies have shown that there are several factors that affect physical activity among adolescents; including gender[16], age[16-18], support received from family[17,19], friends, teachers, and coaches.[20]

Social support is a construct contained in a number of theories (Social Cognitive and Planned Behaviour Theory) and models (Health Belief and Social Ecological Model) used to explain physical activity behaviour.[21] The social cognitive theory by Bandura [22] is a widely accepted framework for understanding and explaining influences of variables on adolescents' physical activity profile. Before intervention can be planned, the key variables that are correlated with behaviour, need to be identified. It is believed that physical activity is not changed by the intervention per se; however, some personal, social or environmental variables influence the physical activity behaviour.

Potential correlates of physical activity were found to track moderately in the transition between childhood and adolescence.[23,24] Understanding of these associated correlates of physical activity would be significantly enhanced by an examination of these correlates, and other factors in a longitudinal study.[17] Intervention programmes are based on the assumptions that physical active behaviour tracks over time.[24]

As physical activity appears to track over time, one would thus also assume that some of its psychological and social-environment would display that pattern, although stability in physical activity behaviour might also be related to other factors such as the behaviour becoming habitual or hereditary.[24] It is important to investigate the changes in social correlates of physical activity in order to identify patterns of change in these correlates and indicate the proper timing for intervention among adolescents.[24] The aim of the study was to investigate the changes in social correlates of physical activity among adolescents in the Tlokwe Local Municipality of South Africa.

Methods

Study design and subjects

The longitudinal design approach, involving data sets from 2012 to 2014 from the "Physical Activity and Health Longitudinal Study" (PAHLS) [25], was used. PAHLS is an observational multidisciplinary longitudinal design that started in 2010. The participants were purposefully drawn from six out of eight secondary schools within the Tlokwe municipality. The schools in the study are from the high socio-economic (Potchefstroom town) and low socio-economic (Township) status. Leaners whose parents completed the informed consent form and have given a verbal accent were recruited as participants in the study. Data on a total of 206 boys and girls (73 and girls: 133), respectively were analysed. Participants with missing/incomplete data were not included in the analysis, and that played a significant role in the unequal number of participants. The numbers of participants are not consistent because of the characteristics inherent in a longitudinal study. Drop-out in the study was inter alia accounted for by absence during the day of measurements, school leaving and transfers from one school to the other. However, subject attrition did not have any significant effect on the data analysed for the objective of the current study of 206 (boys=73 and girls=133).

Instrumentation

Physiological variables

Anthropometric measurements of height, weight, skinfold thickness (triceps, subscapular and calf skinfolds), and waist circumferences were measured using the standard procedures described by the International Society of Advancement of Kinanthropometry (ISAK). [26] Body Mass Index as a measure of body composition was calculated as body mass/stature² (kg/m²). Subsequently, waist-to-height ratio (WHtR) was calculated from weight divided by height. Percentage body fat was derived from skinfolds measurements according to the equation developed by Slaughter *et al.* [27]

Social support for physical activity:

A standardised questionnaire on the Social Support for Physical Activity was used to gather information on social correlates for physical activity.[28] The Social Support for Physical Activity Scale includes nine (9) statements rated on a three-point Likert-type scale (*i.e.* 'never', 'sometimes', and 'everyday'). For this study the social support for physical activity in a typical week participation in physical activity or sport were grouped together under the sub-themes described below on the basis of their commonality.

a. *Encouragement by friends or someone* is covered under question numbers: 1) During a typical week, how often do you encourage your friend to do physical activity or play sports? 2) During a typical week, how often do your friends encourage you to do physical activity or sports? and 5) During a typical week has someone encouraged you to do physical activities or sports?

b. *Do you do PA or sport with friends or someone*, is covered under question numbers: 3) During a typical week, how often do your friends do physical activities or play sport with you? and 6) During a typical week has someone done a physical activity or played sports with you?

c. *Did someone watch you when you participated in PA or Sport?* is covered under question 8) During a typical week has someone watched you participate in physical activities of sports?

d. *Did someone or friends tell you that you are doing good or well,* is covered under question numbers: 4) During a typical week, how often do your friends tell you that you are doing a

good job at physical activity? and 9) During a typical week has someone told you that you are doing well in physical activity?

e. *Transportation to the PA or sport facilities,* is covered under question 7) During a typical week has someone provided transportation to a place where you can do physical activities or play sports?

For statistical analyses, the three-point type scale was scored as follows: Never = 1; sometimes = 2 and every day =3 per item.

Procedures for data collection

Permission for this study was first sought from the District Manager of the Department of Education in Potchefstroom, and ethical approval was obtained from the Ethics Committee of the North-West University, Potchefstroom campus (Ethics number: NWU-0058-01-A1). The participating schools were briefed about the purpose of the study through the information letter which was given to the school authorities, the parents and the learners. The nature of the study, all possible risks and benefits were explained to them. Additionally, participants were told that data collected is for research only and it will be anonymised to protect their identity. Written informed consent was obtained from the school authorities, the parents and the pupils of the participating schools. Only children whose parents gave consent and had given verbal assent were allowed to participate in the study.[25] The participants who were aged 14 years and in grade 8 were purposefully selected from class lists provided so that they could be successfully followed for the duration of the 5 year PAHL study before completing high school at the age of 18 years.The participants were given the questionnaire with adequate instructions and recommendations, and were not given a time limit for the completion of the questionnaire, and any doubts were promptly explained by the research investigator in charge of the data collection. During the questionnaire completion, the adolescents had no communication with each other. This was an attempt to avoid possible undesirable interferences in their responses. The questionnaires were completed in a classroom and the researcher was there to assist and provide clarification of the questions. Anthropometric measurements of height, weight, skinfold thickness (triceps, subscapular and calf skinfolds), and waist and hip circumferences, as well as the social correlates questionnaire, were completed in 2012, 2013 and again in 2014. All procedures were in accordance with the ethical standards of the North-West University Ethics Committee and with the Helsinki Declaration

Statistical analysis

Descriptive statistics including frequency, percentage, mean, and standard deviations were used to explore the data. For comparing the continuous data we used *t*-test, and chi-square was used for comparing mean changes for the social correlates mean over a period of time. Non-parametric repeated-measures ANOVA- with the Friedman test was used to assess changes in the correlates between test measurement number one (T1), test measurement number two T2 and test measurement number three (T3). Since the statistical significant found with Friedman test does not pinpoint which groups in particular differ from each other, post-hoc analyses with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied for multiple comparison, which makes it more likely to declare a results significant when there was no Type I error. To comply with the rules of Bonferroni test, we divided the p-value of 0.05 by the number of the tests (i.e. 0.05/3=0.017). As such, the new significant level used in this test was 0.017; and that means that if the p-value was larger than 0.017, we do not have a statistical significant result. Effect sizes [partial *E*ta squared (η_p^2)] were used to assess the magnitude of these changes. The cut-offs suggested by Cohen (*d*) were used for the interpretation of effect sizes (0.2 = small effect, 0.5 = moderate effect, 0.8 = larger effect).[29] Tracking (stability) was assessed using Spearman's rank order correlation coefficient. Correlation coefficients of <0.30 indicate low correlation, 0.30 to 0.60 moderate, and >0.60 moderately high correlation.[30] Partial correlation coefficient was controlled for the baseline measurements. Attrition analysis was performed using an independent sample *t*-test and chi-square of proportions to determine the difference in baseline characteristics between participants and drop-outs (n=49; 20%). No significant difference (p>0.05) were found between the participants and the drop-outs. Data were analysed using the SPSS statistics software version 21.

Results

Table 3.1 presents participants mean, standard deviation, partial *E*ta square and *p*-value of the differences for body mass, stature, BMI, % BF and WHtR for the total group in the three measurements points.

Table 3.1: Descriptive characteristics of the variables for the total group

	2012 (n=206), 15 yrs	2013 (n=160); 16 yrs	2014 (n=138), 17 yrs	Correlation coefficients	η_p^2	P-value of the differences
	Mean(SD)	Mean(SD)	Mean(SD)	*r*		
Body Mass (kg)	57.22(13.79)	59.04(13.35)	60.66(13.60)	0.96**	0.95	0.001
Stature (cm)	162.60(4.39)	163.29(9.70)	164.77(10.03)	0.97**	0.99	0.001
BMI (kg/m^2)	21.55(4.38)	21.81(4.21)	22.56(4.64)	0.95**	0.98	0.001
%BF (kg)	19.73(9.56)	20.37(8.30)	21.29(10.01)	0.90**	0.90	0.001
WHtR	0.41(0.05)	0.42(0.05)	0.43(0.06)	0.91**	0.99	0.001

η_p^2=Partial *E*ta square or Cohen *d*; BMI = Body mass index; %BF = percentage body fat; WHtR = Waist to height ratio

The results show significant increases (p<0.05) of 1.82 kg (2013) and 1.62kg (2014) for body weight; 0.69 cm (2013); 1.48 cm (2014) in stature; 0.76 kg/m^2 (2013), 0.75 kg/m^2 (2014) in BMI; 0.64 (2013) and 0.92 (2014) for percentage body fat over the period of time. All changes in the body mass, stature, BMI, %BF and WHtR significantly (p=0.001) showed lager effect size (*d*>0.08). However, there has been a constant increase in WHtR ratio of 0.01 in 2013 from baseline and 0.01 in 2014 compared to 2013. The partial *E*ta square of the effect size of the changes was relatively large (**η_p^2** ranged from ***d*=**0.90 to *d*=0.99) for variables of body mass, stature, BMI, %BF and WHtR over a period of three years. There was a statistically significant differences in body mass (X^2(df=2) = 10.354, p=0.006) and BMI (X^2(*df*=2) = 11.400) over a period of three years. Post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a statistical significant level set at p<0.017. Median (IQR) for body mass T1, body mass T2 and body mass T3 were 54.17 (47.50 to 63.06), 57.45 (49.27 to 66.78) and 57.50 (50.47 to 66.70), respectively. There was no statistical significant difference between body mass T1 vs body mass measured at point 3 (T3)(*Z* = -2.241, *p*=0.025) measurements, despite an overall decrease in the body mass measurements. However, there was a statistical significant decrease between body mass measured at time point 1 (T1) vs body mass measured at point 2 (T2) (*Z*= -2.451, *p*=0.014) and between body mass at time 2 (T2) vs body mass at measured at point 3 (T3)(*Z*= 4.079, p=0.000). No statistical significant difference over a period of three years was found for body stature (X^2 (*df*=2) = 2.450, p=0.294) and %BF (X^2 (*df*=2) = 2.425, p=0.297) and WHtR (*Z*=5.225, p=0.073), as such there was no need to do post-hoc analyses. Median (IQR) for BMI T1, BMI T2 and BMI T3 were 20.61 (18.89 to 23.04), 21.12 (19.21 to 24.80) and 21.53 (19.17 to 24.87), respectively. There was no significant differences between BMI T1 (*Z* = -2.240, *p*=0.025) and BMI T2 or between the BMI T1 and BMI T3 (*Z*= -2.313, *p*=0.021) measurements, despite an overall decrease in the BMI measurements. However, there was a

statistical decrease in BMI measured at time point 1 (T2) and BMI at measurement point 2 (T3) (Z= -3.034, p=0.002).

Furthermore, the results show highly significant (p= 0.001) correlation coefficients for the changes in all the variables of body mass (r = 0.96), stature (r=0.97), BMI (r=0.95), %BF (r=0.90) and WHtR (r=0.91) over the period of three years.

Table 3.2: Participants' characteristics by gender and three years of measurements

	Total Group	Boys			Girls			
	2012 (n=206), 15 yrs	2012 (n=73)	2013 (n=62)	2014 (n=51)	2012 (n=133)	2013 (n=98)	2014 (n=87)	P-value
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	
Body Mass (Kg)	57.02(13.43)	55.69(13.00)	63.68(14.77)	63.99(14.42)	57.33(14.02)	57.73(13.11)	58.94(13.85)	0.01
Stature (cm)	161.67(9.49)	164.57(10.78)	171.73(8.38)	172.31(8.13)	158.84(9.00)	159.17(7.37)	159.53(6.31)	<0.001
BMI (kg)	21.75(4.56)	21.64(4.74)	21.43(3.83)	21.37(3.53)	21.44(4.30)	22.56(5.14)	23.86(4.62)	<0.001
%BF	20.26(9.36)	20.61(9.64)	13.19(7.84)	12.02(6.83)	19.45(9.69)	24.78(4.73)	26.54(7.37)	<0.001
WHtR	0.43(0.05)	0.43(0.05)	0.42(0.04)	0.41(0.03)	0.42(0.05)	0.43(0.05)	0.44(0.07)	<0.001

BMI = Body mass index; %BF = percentage body fat; WHtR = Waist to height ratio

Table 3.2 presents the participants' mean and standard deviation for body mass, stature, BMI, %BF and WHtR for the total group by gender during the three measurements. There was a gradual significant increase in mean body mass for both boys and girls in the three measurement points for the whole group. The boys showed a gradual significant increase in stature compared to the girls. Girls showed increased changes BMI, %BF and WHtR compared to boys who showed decreases in the three parameters mentioned over a period of time.

Table 3.3: Social correlates of physical activity among 15 – 17 year-old adolescents

		Mean (SD)				
Social correlates of physical activity	**Gender**	**Baseline (n=206)2012**	**2013 (n=160)**	**2014 (n=138)**	**η_p^2**	**p-value**
During a typical week, how often do you encourage your friend to do physical activity or play sports?	Boys [c]	2.36 (0.51)	2.35 (0.63)	2.20 (0.58)	0.06[†]	0.36
	Girls	2.14 (0.58)	2.16 (0.51)	2.15 (0.66)	0.009[†]	0.77
During a typical week, how often do your friends encourage you to do physical activity or sports?	Boys	2.20 (0.62)	2.19 (0.57)	2.21 (0.53)	0.004[†]	0.72
	Girls	1.96 (0.68)	2.08 (0.68)	2.09 (0.64)	0.003[†]	0.17
During a typical week, how often do your friends do physical activities or play sport with you?	Boys	2.52 (0.58)	2.35 (0.57)	2.45 (0.53)	0.07[†]	0.27
	Girls	2.10 (0.61)	2.13 (0.58)	2.06 (0.62)	0.23[†]	0.71
During a typical week, how often do your friends tell you that you are doing a good job at physical activity?	Boys	2.31 (0.60)	2.12 (0.57)	2.21 (0.63)	0.02[†]	0.14
	Girls	2.19 (0.68)	2.09 (0.66)	2.12 (0.71)	0.05[†]	0.40
During a typical week has someone encouraged you to do physical activities or sports?	Boys	2.29 (0.64)	2.19 (0.61)	2.43 (0.58)	0.01[†]	0.06
	Girls	2.27 (0.69)	2.34 (0.59)	2.25 (0.62)	0.08	0.73
During a typical week has someone done a physical activity or played sports with you?	Boys	2.50 (0.57)	2.51 (0.61)	2.44 (0.55)	0.02[†]	0.21
	Girls	2.17 (0.56)	2.22 (0.51)	2.24 (0.51)	0.00[†]	0.67
During a typical week has someone provided transportation to a place where you can do physical activities or play sports?	Boys	1.93 (0.72)	1.88 (0.71)	1.71 (0.64)	0.08†	0.10
	Girls	1.83 (0.70)	1.88 (0.72)	1.71 (0.69)	0.005[†]	0.74
During a typical week has someone watched you participate in physical activities or sports?	Boys	2.29 (0.64)	2.32 (0.62)	2.29 (0.62)	0.09†	0.81
	Girls	2.21 (0.70)	2.14 (0.60)	2.02 (0.58)	0.007	0.04
During a typical week has someone told you that you are doing well in physical activity?	Boys	2.38 (0.65)	2.27 (0.59)	2.30 (0.63)	0.02[†]	0.11
	Girls	2.21 (0.67)	2.14 (0.60)	2.10 (0.68	0.00[†]	0.68

[C]= statistical significant between baseline and 2 year follow-up; p-value for statistical significant by each gender in the 3 year of measurement point; [†]eta square (η_p^2) or Cohen *d* not significant, which show that there was no significant development over time.

Table 3.3 presents participants' mean, standard deviation, ηp² and p-values of the social correlates of physical activity at the three measurements of 2012 to 2014 for the total group. Out of the nine social correlates of physical activity only two showed significant changes over three measurements points. The variable; '*during a typical week has someone encouraged you to do physical activities or sports?'* show borderline (p=0.06) small practical partial *eta* effect sizes (*d*=0.1) significant differences in the changes in favour of the boys [mean: 2.29(0.64), 2012; mean: 2.19(0.61), 2013; and mean: 2.43(0.58), 2014] compared to the girls [mean: 2.27(0.69), 2012; mean: 2.34(0.59), 2013; and mean: 2.25(0.62), 2014]. In addition, a variable; *'during a typical week has someone watched you participate in physical activities or sports?'* showed small partial *eta* effect sizes (*d*=0.007) significant (p=0.04)(X^2(2)=11.539, p=0.003) decrease [mean: 2.21(0.70), 2012; mean: 2.14(0.60), 2013 and mean: 2.02(0.58] in girls at the three measurements of 2012 to 2014 were observed. When a post-hoc followed was performed, the median (IQR) for *"During a typical week has someone watched you participate in physical activities of sports?"*, for measurement at points 2 and 3 was Z=-2.909, p=0.004. There was no statistical significant between measurement point 1 vs measurement 2 (Z= -0.929, p=0.353) and measurement points 3 and 4 (Z= -1.152, p=0.249), respectively.

Though not statistically significant (p<0.05) the following variables "*during a typical week has someone provided transportation to a place where you can do physical activities or play sports?* and *during a typical week has someone watched you participate in physical activities or sports?"* showed small borderline (p=0.07) practical significant decreases over the three measurements of 2012 to 2014. No practical significant changes could be observed in the other five social correlates.

Discussion

The objective of the study was to determine the three-year developmental changes in social correlates of physical activity for girls and boys from selected schools in the Tlokwe local municipality. Generally, the results showed progressive and larger practical significant increases in all the physiological variables of stature and body weight, with significant increases in BMI, %BF and WHtR for girls. Statistical significant increases (p>0.017) were found for body mass and BMI. Additionally, adolescents in the study never had support in

terms of transportation to participate in physical activity, while on the one hand, they enjoyed support and encouragement from others for participation in physical activity.

A similar study by Kirchergast and Angelika[31] reported a progressive increase in the body composition parameters of both boys and girls, however, with marked increases in %BF among girls. The changes in body mass, stature, BMI, %BF and WHtR seen in this study could be as the result of the developmental stage the adolescents are in. Accretion of body fat mass is in accordance with the normal physiological processes during adolescence.[32] During this process girls gain an average of 17.5% of body fat mass, while boys gain 9 %.[33] The difference between males and females may stem from factor such as maturity.[24] Contextual differences since pubertal maturation have important societal and cultural dimensions [34], which might in turn determine whether or not it will influence PA. Early maturation in girls is hypothesised to have many potential negative psychosocial impacts, including less enjoyment of PA as well as less social support from parents and peers.[35] Early maturation in boys is believed to have advantages, because their body changes conform to the socio-cultural ideal.[36] Early maturation and advanced physical development might lead to a better athletic ability[36] and thus early maturers can more easily be positively reinforced for their sport and physical activity achievements. However, increases in BMI and excess body fat can contribute to the development of chronic non-communicable diseases[37] later in the life of an adolescent.

For social correlates, the study revealed that adolescents never had support in terms of transportation to participate in physical activity. Studies by Bungum *et al*.[38] and Zhanga *et al.* [39] indicated that the physical environment support, such as *'lack of transportation'*, affects participation in physical activity. However, a study by Xu *et al.*[40] indicated that transportation did not have a strong impact on students' participation in extracurricular physical activity.

The adolescents in our study have enjoyed support and encouragement for participation in physical activity from others. These findings are in agreement with those of previous studies [41,42,18] whereby it was concluded that encouragement is positively related to the physical activity participation of the adolescents. Dwyer *et al.*[43], in the study on adolescent girls' perceived barriers to participation in physical activity, found that *'lack of peer influence and parents'* were factors, amongst others, which affected the non-participation. Support from

friends[44] and "s*upport from parents"* [45] was found to be a positive factor for engaging in physical activity.

During preadolescent years, parental modelling of PA plays an integral role in establishing a social norm regarding activity[46], but as the child matures, modelling behaviours in the PA domain may be drawn from the emergent influence of the child's peers, while the influence of parental modelling wanes. During adolescent stages a child may be closer to their peers than their parents. Peers may therefore be more important for unstructured physical activity or active play but less so for organised sports involvement [47]. This in any case, suggests the importance of family-based coactivity interventions in the early years of child development and also peer influence later in adolescence.

Parents providing transport to physical activity multiple days per week improved children's activity levels by approximately 12 minutes of MVPA/day, and reduced sedentary behavior by 19 minutes/day.[48] In another study by Hoefer *et al.*[49] it has been reported that parents' provision of transportation to activity locations is associated with out-of-school PA in a diverse adolescent population. Implying that parents may have the power to control their children's access to these facilities and regulating and improving opportunities for PA, by providing transportation to community activity programs and commercial sports facilities.[49] In our study, the adolescents did not receive transport for physical activity, however a small but insignificant changes in perceived support for physical activity have been found. The results are similar to the findings by Gebremariam *et al.*[24], as the results revealed small and probably not of much practical significance that there were changes in perceived support for physical activity participation.

The current findings are with few limitations, as such the interpretation of the present study should be done with caution. This study has not controlled for the timing of maturation and it was not specified whether the social support is related to adolescents' overall out-of-school PA or participation in sports teams and activity classes. Proper tracking of changes in PA, physiological variables and the social correlates can be improved if differences in the timing of maturation are controlled for.[50] A better understanding of the impact of maturation on PA behaviours and beliefs has been stressed [34,50]. For future studies, investigations therefore should take into cognisant of the timing of maturation and type of activity (organised and non-organised) of participation.

Conclusion

Based on the results, it can be concluded that statistical and larger practical significant changes were found in the body mass and BMI. Two out of nine social correlates of physical activity some developmental changes in the social correlates of physical activity among adolescents, with only support from someone while participating in physical activities contributed much to physical activity participation. There were positive changes in encouragement, support, coactivity and "has someone watched you participate in sport?" There was no significant changes in the variables through the three measurement points of the study. The changes documented in this study are rather small and probably not of much practical significance, nevertheless, they might be indicative of a trend which is being established.

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Chapter 4
The three-year changes of physical activity and selected health-related fitness in girls and boys: the PAHL study

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The three-year changes of physical activity and selected health-related fitness in girls and boys: the PAHL study

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Abstract

Background: Physical activity habits formed early in life may continue into adulthood. However, adolescents do not meet the current physical activity recommendations of 60 minutes of moderate vigorous physical activity per day. Physical activity leads to the improvement of the health-related components of fitness. The purpose of this study was to determine the relationship between changes of physical activity and selected health-related fitness in girls and boys over a period of three years in selected schools in the Tlokwe local municipality.

Methods: A three year study was conducted on 206 adolescents (where 133 girls and 73 boys) in 2012, 160 (where boys: 62 and girls: 98) in 2013 and 138 (where boys: 87 and girls: 51) in 2014 were purposefully selected as participants. Physical activity was measured using the International Physical Activity Questionnaire short form (IPAQ-SF). The cardiorespiratory endurance, muscle strength and endurance, and flexibility tests were used according to the standard procedures of the EUROFIT. Descriptive statistics were used to explore the data. Chi-square was used to determine the difference. Spearman's rank order correlation coefficient was used to determine the development of the outcome variables. Partial correlation coefficient controlled for baseline measurements was used to determine the relationship between physical activity and selected health-related physical fitness. All statistical analysis were done using SPSS version 21.0.

Results: There were strong significant ($p<0.001$) changes in mean standing broad jump (SBJ), Sit-up (SUP) and sit-and-reach (SAR), stature, and body mass ($p=0.002$) and BMI among the boys and girls. Results show increase in stature, body mass and BMI for the entire sample through the three measurement points. The SBJ, SUP and SAR seemed to decrease through the three measurement points. The boys had higher body mass as compared to the girls, while the

girls had higher BMI. The partial *E*ta square of the effect size was moderate (*d*=0.66) for SJB, small (*d*=0.36) and (*d*=0.29) for SUP and SAR respectively. Furthermore, the results revealed significant high correlation between body mass and stature, and a moderate correlation between stature and body mass. There was also an insignificant correlation between stature and BMI (r = -0.04; p = 0.64) and (r = -0.07; p = 0.40). The SUP, SBJ and SAR showed a significantly weak correlation with the body mass. The stature for girls showed a significant moderate correlation with SUP T3 (r = 0.50; p = 0.01). Significant positive moderate correlation coefficient was found between SUP T2 (r = 0.49; p <0.001), and SUP T3 (r=0.37; p=0.05) and TPA 2013 respectively for the boys. There was a significant positive association between SUP2012 and Total PA2013 (r = 0.32; p < 0.001) for the total group. There was a significant positive association between SUP2013 and Total PA2013 (r = 0.37; p = 0.005) for the boys. A significant weak association between stature 2014 and Total PA2013 (r = 0.21; p < 0.05) were found.

Conclusions: There was significant gender difference in SJB, SUP, SAR, stature, body mass and BMI. There were some developmental changes in the health-related fitness variables, and the effect size was large for SJB and small for SUP and SAR. The results revealed significantly high correlation between body mass and stature. Adolesence in the study significantly showed decline in abdominal strength and flexibility. There was weak and insignificant correlation between body mass and SUP, SBJ and SAR. Physical activity was positively correlated with standing broad jump. There was a significant positive association between SUP2013 and Total PA2013. A significant weak association between stature 2014 and Total PA2013 were found. In line with the current findings, School-based multilevel programme aimed at the promotion of physical activity including training programs, physical activity (with the family and community support) are recommended.

Keywords: physical activity, health-related physical fitness, adolescents, tracing, baseline

Background

Regular physical activity in childhood and adolescence improves strength and endurance, helps build healthy bones and muscles, control weight, reduces anxiety and stress, increases self-esteem, and may improve blood pressure and cholesterol levels [1]. Children and youth aged between five and seventeen should accumulate at least 60 minutes of moderate- to vigorous-intensity physical activity daily [2] to gain the health benefits. Although physical activity contributes to health benefits and quality of life among children and adolescents, there is still a high prevalence of physical inactivity [3,4].

International data published in the Lancet Physical Activity Series [5] reported that 80% of 13 to15 year olds do not meet the current physical activity recommendations of 60 minutes of moderate to vigorous physical activity per day. Data from the 2008 National Youth Risk Behavior Survey in South Africa found that 41% of the respondents (46% of females and 37% of males) had insufficient or no physical activity in the week prior to the survey [6]. A study by Toriola and Monyeki [7] revealed that 80 (30%) of the adolescents had low physical activity level, and 78 (27.5%) were moderately active, while 88 (31.1%) were highly active. McVeigh and Meiring [8], assessing the amount of time spent on physical activity revealed an age-related reduction in the physical activity levels. During the early stages of adolescence, for example, participation in physical activity and corresponding physical fitness begin to decline [9]. Another study by Craig [10] revealed that only 26% of adolescents complied with the recommended levels of physical activity.

This lack and decline in physical activity participation has contributed to a greater prevalence of paediatric obesity, a decrease in fitness (e.g., flexibility, muscular strength, cardiorespiratory capacity), and a greater risk of disease [11-13]. There is strong and consistent evidence from observational studies that physical inactivity and poor cardiorespiratory fitness (i.e. fitness) are associated with higher morbidity and mortality from all causes, including cardiovascular disease (CVD) and cancer [14]. Poor health-related fitness are reported to be related to decreases in physical activity capability and then reduced health-related physical fitness, such as cardiorespiratory fitness, strength and speed of movement [15]. An experimental study has shown that exercise training improves fitness [16]. Regular physical activity, whether structured (exercise) or unstructured, has been found to improve health related fitness [16] and physical activity capabilities [15].

Tracking the changes in physical activity and health related fitness levels of the children is important, as these variables correlate with body weight and risk factors of cardiovascular and metabolic diseases in childhood [20]. Health-related behaviours and disease risk factors track from childhood to adulthood, indicating that early and ongoing opportunities for physical activity are needed for maximum health benefit [21]. Therefore, the study assessed the changes of physical activity and selected health-related fitness in girls and boys from schools in the Tlokwe local municipality.

Methods

Study design and subjects

The longitudinal design approach involving data sets from 2012 (Test measurement 1(T1)(2013 Test measurement 2(T2) to 2014 (Test measurement 3(T3) from the Physical Activity and Health Longitudinal Study (PAHLS) [22], was used. PAHLS is an observational multidisciplinary longitudinal design that started in 2010. The participants were purposefully drawn from six out of eight secondary schools within the Tlokwe municipality. The schools in the study are from the high socio-economic (Potchefstroom town) and low socio-economic (Township) status. The participants who were aged 14 years and in grade 8 were purposefully selected from class lists provided so that they could be successfully followed for the duration of the 5 year PAHL study before completing high school at the age of 18 years. Only learners whose parents completed the informed consent form and provided a verbal accent were recruited as participants in the study. Data on a total of 206 boys and girls (boys: 73 and girls: 133), respectively were analysed. The numbers of participants are not consistent because of the characteristics inherent in a longitudinal study. Drop-out in the study was accounted for by absence during the day of measurements, school leaving and transfers from one school to the other.

Instruments

Anthropometric measurements of height and weight were measured using the standard procedures described by the International Society for the Advancement of Kinanthropometry

(ISAK) [23]. Body Mass Index (BMI) as a measure of body composition was calculated as body mass/stature^2 (kg/m^2).

Selected health-related physical fitness

This was assessed by making use of cardiorespiratory endurance, muscle strength and endurance, and flexibility tests according to the standard procedures of the EUROFIT [24] test and the Australian Sports Commission [25]. Cardiovascular endurance was assessed with the 20-metre shuttle run test which is valid to use in a field tests for aerobic capacity in adolescents and comparing maximal oxygen consumption [26]. The following health-related fitness test items of sit and reach, sit-ups, bent arm hang and standing broad jump were tested according to the EUROFIT test protocol [24]. Sit and reach expressed in centimetres is a test of hamstring flexibility in adolescents. Sit-ups measure abdominal strength and endurance and the test is determined by correctly performing a number of sit-ups in 30 seconds. Standing broad jump measures explosive leg strength in centimetres. The bent arm hang test measures functional arm and shoulder muscular endurance to the point of exhaustion in seconds.

Data collection

The International Physical Activity Questionnaire short form (IPAQ-SF) was presented separately from the other test measurements under the supervision of the principal investigator. For the IPAQ completion, the adolescents were gathered in a classroom to complete the questionnaire. The participants were given the questionnaire with adequate instructions and recommendations, and were not given a time limit for the completion of the questionnaire, and any doubts were promptly explained by the research investigator in charge of the data collection. During the completion of the questionnaire, the adolescents had no communication with each other. This was an attempt to avoid possible undesirable interferences in their responses. With regard to physical measurements, anthropometric measurements were measured first, followed by all health-related fitness tests. Anatomical landmarks were made on each participant and were then directed to anthropometric measurements station. All anthropometric sites were measured twice by Level 2 ISAK certified anthropometrists on both sides of the body. Prior the study, all participants were informed about the nature of the study, all possible risks and benefits were explained to them. Additionally, participants were told that data collected is for research only and it will be anonymised to protect their identity. Informed

consent and permission respectively were obtained from the school authorities, parents of participating learners and the participants. Only children whose parents gave consent and had given verbal assent were allowed to participate in the study. All procedures followed were in accordance with the ethical standards of the North-West University Ethics Committee and with the Helsinki Declaration. Written informed consent was obtained from the school authorities, the parents and the pupils of the participating school. Clearance by the Ethics Committee of North-West University, Potchefstroom campus (Ethics number: NWU-0058-01-A1) was granted.

Statistical analyses

Descriptive statistics including frequency, percentage, mean, and standard deviations were used to explore the data. For comparing the continuous data we used *t*-test. Non-parametric repeated-measures ANOVA- with the Friedman test was used to assess changes in the correlates between test measurement one (T1), test measurement two (T2) and test measurement three (T3). Since the statistical significant found with Friedman test does not pinpoint which groups in particular differ from each other, post-hoc analyses with Wilcoxon signed-rank tests was conducted with a Bonfforoni correction applied for multiple comparison, which makes it more likely to declare a results significant when there was no Type I error. To comply with the rules of Bonferroni test, we divided the p-value of 0.05 by the number of the tests (i.e. 0.05/3=0.017). As such, the new significant level used in this test was 0.017; and that means that if the p-value was larger than 0.017, we do not have a statistical significant result. Effect sizes (partial eta squared) were used to assess the magnitude of these changes. The cut-offs suggested by Cohen (*d*) were used for the interpretation of effect sizes (0.2 = small effect, 0.5 = moderate effect, 0.8 = larger effect) [27]. Tracking (stability) was assessed using Spearman correlation coefficient. The correlation coefficients of <0.30 indicate low correlation, 0.30 to 0.60 moderate, and >0.60 moderately high correlation [28]. The partial correlation coefficients controlled for baseline measurements was used to study the relationships between changes of social correlates of physical activity and selected health-related fitness for the total group and by gender. In addition, partial correlation controlled for baseline measurements and age was employed to study the relationship between changes of physical activity and selected health-related fitness in girls and boys. Attrition analysis was performed using independent sample *t*-test and chi-square of proportions to determine the

difference in baseline characteristics between participants and drop-outs (n=49; 20%). Data were analysed using the SPSS statistics software version 21.

Results

Table 4.1 presents the participants' mean, standard deviation and p-value of the differences of stature, body mass, and Body Mass Index (BMI) for the total group in the three measurements points. There was a statistically significant difference in body mass over a period of three years, X^2(df=2) = 10.354, p=0.006. Post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for body mass T1, body mass T2 and body mass T3 were 54.17 (47.50 to 63.06), 57.45 (49.27 to 66.78) and 57.50 (50.47 to 66.70), respectively. There was no significant differences between body mass T1 vs body mass measured at point 3 (T3)(Z = -2.241, p=0.025) measurements, despite an overall decrease in the body mass measurements. However, there was a statistical significant decrease between body mass measured at time point 1 (T1) vs body mass measured at point 2 (T2) (Z= -2.451, p=0.014) and between body mass at time 2 (T2) vs body mass at measured at point 3 (T3)(Z= 4.079, p=0.000). No statistical significant differences over a period of three years was found for body stature (X^2(2) = 2.450, p=0.294), as such there was no need to do post-hoc analyses.

There was a statistically significant difference in BMI over a period of three years, X^2 (df=2) = 11.400, p=0.003. A post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for BMI T1, BMI T2 and BMI T3 were 20.61 (18.89 to 23.04), 21.12 (19.21 to 24.80) and 21.53 (19.17 to 24.87), respectively. There was no significant difference between BMI T1 (Z = -2.240, p=0.025) and BMI T2 or between the BMI T1 and BMI T3 (Z= -2.313, p=0.021) measurements, despite an overall decrease in the BMI measurements. However, there was a statistical decrease in BMI measured at time point 1 (T2) and BMI at measurement point 2 (T3) (Z= -3.034, p=0.002).

Table 4.1: Anthropometric charateristics for the boys and girls during the three measurements

	Boys			Girls			Total Group			P-value of the differences
Year of measurement	**2012 (n=73)**	**2013 (n=62)**	**2014 (n51)**	**2012 (n=133)**	**2013 (n=98)**	**2014 (n=87)**	**2012 n=206**	**2013 (n=160)**	**2014 (n=138)**	
	Mean(SD)	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	
Stature (cm)	164.57(10.78)	171.73(8.38)	172.31(8.13)	158.48(9.00)	159.17(7.37)	159.53(7.37)	162.60(4.39)	163.29(9.70)	164.77(10.03)	<0.001
Body mass (kg)	55.69(13.00)	63.68(14.77)	63.99(14.42)	57.33(14.02)	58.73(13.11)	58.94(13.95)	57.22(13.79)	59.04(13.35)	60.66(13.60)	0.002
BMI (kg/m^2)	21.64(4.74)	21.43(3.83)	21.37(3.53)	21.44(4.30)	21.56(5.11)	22.86(4.62)	21.50(4.53)	22.31(4.46)	22.55(4.64)	<0.007

BMI = Body Mass Index, SD=standard deviation;n= total number of participants

The results in **Table 4.1** above shows a strong significant difference (p<0.001) in stature, body mass (p=0.002) and BMI (p<0.007) between the boys and girls. There was a 1.44 cm (2013); 0.43 cm (2014) increases in stature for the whole population. Boys were generally taller than the girls. Furthermore, the results showed increases in body mass for boys were 9. 99 kg (2013) and 0.31 kg (2014) respectively. The girls showed increases of 1.4 kg in 2013 and 0.21 kg in 2014. Generally there was an increase of 3 kg and 0.9 kg in 2013 and 2014 for the whole population respectively. The mean BMI decreased in 2013 (0.27 kg/m^2) and increased in 2014 (0.06 kg/m^2) among the boys, while the girls' BMI increased both in 2013 (1.12 kg/m2) and 2014 (1.3 kg/m^2).

In **Table 4.2** results show strong significant differences (p<0.001) in mean SBJ, SUP and SAR among the boys and girls. In the total group, decrease was observed in measurement point 2 and an insignificant increase of 4.22 cm from second measurement point (SUP T1=167.56; SUP T2=163.79 & SUP T3=168.01) was found. For SUP show a decrease of 1.18 cm at the third measurement point (SUP T1=25.24, SUP T2=25.68 & SUP T3=24.50), and SAR a decrease of 3.82 cm in the last measurement point (SAR T1=46.69, SAR T2=45.63 & SAR T3=41.81) was observed. There was a statistically significant difference in SBJ (X^2 (*df*=2) =4.621, p=0.099). However, when a post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for SUP 1, SUP 2 and SUP 3 were 13.50 (2.52 to 26), 25.00 (16.00 to 36.00) and 23.00 (15.25 to 31.00), respectively. Statistical significance was observed for SUP (X^2(*df*=2)=19.015, p=0.000), and when a post-hoc follow up was done significant differences were SUP 1 vs SUP 2; *Z*= -6.092, p=0.000, SUP 2 vs SUP 3; Z= -4.523, p=0.000; and no significant differences for SUP 3 vs SUP 4, *Z*= -1.857, p=0.063 was found. Additionally, statistical significant differences was found for SAR (X^2(*df*=2)=18.617, p=0.000) with the difference SAR at measurement points 2 vs 3 (*Z*= -1.421, p=0.000), and measurement points 1 and 3 (*Z*= -5.132), The practical (partial Eta square of the effect size) developmental changes was moderate for SBJ (*d*=0.66), small (*d*=0.36) for sit-up and sit and reach (*d*=0.29) respectively. There was a reduction in mean for SBJ from 167.2 cm (2012) to 164.0 cm (2013) and 31.83 cm (2014) for the boys and girls. There was a decrease in the mean (46.69 cm in 2012; 45.63 cm in 2013; 41.81 cm in 2014) for sit and reach for the whole sample. However, there was an increase in sit-ups from baseline measurements 15.54 count/sec (2012); 25.68 count/sec (2013 and 24.50 count/sec (2014). The boys SBJ was higher than the girls in 2012 and 2013, however, in 2014, the girls mean SBJ was higher than the boys. The mean SUP for

the boys was generally higher than that of the girls. Furthermore, the results show that girls had higher sit and reach values as compared to the boys. There is a noticeable decrease in mean 46.18 cm (2012), 42.97 cm (2013) and 38.17 cm (2014) for SAR among boys.

Table 4.2: Physical fitness of the boys and girls during the three measurents

	Boys			Girls			Total G/B			P-value of the differences	η_p^2
Year of measurement	**2012**	**2013**	**2014**	**2012**	**2013**	**2014**	**2012**	**2013**	**2014**		
Parameters	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**		
SBJ (cm)	n= 48	n= 48	n= 48	n=79	n=79	n=79	n=127	n=127	n=127	<0.001	0.66
	170.03(105.17)	184.92(46.75)	27.43(68.87)	165.48(55.64)	151.40(161.91)	34.51(59.97)	167.20(77.76)	164.07(131.57)	31.83(63.31)		
SUP (x/sex)	N= 45	N= 45	N= 45	N=75	N=75	N=75	N=120	N=120	N=120	<0.001	0.36
	13.14(14.54)	35.98(7.69)	33.44(10.05)	16.99(12.12)	19.51(9.91)	19.13(14.12)	15.54(13.15)	25.68(12.13)	24.50 (14.49)		
SAR (cm)	N= 34	N= 34	N= 34	N=57	N=57	N=57	N=91	N=91	N=91	<0.001	0.29
	46.18(7.21)	42.97(8.78)	38.17(9.12)	47.00(7.93)	47.21(7.85)	43.97(8.05)	46.69(7.64)	45.63(8.42)	41.81(8.88)		

SBJ= standing broad jump, SUP= sit-ups; SAR= sit and reach, n= total number of participants; Total G/B = total for girls and boys, ηp^2=Eta square or Cohen d not significant

Table 4.3 presents the results on the tracking (stability) of the health-related fitness parameters (body mass, stature, BMI, SBJ, SUP, SAR) in 2013 and 2014 respectively. The results revealed that there was a highly significant correlation (r=0.84; p<0.01) between body mass (2013) and the BMI T2. A moderate correlation (r=0.49; p<0.01) and (r=0.45; p<0.01) for T2 and T3 respectively was revealed. There was a significant moderate correlation between stature (2013) and body mass T3 and a significantly high correlation between stature 2013 and stature T3 (r=0.97; p<0.01). The results show a significantly high correlation between BMI 2013 and body mass in T2 and T3, (r=0.84; p<0.01) and (r=0.78; p<0.01) respectively. The body mass 2014 showed a significantly high correlation with BMI (r=0.78; p<0.01) and (r=0.83; p< 0.01) in T2 and T3 respectively. Furthermore, there was a moderate, but significant change between body mass and stature. The results also revealed an insignificant weak correlation (r= -0.07; p=0.40) between stature and BMI. There was a moderate, however significant correlation between stature and body mass. The results revealed a significantly high correlation (r=0.81; p<0.00) and (r=0.83; p<0.01) between BMI 2014 and body mass T2 and T3 respectively. The body mass T2 (r=0.12; p=0.28) and T3 (r=0.13; p=0.25) and BMI T2 (r= -0.08; p=0.46) showed an insignificant weak correlation with the SBJ T2. Stature showed a moderate (r=0.36; p<0.01) and (r=0.33; p<0.01), but significant correlation with SBJ T2. There was a significantly weak correlation between SUP T2 and body mass (r=0.25; p=0.03); (r=0.27; p=0.01) in T2 and T3. The results showed a consistent insignificant weak correlation between SAR T2 with body mass, stature, BMI for T2 and T3. The results further revealed a consistent negative insignificant weak correlation between SBJ T3 and body mass, stature and BMI. The BMI T2 and T3 (r= -0.10; p=0.38) and (r=-0.09; p=0.43) showed a negative insignificant weak correlation with SUP T3. There was a significant but moderate correlation between stature and SUP T3. Lastly, the results for SAR T3 revealed that the body mass showed a negative insignificant correlation in T2 (r= -0.21; p=0.01) and a significant weak correlation T3 (r= -0.25; p=0.02). Stature showed a significant weak correlation in T2 (r= -0.33; p<0.01) and a negative and insignificant weak correlation at T3 (r= -0.08; p=0.44) with SAR T3, while the BMI showed an insignificant weak correlation in T2 (r= -0.03; p=0.77) and a significant weak change in T3 (r= -0.25; p=0.02) with SAR T3.

Table 4.3: The relationship of the variables for total group

		Body Mass T2	Stature T2	BMI T2	Body MassT3	Stature T3	BMI T3
Body Mass2013	*R*	-	0.49	0.84	0.96	0.45	0.81
	P	.	0.00	0.00	0.00	0.00	0.00
Stature2013	*R*	0.49	-	0-.04	0.51	0.97	-0.02
	P	0.00	.	0.64	0.00	0.00	0.83
BMI2013	*R*	0.84	-0.04	-	0.78	-0.07	0.95
	P	0.00	0.64	.	0.00	0.40	0.00
Body Mass2014	*R*	0.96	0.50	0.78	-	0.49	0.83
	P	0.00	0.00	0.00	.	0.00	0.00
Stature2014	*R*	0.45	0.97	-0.07	0.49	-	-0.05
	P	0.00	0.00	0.40	0.00	.	0.57
BMI2014	*R*	0.81	-0.01	0.95	0.83	-0.05	1.00
	P	0.00	0.83	0.00	0.00	0.57	.
SBJ T2	*R*	0.12	0.36	-0.08	0.13	0.33	-0.07
	P	0.28	0.00	0.46	0.25	0.00	0.52
SUP T2	*R*	0.25	0.62	-0.09	0.27	0.27	0.61
	P	0.03	0.00	0.43	0.01	0.00	0.46
SAR T 2	*R*	-0.11	-0.17	0.00	-0.15	-0.19	-0.03
	P	0.33	0.13	0.93	0.20	0.10	0.79
SBJ T3	*R*	-0.08	-0.10	-0.00	-0.12	-0.12	-0.05
	P	0.49	0.39	0.97	0.28	0.30	0.62
SUP T3	*R*	0.16	0.45	-0.10	0.24	0.58	-0.09
	P	0.15	0.00	0.38	0.03	0.00	0.43
SAR T3	*R*	-0.21	-0.33	-0.03	-0.25	-0.31	-0.08
	P	0.06	<0.001	0.77	0.02	<0.001	0.44

SBJ=standing broad jump; SUP= sit-ups; SAR = sit and reach; Controlled for Body Mass measure of 2012 (T1) & Stature measure of 2012 (T1) & BMI measure of 2012 (T1) & Age

Table 4.4 presents the results on correlation coefficients of the health-related fitness parameters (body mass, stature, BMI, SBJ, SUP, SAR) in 2013 and 2014 respectively, compared with body mass, stature and BMI for T2 and T3 for the boys and girls.

Body mass T2: The results reveal that there was a significantly high correlation in body mass, BMI and stature (T2 and T3) for the boys and girls. In the other results, it was revealed that the body mass for T2 and T3 was highly significant correlation with stature for the boys.

Stature T2: There was a highly significant moderate correlation between BMI T3 and stature T2 (r=0.36; p=0.01) for the boys. The stature T2 for girls showed an insignificant weak correlation (r=0.00; p=0.94) in BMI T2 and (r=0.30; p=0.79) BMI T3. The body mass T2 (r=0.91; p<0.001), body mass T3 (r=0.85; p=0.001) and BMI T3 (r=0.95; p<0.001) were highly significant correlated with BMI T2. *BMI T2*: There was a moderate, but significant correlation between stature (r=0.03; p=0.52) and BMI T2. The results for the girls' revealed a highly significant correlation with body mass T3 (r=0.91; p=0.001) and BMI T3 (r=0.94; p=0.001). Furthermore, the results revealed a weak insignificant correlation between BMI T2 and the stature, T2 (r=0.00; p=0.94) and T3 (r= -0.01; p=0.89).

Body Mass T3: The body mass T2, stature T2, and BMI T2 showed a significant high correlation with body mass T3 for the boys. There was a highly significant correlation between body mass T3 and body mass T2 and BMI T2 for the girls.

Stature T3: the body mass was found to be highly significant correlated with stature T3 ($r=0.66$; $p<0.001$). The stature T2 and body mass T3 were highly correlated ($r=0.98$; $p<0.001$) and ($r=0.71$; $p<0.001$) respectively with the stature T3. The BMI showed an insignificant moderate correlation among the boys. In the other results for the girls, it was revealed that the body mass T2 ($r=0.38$; $p<0.001$), body mass T3 ($r=0.39$; $p<0.001$) showed a significant moderate correlation. The results further revealed a weak insignificant correlation for stature and the BMI T2 and T3.

BMI T3: The results showed a high significant correlation for Body mass T2 ($r=0.90$; $p<0.001$), BMI T2 ($r=0.95$; $p<0.001$) and body mass T3 ($r=0.91$; $p<0.001$). The stature was found to be moderate significant ($r=0.41$; $p<0.001$) for T2 and an insignificant moderate correlation ($r=0.38$; $p<0.001$) for T3 among the boys. The body mass and the BMI were found to be highly significant, while the stature showed a weak and insignificant correlation for T2 ($r=0.03$; $p=0.79$) and T3 ($r=0.00$; $p=0.98$) among the girls.

SBJ T2: The results for the SBJ T2 show a weak insignificant correlation for body mass, stature and BMI in T2 and T3 among the boys and girls.

SUP T2: The results show a weak insignificant correlation for body mass T2 and the BMI T2 among the boys. The girls' results revealed a significantly moderate correlation with stature T2 and SUP T2 ($r=0.49$; $p<0.001$).

SAR T2: There was an insignificant negative weak correlation for body mass, stature and BMI among the boys and girls. *SBJ T3*: there was an insignificant negative weak correlation for body mass, stature and BMI among the boys and girls.

SUP T3: The stature for the girls showed a significant moderate correlation ($r=0.50$; $p<0.001$) with SUP. Lastly, SAR T3 showed an insignificant negative weak correlation for body mass, stature and BMI among the boys and girls.

Table 4.4: The relationships of the physical activity and health related fitness variables during the three measurents

		Boys						Girls					
		Body Mass T2	**Stature T2**	**BMI T2**	**Body Mass T3**	**Stature T3**	**BMI T3**	**Body Mass T2**	**Stature T2**	**BMI T2**	**Body Mass T3**	**Stature T3**	**BMI T3**
Body Mass T2	*r*	-	0.70	0.91	0.97	0.66	0.90	-	0.41	0.91	0.95	0.36	0.87
	p	.	<0.001	<0.001	<0.001	<0.001	<0.001	.	<0.001	<0.001	<0.001	<0.00!	<0.001
Stature T2	*r*	0.71	-	0.36	0.73	0.98	0.41	0.40	-	<0.001	0.40	0.93	0.03
	p	<0.001	.	0.01	<0.001	<0.001	<0.001	<0.001	.	0.94	<0.001	<0.001	0.79
BMI T2	*r*	0.91	0.36	-	0.85	0.32	0.95	0.91	<0.001	-	0.85	-0.01	0.94
	p	0.00	0.01	.	<0.001	0.03	<0.001	<0.001	0.94	.	<0.001	0.89	<0.001
Body Mass T3	*r*	0.97	0.73	0.85	-	0.71	0.91	0.95	0.40	0.85	-	0.39	0.91
	p	<0.001	<0.001	<0.001	.	<0.001	<0.001	<0.001	<0.001	<0.001	.	<0.001	<0.001
Stature T3	*r*	0.66	0.98	0.32	0.71	-	0.38	0.36	0.93	-0.01	0.39	-	<0.001
	p	<0.001	<0.001	0.03	<0.001	.	<0.001	<0.001	<0.001	0.89	<0.001	.	0.98
BMI T3	*r*	0.90	0.41	0.95	0.91	0.38	-	0.87	0.03	0.94	0.91	<0.001	-
	p	<0.001	<0.001	<0.001	<0.001	<0.001	.	<0.001	0.79	<0.001	<0.001	0.98	.
SBJ T2	*r*	0.25	<0.001	0.33	0.28	-0.04	0.41	-0.18	0.16	-0.28	-0.21	0.09	-0.30
	p	0.25	0.96	0.12	0.19	0.85	0.05	0.22	0.28	0.06	0.15	0.51	0.04
SUP T2	*r*	0.05	0.09	0.03	0.14	0.13	0.11	0.25	0.49	0.06	0.21	0.40	0.03
	p	0.81	0.69	0.89	0.52	0.54	0.59	0.08	<0.001	0.66	0.15	<0.001	0.80
SAR T 2	*r*	-0.12	-0.13	-0.07	-0.15	-0.14	-0.11	-0.06	<0.001	-0.01	-0.11	-0.03	-0.07
	p	0.59	0.53	0.75	0.49	0.52	0.60	0.68	0.99	0.91	0.45	0.83	0.64
SBJ T3	*r*	-0.12	-0.04	-0.12	-0.07	-0.03	-0.07	0.04	-0.04	0.09	-0.04	-0.05	-0.00
	p	0.53	0.85	0.58	0.72	0.86	0.74	0.79	0.77	0.54	0.78	0.70	0.98
SUP T3	*r*	-0.14	-0.11	-0.12	-0.04	0-.05	-0.03	0.14	0.23	0.03	0.21	0.50	0.01
	p	0.53	0.60	0.57	0.83	0.79	0.87	0.33	0.12	0.83	0.15	<0.001	0.90
SAR T3	*r*	-0.04	-0.22	0.07	-0.09	-0.17	-0.03	-0.20	-0.12	-0.13	-0.22	-0.10	-0.17
	p	0.86	0.31	0.73	.672	.439	0.89	0.17	0.41	0.37	0.13	0.50	0.24

SBJ=standing broad jump; SUP= sit-ups; SAR = sit and reach; Controlled for BodyMass 2012 & Stature 2012 & BMI 2012 & Age

Table 4.5 shows the correlation coefficients between selected health-related fitness and physical activity for the total group and gender comparisons. Stature was significantly ($p<0.05$) and weakly correlated with PA in period of 2013 and 2014 respectively. A moderate significant positive correlation coefficients was observed respectively for *SBJ T2* (r=0.31; p=0.01) and *SUP T2* (r=0.32; p=0.01), and TPA 2013 for the total group. Significant positive moderate correlation coefficients was found between *SUP T2* (r=0.49; $p<0.001$), and *SUP T3* (r=0.37; p=0.05) and TPA 2013 respectively for the boys. Surprisingly, *SAR T3* was negatively correlated with PA 2013 for the boys. Non-significant ($P>0.05$) correlation coefficients was found between body mass and BMI and PA.

Table: 4.5: The relationship between health-related fitness and physical activity

		Total group		Boys		Girls	
		Total PA 2013	**Total PA 2014**	**Total PA 2013**	**Total PA 2014**	**Total PA 2013**	**Total PA 2014**
Body Mass2013	***R***	0.07	-0.10	0.08	-0.19	0.12	-0.10
	P	0.43	0.26	0.61	0.25	0.32	0.41
Stature2013	***R***	0.21	0.08	0.10	-0.03	0.09	0.09
	P	0.02	0.38	0.51	0.85	0.47	0.46
BMI2013	***R***	-0.05	-0.16	0.03	-0.23	0.09	-0.15
	P	0.57	0.08	0.83	0.15	0.47	0.23
Body Mass2014	***R***	0.12	-0.10	0.13	-0.17	0.13	-0.11
	P	0.20	0.29	0.42	0.29	0.28	0.39
Stature2014	***R***	0.20	0.08	0.10	-0.03	0.03	0.10
	P	0.03	0.36	0.53	0.85	0.76	0.41
BMI2014	***R***	0.00	-0.15	0.10	-0.21	0.11	-0.16
	P	0.98	0.10	0.54	0.19	0.36	0.20
SBJ T2	***R***	0.31	0.04	0.11	-0.08	0.14	0.04
	P	0.00	0.69	0.57	0.67	0.28	0.74
SUP T2	***R***	0.32	0.11	0.49	-0.00	0.13	0.01
	P	0.00	0.26	<0.001	0.96	0.34	0.91
SAR T 2	***R***	-0.09	0.07	-0.21	0.14	-0.07	-0.11
	P	0.38	0.51	0.26	0.47	0.60	0.40
SBJ T3	***R***	0.12	-0.08	0.13	-0.07	0.09	-0.02
	P	0.22	0.44	0.50	0.72	0.49	0.85
SUP T3	***R***	0.16	0.06	0.37	-0.15	0.00	0.01
	P	0.12	0.53	0.05	0.42	0.98	0.91
SAR T3	***R***	-0.18	-0.05	-0.35	-0.18	0.08	0.16
	P	0.09	0.64	0.05	0.34	0.55	0.25

BMI= body mass index, r= correlation coefficient, p= significance, PA= physical activity, SBJ=standing broad jump; SUP= sit-ups; SAR = sit and reach; Controlled for Body Mass 2012 & Stature 2012 & BMI2012 & Age

Discussion

The objective of the study was to determine the three-year developmental changes in physical activity and selected health-related fitness among girls and boys from selected schools in the Tlokwe local municipality. Statistical significant decreases was found in SUP and SAR over a period of time. Generally the results revealed that there was a significant gender difference in SBJ, SUP, SAR, stature, body mass and BMI. Additionally, there were some developmental changes in the health-related fitness variables with moderate practical effect size in SBJ and small practical effect size for sit-up and sit-and-reach. Furthermore, the results revealed a significant high correlation between body mass and stature, a moderate correlation between stature and body mass for both girls and boys. There was also an insignificant correlation between stature and BMI, while, the SUP, SBJ and SAR showed a significantly weak correlation with the body mass. Participation in physical activity was positively associated with

standing broad jump for the total group, whilst SUP was also positively associated with PA in 2013 and 2014 respectively for boys.

The current findings concerning the stature, body mass and the BMI concur with literature [29, 30]. The transition from childhood to the phase adolescence is characterised by physical, psychological and social changes. It is a period during which major events such as the growth spurt and sexual maturation occur. The obtained results were consistent with the results of previous research. A study by Sartorius *et al.* [30] in South Africa also revealed a gender influence on BMI gains, especially in female school-aged children between eight and twelve years of age. This may be as a result of adolescent males having lower energy intakes and engaging in higher levels of physical activity than adolescent females [31, 29]. There is a need to monitor body composition during this phase because aspects of composition, such as weight, body fat and lean tissue, are predictive of adult phase characteristics [32].

For physical performance variables, the study revealed that boys showed higher physical performance than girls. The results concurs with a similar study by Gashi *et al.* [33], where boys showed higher physical performance than girls. The significant gender difference in the physical performance in favour of boys may be due to different interests regarding physical activities and play and also by different social expectations [34] and also due to sexual maturity, suggesting that lower physical performance may be related to maturing at an earlier chronological age [35]. Girls have been shown to participate less in organised sport [36]. Girls were observed to have less favourable individual attributes associated with PA, including lower CRF and EHC, higher %BF and lower levels of perceived competence in PE [37]. A greater understanding of the mechanisms underlying gender difference has the potential to guide PA intervention strategies. Strategies aiming at increasing PA should be multicomponent and take into consideration that pathways to increasing PA are likely to differ among boys and girls

The sit and reach measures were found to decrease for both girls and boys, though the girls' had higher SAR measures than the boys. Studies have reported that girls are more flexible at all ages [16;38;39], which mostly commonly occur during the pubertal period [40]. These results contradicts the findings by Toriola *et al.,* [41] which examined the relationship between body composition and musculoskeletal fitness among Nigerian children. Toriola *et al.,* [41] reported that boys were more flexible than girls. In another study by Monyeki *et al.,* [42] among

South African rural school children, there was non-significant gender differences were observed.

The overall performance for the sit-up (SUP) showed that the boys performed better than the girls. The results concurs with the findings by Andreasi *et al.*, [43] whose study examined the association between health-related fitness and anthropometric and demographic indications of Brazillian children. The boys were constantly performed better than the girls. These findings are in contrast with findings by Toriola *et al.,* [41], in their study among Nigerian children. Toriola *et al.,* [4] reported that girls'significantly out performed better than girls in the sit-up test.

Generally, the boys performed better in standing broad jump (SBJ) compared to the girls. A study by Ramos-Sepulveda *et al*., [44] which examined the sex- age- specific physical fitness and anthropometric reference standards among 576 Colombian-Indian school children revealed that boys significantly performed better than girls. These results concurs with the findings in this study. Temfemo *et al*., [45] in their study assessing the jumping ability, leg power and anthropometric characteristics in 11-16 years old children have found that jumping performance increased during growth, with gender differences manifesting after the age of 12 and increasing more after the age of 14, this they explained that is probably due to the onset of puberty in both genders that resulted in a much greater increase in leg length and leg muscle volume in boys compared with girls. Sheffield *et al.*, [46] explained that the greater leg muscle volume may be caused by the increased testosterone secretion in boys around 14 years old, which leads to an increase in fat-free mass, as well as by the greater involvement of boys in strenuous physical activities that increase muscle power [47; 48]. On the other hand, puberty in girls is related with increased adipose tissue and decreased strength and power relative to body mass after the age of 14 y [49].

The body Mass Index (BMI) has been reportedly associated with poor sit and reach (SAR) performances [41]. Flexibility also seems to be less influenced by body weight [50]. In this study it was revealed that there was no relationship between SAR and BMI. These results concurs with the findings by Toriola *et al.,* [41], who reported no relationship between flexibility and BMI among school children. Similarly, our findings show that there was no substantial relationship between sit-up (SUP) and BMI. However, other studies [51-55] reported contrary findings, showing a positive relationship betweeen SUP and BMI. There was

strong associations between standing broad jump (SBJ) and the BMI. Our results are in contrast with the findings by Toriola *et al.,* [41] and Zivkovic *et al.,* [52] who both found that standing broad jump (SBJ) was negatively associated with BMI.

In the other results, the standing broad jump (SBJ) was positively associated with PA for the total group, whilst SUP was also positively associated with PA in 2013 and 2014 respectively for boys. The results concur with the findings by Van Der Niet *et al.,* [56] among children where strong significant relationships were found between physical activity and physical fitness measures (SBJ and SUP). The same tendency was previously reported by Volbekienė *et al.,* [57], Huang and Malina [58].

The current findings do have limitations, as such the interpretation should be done with great caution. The examined variables are by no means exhaustive, and the other important variables correlated with physical activity were not included. This study did not control for the timing of maturation. Proper tracking of changes in PA, physiological variables could be improved if differences in the timing of maturation were to be controlled for [55]. The future studies could take into account the limitations stated. Our results highlight the need for close investigation into where similar patterns may exist, thus providing a basis for public health interventions specifically targeting geographical areas and/or population segments, as well as potentially some more general innovative policy measures.

Conclusions

Based on the results of the study, it can be concluded that there was significant gender difference in SBJ, SUP, SAR, stature and body mass in favour of the boys, while the girls had higher BMI mean over a period of time. There were some developmental changes in the health-related fitness variables and the practical effect size was moderate for SBJ and small for sit-up and sit and reach over three year period. Adolesence in the study significantly showed decline in abdominal strength and flexibility. The body mass was strongly correlated with stature. Participation in physical activity was positively associated with explosive strength test for the total group, and with flexibility in boys.

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Chapter 5
The three year longitudinal relationship between changes in social correlates of physical activity and physical activity in girls and boys: the PAHL study

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The three year longitudinal relationship between changes in social correlates of physical activity and physical activity in girls and boys: the PAHL study

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Abstract

Background: Research has demonstrated consistently that physical activity levels decline with increasing age and tend to be lower in girls than in boys. The objective of this study was to investigate the longitudinal relationship between changes in social correlates of physical activity and physical activity in girls and boys from schools in the Tlokwe local municipality, South Africa.

Methods: Fourteen year old learners were purposefully selected to be participants in the study. Data on a total of 206 boys and girls in 2012, (where boys: 73 and girls: 133), 160 in 2013 (where boys: 62 and girls: 98) and 138 in 2014 (where boys: 87 and girls: 51) at the three measurements from 2012 to 2014 in the Physical Activity and Health Longitudinal Study (PAHLS) were used. A standardised questionnaire on the 'Social Support for Physical Activity' was used to gather information on social correlates for physical activity and physical activity participation was assessed by the International Physical Activity Questionnaire short form (IPAQ-SF). Chi-square was used to determine the difference for categorical variables. Significant changes over time were analysed with paired sample-tests. Age-adjusted Pearson correlation analysis was performed to determine the development of the variables. Linear regression analyses adjusted for age and maturation were done to determine the relationship of the variables. All analyses were performed using the SPSS version 21.0.

Results: The results showed significant positive changes for vigorous PA, moderate PA and minutes spend watching TV/Sitting ($p<0.001$) for the period of measurement. When ANOVA for repeated measure with Friedman test, statistical significant ($p=0.017$) was found for the physical activity measure of vigorous (X^2 (df=2)=11.382, p=0.003), moderate physical activity (X^2 (df=2)=13.446, p=0.001) minutes spent watching TV/sitting (X^2 (df=2)=29.531, p=0.000)

and total physical activity (X^2 (*df*=2)=29.531, p=0.000). The partial *E*ta square of the effect size (ES) results revealed moderate changes for vigorous minutes per week spent doing physical activity (11%) and moderate minutes spent doing physical activity (7%). There were large changes observed for minutes spent watching TV/Sitting (61%). The effect size of the changes was relatively small (*d*= 0.2) for all the the social correlates. The results also revealed a significant relation for "*has someone done a physical activity or played sports with you"* (p<0.001), *"has someone provided transportation to a place where you can do physical activities or play sports?"*(p=0.03) and "*has someone watched you participate in physical activities of sports?"*(p=0.01). The results also reveal that a significant relation for "*has someone done a physical activity or played sports with you?"* (p<0.001), *"has someone provided transportation to a place where you can do physical activities or play sports?"*(p=0.03) and "*has someone watched you participate in physical activities of sports?"*(p=0.01). There were high mean values in social correlates and physical activity for the boys as compared to the girls. There was a significantly high association between *"During a typical week has someone told you that you are doing well in physical activity?"* and vigorous physical activity (r=0.61; p=0.03). The results also showed a significant association between moderate physical activity and minute spend watching TV or sitting (r=0.67; p=0.01).

Conclusions: The girls received less social support as compared to the boys. The girls participated less frequently in physical activity as compared to the boys and spent more "minutes watching TV/Sitting" in 2012 and 2014. The study also revealed that the children participated in vigorous physical activity when friends and family or someone told them that they were doing well in physical activity and sport. On the basis of the findings, we recommend the establishment of teacher, peers'and parental physical activity social support that will enhance children physical activity participation. Also, the creation of conducive school and home environment intervention programmes that will foster PA participation and reduction of sedentary behaviour.

Key words: social correlates, changes, health-related fitness, physical activity

Background

Despite extensive evidence supporting the protective effects of PA, physical inactivity during adolescence remains widespread.[1,2] Furthermore, PA declines steeply during adolescence[3] and behaviours established during this period are likely to track into adulthood.[1] The population burden of inactivity is unacceptably high.[4] Considering the extensive benefits of participation in regular PA and the existing low levels among youth, there is an urgent need to enhance our understanding of PA behaviour within this population.

There are several systematic reviews on correlates of physical activity in adolescents[5-7], most of which identified social support as a factor positively associated with physical activity participation in adolescents.[7-9] Social support describes resources provided from interactions with significant others that can influence behaviour.[10,11] These resources can be emotional (e.g. encouragement, praise), instrumental (e.g. equipment, financial), or informational support (e.g. advice, instruction) and they can be provided by various individuals (providers) within one's social network (e.g. friends, family, teachers).[12] However, these reviews clustered the results of the association from various measures and outcomes of physical activity (overall measure; physical activity by domain: leisure, commuting, structured and unstructured sports, among others) with overall scores of sources and types of social support. This procedure does not allow for an assessment of how different measures of sources and types of social support are associated with a particular global and specific means of measuring physical activity, as well as the simultaneous effect of providing different types of social support. [7]

Initiation and maintenance of regular physical activity originates in early childhood ,[13] and track into later life .[14] Parents and friends may foster their children and adolescents'engagement in physical activity using a variety of mechanisms, such as exercising together, verbally encouraging their children to participate in physical activity.[15] A cross-sectional study among preschool children (ages 3-11) and their parents showed that parents who are physically active are more likely to support their children's engagement in physical activity .[16] Parental assistance strongly associated with children's physical activity participation included transporting the child to various exercise or sporting venues, or providing equipment, acess or opportunities to be active .[16]

Of particular interest in this study, is the relationship between the changes in social correlates of physical activity and physical activity—and in this case how the social correlates of physical activity facilitated changes in physical activity behaviour over a period of time. This would

provide the evidence of the causal relationship between factors and physical activity.[8,9] Longitudinal observational studies and experimental data could assist in identifying factors that have strong causal associations with physical activity and help guide practical interventions .[9] The objective of this study, however, was to determine the three year longitudinal relationship between changes in social correlates of physical activity and physical activity in girls and boys from selected schools in the Tlokwe local municipality.

Methods

Study design and subjects

A longitudinal design approach involving data sets from 2012 to 2014 from the Physical Activity and Health Longitudinal Study (PAHLS) [17], was used. PAHLS is an observational multidisciplinary longitudinal design that started in 2010. The participants were purposefully drawn from six out of eight secondary schools within the Tlokwe municipality. The schools in the study are from the high socio-economic (Potchefstroom town) and low socio-economic (Township) status. Learners whose parents have completed the informed consent form and have given a verbal accent were recruited as participants in the study. The participants who were aged 14 years and in grade 8 were purposefully selected from class lists provided so that they could be successfully followed for the duration of the 5 year PAHL study before completing high school at the age of 18 years. Data on a total of 206 boys and girls (2012, boys: 73 and girls: 133), 160 (where boys: 62 and girls: 98) and 138 (where boys: 87 and girls: 51) in 2012, 2013 and in 2014 respectively were analysed. The numbers of participants were not consistent because of the characteristics inherent in a longitudinal study. Drop-out in the study was accounted for by absence during the day of measurements, school leaving and transfers from one school to the other. No significant difference ($p>0.05$) were observed between drop-out and the participants in the study.

Instrumentation

Anthropometric measurements of height and weight were measured using the standard procedures described by the International Society for the Advancement of Kinanthropometry (ISAK).[18] Body Mass Index (BMI) as a measure of body composition was calculated as body mass/stature^2 (kg/m^2).

Physical activity was assessed by the use of the International Physical Activity Questionnaire short form (IPAQ-SF).[19-21] The IPAQ-SF is a valid and reliable tool for assessing physical activity.[22] The questionnaire comprised of seven questions which ask the participants about the frequency and time spent in sitting, walking and moderate-to-vigorous intensity physical activity (including physical activity related to occupation, transportation, household chores and leisure time activity) in the last seven days. Only those sessions which lasted ten minutes or more was analysed. Total Physical Activity (TPA) was calculated as the metabolic equivalent (Total MET-min/week = (Walk METs*min*days) + (Moderate METs*min*days) + Vigorous METs*min*days) scores for moderate-to-vigorous, walking and sitting activities in the last seven days. Subsequently, TPA was categorised into three groups namely, Low level of TPA= 495 MET-min/week, Moderate level of TPA= 600 MET-min/week and High level of TPA= 1200 MET-min/week.

A standardised questionnaire on the ***Social Support for Physical Activity*** was used to gather information on social correlates for physical activity.[23] The Social Support for Physical Activity Scale includes nine (9) statements rated on a three-point Likert-type scale (*i.e.* 'never', 'sometimes', and 'everyday'). For this study the social support for physical activity in a typical week participation in physical activity or sport were grouped together under the sub-themes described below on the basis of their commonality.

a. *Encouragement by friends or someone* is covered under question numbers: 1) During a typical week, how often do you encourage your friend to do physical activity or play sports? 2) During a typical week, how often do your friends encourage you to do physical activity or sports? and 5) During a typical week has someone encouraged you to do physical activities or sports?

b. *Do you do PA or sport with friends or someone*, is covered under question numbers: 3) During a typical week, how often do your friends do physical activities or play sport with you? and 6) During a typical week has someone done a physical activity or played sports with you?

c. *Did someone watch you when you participated in PA or Sport?* is covered question 8) During a typical week has someone watched you participate in physical activities of sports?

d. *Did someone or friends tell you that you are doing good or well,* is covered under question numbers: 4) During a typical week, how often do your friends tell you that you are doing a

good job at physical activity? and 9) During a typical week has someone told you that you are doing well in physical activity?

e. *Transportation to the PA or sport facilities,* is covered under question 7) During a typical week has someone provided transportation to a place where you can do physical activities or play sports?

For statistical analyses, the three-point type scale was scored as follows: Never = 1; sometimes = 2 and every day =3 per item.

Procedures for data collection

Permission for this study was first sought from the District Manager of the Department of Education in Potchefstroom, and ethical approval (Ethics number: NWU-0058-01-A1) was obtained from the Ethics Committee of the North-West University. The participating schools were briefed about the purpose of the study through the informed consent forms which were given to the school authorities, the parents and the learners. Prior the study, all participants were informed about the nature of the study, all possible risks and benefits were explained to them. Additionally, participants were told that data collected is for research only and it will be anonymised to protect their identity. Informed consent and permission respectively were obtained from the school authorities, parents of participating learners and the participants. Only children whose parents gave consent and had given verbal assent were allowed to participate in the study.[17] The participants were given the questionnaire with adequate instructions and recommendations, and were not given a time limit for the completion of the questionnaire, and any doubts were promptly explained by the research investigator in charge of the data collection. During the completion of the questionnaire, the adolescents had no communication with each other. This was an attempt to avoid possible undesirable interferences in their responses. Anthropometric measurements of height, weight, skinfold thickness (triceps, subscapular and calf skinfolds), and waist and hip circumferences as well as physical activity social correlates questionnaire were completed in 2012, 2013 and again in 2014.

Statistical analysis

To detect whether the data was normally distributed, Kolmogorov-Smirnov tests for normality were used. Chi-square was calculated for categorical variables to determine the differences

between variables. For longitudinal analyses, descriptive analyses for baseline and follow-up measurements for the relationship between changes in social correlates of physical activity and physical activity were performed. Significant changes over time in social correlates of physical activity and physical activity variables were analysed with paired sample-tests. Non-parametric repeated-measures ANOVA- with the Friedman test was used to assess changes among the variables of interest in the study. Since the statistical significant found with Friedman test does not pinpoint which groups in particular differ from each other, post-hoc analyses with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied for multiple comparison, which makes it more likely to declare a results significant when there was no Type I error. To comply with the rules of Bonferroni test, we divided the p-value of 0.05 by the number of the tests (i.e. 0.05/3=0.017). As such, the new significant level used in this test was 0.017; and that means that if the p-value was larger than 0.017, we do not have a statistical significant result. The cut-offs suggested by Cohen (*d*) were used for the interpretation of effect sizes (0.2 = small effect, 0.5 = moderate effect, 0.8 = larger effect).[24] Effect sizes (partial *Eta* squared) were used to assess the magnitude of these changes. An age-adjusted and baseline measurements partial correlation analyses were performed to study the development of social correlates of physical activity and physical activity. All analyses were performed using the SPSS version 21.0 (IBM SPSS Inc., Chicago III 2013) statistical programme.

Results

Table 5.1 represents the participants mean, standard deviation, and *p*-value of the differences of stature, body mass, and body mass index (BMI) for the total group over the three measurement points. There was an increase in stature, BMI and body mass of the boys and girls. The boys showed significant increase in body mass compared to the girls. While, the girls showed increases in BMI during the three measurement points. There was a statistically significant differences in body mass over a period of three years, X^2 (*df*=2) = 10.354, p=0.006. Post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for body mass T1, body mass T2 and body mass T3 were 54.17 (47.50 to 63.06), 57.45 (49.27 to 66.78) and 57.50 (50.47 to 66.70), respectively. There was no significant differences between body mass T1 vs body mass measured at point 3 (T3)(Z = -2.241, p=0.025) measurements, despite an overall decrease in the body mass measurements. However, there was a statistical significant

decreases between body mass measured at time point 1 (T1) vs body mass measured at point 2 (T2) (Z= -2.451, p=0.014) and between body mass at time 2 (T2) vs body mass at measured at point 3 (T3)(Z= 4.079, p=0.000). No statistical significant difference over a period of three years was found for body stature (X^2 (df=2) = 2.450, p=0.294), as such there was no need to do post-hoc analyses.

There was a statistically significant difference in BMI over a period of three years, X^2 (df=2) = 11.400, p=0.003. A post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for BMI T1, BMI T2 and BMI T3 were 20.61 (18.89 to 23.04), 21.12 (19.21 to 24.80) and 21.53 (19.17 to 24.87), respectively. There was no significant differences between BMI T1 (Z = -2.240, p=0.025) and BMI T2 or between the BMI T1 and BMI T3 (Z= -2.313, p=0.021) measurements, despite an overall decrease in the BMI measurements. However, there was a statistical decrease in BMI measured at time point 1 (T2) and BMI at measurement point 2 (T3) (Z= -3.034, p=0.002).

Table 5.1: The anthropometric characteristics of boys and girls through the three measurements

	Boys			Girls			Total group			P-value of the differences
Yearof measurment	**2012 (n=73)**	**2013(n=62)**	**2014(n=51)**	**2012 (n=133)**	**2013(n=98)**	**2014(n=87)**	**2012(n=206)**	**2013(n=160)**	**2014(n=138)**	
Parameters	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	
Stature (cm)	164.57(10.78)	171.36(8.38)	172.31(8.13)	158.84(9.00)	159.17(7.37)	159.53(6.31)	162.60(4.39)	163.29(9.70)	164.77(10.03)	<0.001
Body mass (kg)	56.69(14.77)	63.68(14.42)	63.99(14.42)	57.33(14.02)	57.13(13.11)	58.94(13.85)	57.22(13.79)	59.04(13.35)	60.66(14.60)	0.001
BMI (kg/m^2)	21.64(4.74)	21.37(3.53)	21.43(3.83)	21.44(4.30)	22.56(4.62)	23.86(4.65)	21.55(4.38)	21.81(4.21)	22.56(4.64)	<0.007

BMI = Body Mass Index, N= total number of participants

Table 5.2 represents the participants mean, standard deviation, partial *Eta* square and *p*-value of the differences of stature, body mass, and body mass index (BMI) for the total group over the three measurement points. The girls showed a higher mean value 100.77(71.81) for minutes spent watching TV/Sitting in 2012 as compared to the boys 96.67(98.68). The results also show a significant difference for vigorous, moderate and minutes spent watching TV/Sitting (P<0.001) for the boys and girls. When ANOVA for repeated measure with Friedman test, statistical significant (p=0.017) was found for the physical activity measure of vigorous (X^2 (*df*=2)=11.382, p=0.003), moderate physical activity (X^2 (*df*=2)=13.446, p=0.001), minutes spent watching TV/sitting (X^2 (*df*=2)=29.531, p=0.000) and total physical activity (X^2 (*df*=2)=29.531, p=0.000). There was no statistical significant difference (p>0.017) in TPA in all the three measurement points (T 1 vs T2, *Z*= -2.071, p=0.038; T2 vs T3, *Z*= -0.088, p=0.930 & T1 vs T3, *Z*= -2.367, p=0.018), and total physical activity declined over a period of time. The partial *E*ta square of the effect size (ES) results revealed practical small changes for vigorous minutes per week spent doing physical activity (*d*=0.11) and moderate minutes spent doing physical activity (*d*=0.07). There were practical moderate changes observed for minutes spent watching TV/Sitting (*d*=61).

Table 5.2: The physical activity for boys and girls during the three measurents

	Boys			Girls			Total group			P-value of the difference	η_p^2
Year measurement	**2012 (n=73)**	**2013(n=62)**	**2014(n=51)**	**2012 (n=133)**	**2013(n=98)**	**2014(n=87)**	**2012(n=206)**	**2013(n=160**	**2014(n=138)**		
Variables	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**		
Vigmets/wk	632.79(1712.49)	246.08(412.29)	634.10(1414.00)	210.65(530.15)	124.16(331.65)	435.28(944.24)	362.02(1123.84)	167.88(366.32)	509.80(1136.08)	<0.001	0.11
Modemets/wk	430.40(1771.57)	53.70(94.63)	208.29(601.43)	82.95(193.54)	23.43(48.79)	74.16(211.48)	207.04(1078.14)	34.24(70.05)	122.06(401.01)	<0.001	0.07
Minutes spend watching TV/Sitting/wk	96.67(98.68)	14.47(16.87)	39.89(49.40)	100.77(71.81)	5.15(11.11)	38.23(54.05)	98.57(85.70)	10.14(15.00)	39.89(50.66)	<0.001	0.61
TOTALPAMET/wk	999.07(2089.19)	1277.65(2159.58)	1098.90(2358.90)	446.22(686.79)	623.29(951.77)	664.10(1120.95)	642.8591(1382.49)	856.03(1524.41)	818.75(1676.71)	0.28	0.01

Vigmets/wk = vigorous minutes per week, modemets/wk= moderate activity per week, TOTALPAMETS/wk= total physical activity minutes per week, N= total number of participants, η_p^2= *E*ta square

Table 5.3: The social correlates of boys and girls over the three measurements

	Boys			Girls			Total group			P-value of the differences	η_p^2
Year measurement	2012	2013	2014	2012	2013	2014	2012	2013	2014		
Variables	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)		
How often do you encourage your friend to do physical activity or play sports?	2.39(.49)	2.34(.60)	2.23(.56)	2.16(.63)	2.18(.54)	2.09(.61)	2.25(.59)	2.24(.57)	2.14(.56)	0.98	.007
How often do your friends encourage you to do physical activity or sports?	2.23(.60)	2.16(.52)	2.23(.56)	2.01(.70)	2.16(.70)	2.13(.64)	2.10(.67)	2.16(.63)	2.17(.61)	0.68	.002
How often do your friends do physical activities or play sport with you?	2.49(.59)	2.442(.58)	2.47(.505)	2.08(.56)	2.143(.55)	2.11(.64)	2.24(.61)	2.262(.58)	2.25(.61)	0.98	.007
How often do your friends tell you that you are doing a good job at physical activity?	2.23(.64)	2.18(.58)	2.25(.61)	2.24(.65)	2.07(.65)	2.18(.69)	2.23(.64)	2.12(.62)	2.21(.66)	0.35	.02
Has someone encouraged you to do physical activities or sports?	2.36(.65)	2.182(.62)	2.43(.54)	2.30(.69)	2.343(.61)	2.27(.64)	2.32(.67)	2.279(.62)	2.33(.60)	0.46	.01
Has someone done a physical activity or played sports with you?	2.56(.54)	2.60(.66)	2.47(.55)	2.21(.59)	2.23(.49)	2.24(.55)	2.35(.59)	2.38(.59)	2.33(.56)	<0.001	.02
Has someone provided transportation to a place where you can do physical activities or play sports?	1.93(.70)	2.60(.66)	1.70(.63)	1.86(.67)	2.23(.49)	1.76(.63)	1.89(.68)	2.38(.59)	1.73(.63)	0.03	.06
Has someone watched you participate in physical activities of sports?	2.39(.61)	2.32(.67)	2.25(.57)	2.27(.64)	2.11(.63)	2.02(.59)	2.32(.63)	2.19(.65)	2.11(.59)	0.01	.034
Has someone told you that you are doing well in physical activity?	2.44(.62)	2.26(.62)	2.40(.54)	2.24(.69)	2.19(.62)	2.12(.65)	2.32(.67)	2.22(.62)	2.23(.62)	.057	.03

N= total number of participants, total G/B= total for girls and boys, SD= standard deviation, η_p^2= *E*ta square or Cohen *d*

In **Table 5.3** the mean values for the boys were higher as compared with the mean values for the girls, for the all social correlates of physical activity. The partial Eta square of the effect size of the changes was relatively small ($d \leq 0.2$) for all the variables. The results also reveal a significant relation for "*has someone done a physical activity or played sports with you?"* ($p<0.001$), *"has someone provided transportation to a place where you can do physical activities or play sports?"*($p= 0.03$) and "*has someone watched you participate in physical activities of sports?"*($p= 0.01$). When a post-hoc followed was performed, the median (IQR) for *"During a typical week has someone watched you participate in physical activities of sports?"*, for measurement at points 2 and 3 was $Z=-2.909$, $p=0.004$. There was no statistical significance between measurement point 1 vs measurement 2 ($Z= -0.929$, $p=0.353$) and measurement points 3 and 4 ($Z= -1.152$, $p=0.249$), respectively.

Table 5.4: The relationship between the variables controlled for first measurement

		Body Mass 2013	Body Mass 2014	do you encourage your friend	do your friends encourage you	do your friends do physical activities	do your friend s tell you that you are doing a good	has someone encouraged you	has someone done a physical activity or played sports with you?	has someone provided transportation	has someone watched you participate	has someone told you that you are doing well	VIGMETS 2014/wk	MODMETS 2014/wk	Minutes spend watching TV/Sitting 2014/wk	TOTALPA 2014/wk
Body Mass2013	***r***	1.00	0.98	0.99	0.31	-0.01	-0.51	-0.35	0.45	-0.16	-0.36	-0.06	0.03	-0.20	-0.22	-0.27
	p	.	<0.001	<0.001	0.31	0.95	0.08	0.25	0.14	0.60	0.24	0.83	0.92	0.51	0.48	0.39
Body Mass2014	*r*	0.98	1.00	0.06	0.34	0.04	-0.54	-0.31	0.52	-0.12	-0.40	0.03	0.15	-0.24	-0.29	-0.22
	p	<0.001	.	0.84	0.27	0.89	0.06	0.32	0.07	0.70	0.19	0.91	0.62	0.44	0.35	0.49
Do you encourage your friend	*r*	0.00	0.06	1.00	-0.19	0.20	-0.26	-0.05	0.18	-0.15	-0.01	-0.14	0.02	0.04	-0.08	0.08
	p	0.99	0.84	.	0.54	0.51	0.40	0.86	0.57	0.62	0.96	0.65	0.94	0.88	0.78	0.78
Do your friends encourage you	*r*	0.31	0.34	-0.19	1.00	0.17	0.06	0.05	0.24	-0.28	0.33	0.34	0.30	-0.54	-0.43	-0.36
	p	0.31	0.27	0.54	.	0.57	0.84	0.85	0.44	0.36	0.28	0.26	0.33	0.06	0.15	0.24
Do your friends do physical activities	*r*	-0.01	0.04	0.20	0.17	1.00	-0.59	0.03	0.57	0.05	0.15	0.14	-0.06	0.11	0.21	-0.08
	p	0.95	0.89	0.51	0.57	.	0.04	0.91	0.04	0.86	0.63	0.64	0.83	0.72	0.49	0.78
Do your friend s tell you that you are doing a good	*r*	-0.51	-0.54	-0.26	0.06	-0.59	1.00	0.07	-0.68	-0.12	0.22	0.19	0.20	-0.38	-0.19	-0.08
	p	0.08	0.06	0.40	0.84	0.04	.	0.82	0.01	0.69	0.47	0.54	0.52	0.21	0.54	0.78
Has someone encouraged you	*r*	-0.35	-0.31	-0.05	0.05	0.03	0.07	1.00	0.32	0.44	0.50	-0.16	0.15	0.09	-0.40	0.22
	p	0.25	0.32	0.86	0.85	0.91	0.82	.	0.30	0.14	0.09	0.61	0.64	0.75	0.19	0.48
Has someone done a physical activity or played sports with you?	*r*	0.45	0.52	0.18	0.24	0.57	-0.68	0.32	1.00	0.36	0.05	0.05	-0.01	-0.11	-0.32	-0.29
	p	0.14	0.07	0.57	0.44	0.04	0.01	0.30	.	0.25	0.86	0.87	0.95	0.71	0.30	0.35
Has someone provided transportation	*r*	-0.16	-0.12	-0.15	-0.28	0.05	-0.12	0.44	0.36	1.00	0.26	0.13	0.14	0.31	-0.21	0.26
	p	0.60	0.70	0.62	0.36	0.86	0.69	0.14	0.25	.	0.40	0.68	0.65	0.32	0.50	0.41
Has someone watched you participate	*r*	-0.36	-0.40	-0.01	0.33	0.15	0.22	0.50	0.05	0.26	1.00	-0.00	-0.07	0.01	-0.25	-0.13
	p	0.24	0.19	0.96	0.28	0.63	0.47	0.09	0.86	0.40	.	0.98	0.82	0.95	0.41	0.68
Has someone told you that you are doing well	*r*	-0.06	0.03	-0.14	0.34	0.14	0.19	-0.16	0.05	0.13	-0.00	1.00	0.61	-0.38	-0.28	0.00
	p	0.83	0.91	0.65	0.26	0.64	0.54	0.61	0.87	0.68	0.98	.	0.03	0.21	0.36	0.99
VIGMETS2014/wk	*r*	0.03	0.15	0.02	0.30	-0.06	0.20	0.15	-0.01	0.14	-0.07	0.61	1.00	-0.35	-0.61	0.39
	p	0.92	0.62	0.94	0.33	0.83	0.52	0.64	0.95	0.65	0.82	0.03	.	0.26	0.03	0.19
MODMETS2014/wk	*r*	-0.20	-0.24	0.04	-0.54	0.11	-0.38	0.09	-0.11	0.31	0.01	-0.38	-0.35	1.00	0.67	0.68
	p	0.51	0.44	0.88	0.06	0.72	0.21	0.75	0.71	0.32	0.95	0.21	0.26	.	0.01	0.01
Minutes spend watching TV/Sitting2014/wk	*r*	-0.22	-0.29	-0.08	-0.43	0.21	-0.19	-0.40	-0.32	-0.21	-0.25	-0.28	-0.61	0.67	1.00	0.22
	p	0.48	0.35	0.78	0.15	0.49	0.54	0.19	0.30	0.50	0.41	0.36	0.03	0.01	.	0.48
TOTALPA2014/wk	*r*	-0.27	-0.22	0.08	-0.36	-0.08	-0.08	0.22	-0.29	0.26	-0.13	0.00	0.39	0.68	0.22	1.00
	p	0.39	0.49	0.78	0.24	0.78	0.78	0.48	0.35	0.41	0.68	0.99	0.19	0.01	0.48	.

Vigmets/wk = vigorous minutes per week, modemets/wk= moderate activity minutes per week, TOTALPAMETS/wk= total physical activity minutes per week

The results in **Table 5.4** show that there is a weak association between "*During a typical week, how often do your friends do physical activities or play sport with you?"* and *"During a typical week how often do your friends tell you that you are doing a good job at physical activity and sport?"* (r=-0.59; p=0.04). There was a significant moderate association between *"During a typical week has someone done a physical activity or played sports with you?"* and *"During a typical week, how often do your friends do physical activities or play sport with you?"* (r=0.57; p=0.04). The other results show that there is a weak association between "*During a typical week, how often do your friends do physical activities or play sport with you?"* and *"During a typical week how often do your friends tell you that you are doing a good job at physical activity and sport?"* (r=-0.68; p=0.01). There is a significantly high association between *"During a typical week has someone told you that you are doing well in physical activity?"* and vigorous activity minutes per week (r=0.61; p=0.03). Furthermore, there was a negative weak association between vigorous activity minutes per week and minute spend watching TV or sitting (r=-0.61; p=0.03). The results also showed a significant association between modemets and minute spent watching TV or sitting (r=0.67; p=0.01). Lastly there was a significant association between moderate minutes of activity per week and total physical activity (r=0.68; p=0.01).

Discussion

The objective of this study was to determine the three year longitudinal relationship between changes in social correlates of physical activity and physical activity in girls and boys from selected schools in the Tlokwe local municipality. The results showed significant changes for vigorous physical activity, moderate physical activity and minutes spent watching TV/Sitting (P<0.001). Overall physical activity decreases over a period of time with the time spent watching television increased. The partial *E*ta square of the effect size of the changes was small for vigorous activity minutes per week (*d*=0.11), moderate activity minutes per week (*d*=0.07) and medium for minutes spend watching TV/Sitting (0.61). The partial Eta square of the effect size of the changes was relatively small (d≤ 0.2) for all the variables. The results also revealed a significant relation for "*has someone done a physical activity or played sports with you"* (p<0.001), *"has someone provided transportation to a place where you can do physical activities or play sports?"*(p= 0.03) and "*has someone watched you participate in physical activities of sports?"*(p= 0.01). There were high mean values in social correlates and physical activity for the boys as compared to the girls. There was a significantly high association between *"During a typical week has someone told you that you are doing well in physical*

activity?" and vigorous physical activity (r=0.61; p=0.03). The results also showed a significant association between moderate physical activity and minute spent watching TV or sitting (r=0.67; p=0.01).

The findings of our study have revealed that girls participated less in physical activity. These findings are consistant with literature where less participation in physical activity among girls is a persistent finding.[25,26] Previous research points to several possible explanations as to why girls are less physically active than boys. Girls have been shown to participate less in organised sport [27], may receive less social support to engage in PA [28], and may perceive less enjoyment when taking part in physical education.[29] Similar results were found in this study, where boys were found to have more social support than the girls. Recent evidence also suggests that relationships between physical and social environment correlates and PA may differ between boys and girls.[30] The other reason may be biologically, where the lower participation among girls may be related to maturing at an earlier chronological age.[31]

Sedentary behaviour (SB), characterised by low-energy-expenditure activities (<1.5 metabolic equivalents) in a sitting or reclining posture, such as watching television (TV) or sitting in the classroom,[32] is an emerging risk factor for cardiometabolic disease later in life [33-35] and has attracted considerable attention as a candidate risk marker in young people.[36-39] The results in our study revealed a significant association between moderate physical activity and minute spent watching TV or sitting. Studies that measure SB objectively using accelerometers generally find no association,[40-43] although TV viewing consistently shows direct associations with adiposity-related outcomes.[36,43,44] A review found that screen time and TV viewing were associated with poor diet in children and adolescents,[45] and a study among Greek children found that the association between TV viewing time and obesity became insignificant when total energy intake was accounted for.[46] South African adolescents on average spend three hours a day watching TV on weekdays and the time increases to 3.5 hours on weekends.[47]

The parents, friends, teachers and other people who interact with children have the potential to influence participation in physical activity. This influence may occur either directly - through social support, or indirectly - through behaviour modelling.[48,49] There is evidence that more physically active parents and friends offer more social support,[50] and that social support is positively associated with physical activity among adolescents.[51] In a study by Cheng *et al.*[52] among 2,361 adolescents, participants' who perceived that their parents and friends

participated in physical activities more frequently, had higher levels of physical activity. Reviews by Seabra *et al.*[53] and by Edwardson & Gorely [16] observed that in general, physically active parents were more likely to have physically active children. Parents and friends may influence the adolescents' participation in physical activities by providing different types of social support (e.g. by encouraging, stimulating, practising together, providing transportation for the adolescents to the practise sites).[54] Similarly in this study, the parents and friends gave support by providing transport, watching children participate and participating with the children. Furthermore, the children participated in vigorous physical activity when told that they were doing well. That is, by providing encouragement the children's self-efficacy can be improved and thus improve participation in sport. Social support can also exert an indirect influence, increasing the perception of self-efficacy.[55,40] Higher levels of self-efficacy have been observed among adolescents who received more social support from parents and friends.[56,57] This construct has been consistently associated with higher levels of physical activity among adolescents.[57]

The results of the study revealed a significant relation for "*has someone done a physical activity or played sports with you"* ($p<0.001$) and physical activity participation among the girls and boys. The results further revealed a significant relation for "*do your friends do physical activity or sport?"* and physical activity. The results of this study concurs with the findings by Yao and Rhodes,[58] whose study found that co-participation was most strongly related with PA in samples of male and female children and adolescents. We have however not distinguished who between the parent and the friend has done physical activity or played with the child or adolescent. But since it has been found that friends do physical activity we can deduce that the friends are the ones who have done physical activity or played sport with the adolescents, because the nature of the relationship between children and their parents transforms significantly during adolescence.[59] Adolescents spend less time with their parents and more time with their friends,[60] therefore, we anticipated that friends might be better positioned to influence adolescent PA than parents. Laird *et al.*[61] has aluded that it is likely that ways in which parents and friends provide social support and influence activity levels are different. They further explained that, friends might contribute to positive experiences in physical education or organised physical activities whilst parents could create a foundation for lifelong habits in PA in their children at an early age and provide support for their ongoing participation in PA during adolescence.[61]

Our findings also revealed a significant relationship for *"has someone provided transportation to a place where you can do physical activities or play sports?"*(p= 0.03) and physical activity participation. The findings of this study agrees with the findings by Hoefer et al., (2001) among ethnically diverse children (n=1678; 712 boys, 966 girls; M age=13.0 years) from 24 middle schools (grades six to eight) and their parents completed surveys (response rate=72%) demonstrated that parent provision of transportation and the child's use of activity locations were associated with adolescents' total PA and participation in different sports teams and activity classes. Parental assistance strongly associated with children's physical activity participation includes transporting them to various exercise or sporting venues .[18]

There was a significant relationship found for "*has someone watched you participate in physical activities of sports?"*(p= 0.01) and physical activity participation. In a study by Yungblut *et al.*[62] about the views of adolescent female youth on physical activity during Early Adolescence, it was found that the adolescents indicated that trying new activities, being bad at an activity, or having to do an activity that was boring were considered to be more viable if there was at least one friend present. They felt that friends offered support and encouragement during stressful situations. Similar to adolescets in this study participated more often in physical activity when someone familiar (either a parents or friend) comes to watch them participate in physical activity. The friends allowed one to avoid judgment from others, creating a sense of comfort and avoidance of the unpleasant outcomes often associated with narrow conception of sport and physical activity.[62] These finding is consistent with the findings of Weiss *et al.*[63] that within sport contexts peers are inextricably linked with one's self-perceptions and motivational outcomes.

The current findings also have some limitations; as such the interpretation of the present study should be done with caution. Biological or physiological variables such as the timing of maturation need to be controlled.[64] This has been found to influence participation in physical activity among girls. If we are to improve participation among girls, a better understanding of the impact of maturation on PA behaviours and beliefs has to be stressed.[65,66] However, the questions used achieved satisfactory levels of reproducibility and have been used in other studies.[67] This study also has strengths: the longitudinal nature of the study gives a picture of to what extent the social correlates influence the participation of children in physical activity.[68,69] Interventions to increase physical activity among adolescents should include: actions to stimulate the participation of parents and friends in physical activities with

adolescents;[69] the facilitation and creation of opportunities for joint practices of these groups with adolescents; education regarding the importance of their social support for the physical activity of adolescents; and guidance on how to provide different forms of social support.

Conclusion

Based on the results of the study, it can be concluded that girls received lesser social support as compared to the boys. The girls participated less in physical activity as compared to the boys. The girls spent more minutes watching TV/Sitting in 2012 and 2014 as compared to the boys. The study also revealed that the children participate in vigorous physical activity when friends and family or someone has told them that they are doing well in physical activity and sport. Furthermore, those who participated moderately also spent minutes watching TV or sitting.

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Chapter 6
Summary, Conclusions, Limitations and Recommendations

6.1 SUMMARY

Regular physical activity promotes growth and development and has multiple benefits for physical, mental, and psychosocial health that undoubtedly contribute to learning (Kohl, 2013:15). WHO (2018) reported that regular and adequate levels of physical activity have been found to improve muscular and cardiorespiratory fitness; and to improve bone and functional health which are components of health-related fitness. Regular physical activity may influence the body proportions, particularly skeletal dimensions, and these may in turn influence performance success, fitness and the types of activities in which adolescents may wish to engage (Kohl, 2013:15).

Insufficient physical activity is one of the leading risk factors for global mortality and is on the rise in many countries, adding to the burden of NCDs and affecting general health worldwide (WHO, 2018). Globally, 81% of adolescents aged 11 to17 years were insufficiently physically active in 2010. Adolescent girls were less active than adolescent boys, with 84% versus 78% not meeting WHO recommendations (WHO, 2018).

Studies have shown that there are several social correlates that affect participation among adolescents (Shokrvash, *et al.,* 2013:8) including gender (Al-Hazzaa *et al.,* 2011:140), age (Mushtag *et al.,* 2011:130), and support received from family (Bauer *et al.,* 2011: 25; Craggs *et al.,* 2011: 645), friends (Beets *et al.,* 2006:278), teachers, and coaches (Humbert *et al.,* 2006: 467). Research has suggested that the support of family and friends is correlated with an active lifestyle (Bauer *et al.,* 2008: 12; Dishman e*t al.,* 2009:1) among children and adolescents. Support could be perceived through role modelling (Bauer *et al.,* 2011: 25; Dishman *et al.,* 2009:1),or providing practical and emotional support, which may include watching or encouraging them to be active (Bauer *et al.,* 2011: 25; Dishman *et al.,* 2009:1). A core tenet of ecological models of physical activity is that correlates are embedded in a complex system

whereby multiple environmental and individual characteristics are interrelated and exert independent and interactive effects (Sallis *et al.*, 2006: 297). A systematic review of 38 studies, revealed that several characteristics of the social environment associated with overall physical activity, including walking and sports participation, with higher quality social environments (i.e. increased sense of community, trustworthiness, reciprocity, social cohesion and social control) has shown higher levels of activity (Samuel *et al.*, 2014:359).

An understanding why some people are physically active and others inactive or looking into the factors that make people be active or inactive, may contribute to evidence-based planning of public health interventions (Bauman *et al.*, 2012: 257). Due to the abovementioned problem, the objectives of this study were, therefore, to determine:

- the three-year developmental changes of social correlates of physical activity in girls and boys from selected schools in the Tlokwe local municipality.

- the three-year relationship between changes of physical activity and selected health-related fitness in girls and boys from selected schools in the Tlokwe local municipality; and

- the three-year relationship between changes in social correlates of physical activity and physical activity in girls and boys from selected schools in the Tlokwe local municipality.

Chapter 2 addressed the changes in the social correlates of physical activity, physical activity and health-related fitness among adolescents over a period of time. The theories used to define the correlates of physical activity were reviewed. The assessment tools of physical activity, health-related fitness and social correlates of physical activity were discussed thereafter.

Chapters 3, 4 and 5 were presented in the form of research articles. The literature reviews, methods of the research, research design, results, discussion and conclusion of each article were presented in each chapter. The structure of the different articles is explained below.

- **Chapter 3:** Article 1: The three-year developmental changes of social correlates of physical activity in girls and boys: the PAHL study. The manuscript was prepared for publication in the *Journal of Physical Activity and Health.* The references were

prepared in accordance with the guidelines proposed by the *Journal of Physical Activity and Health.*

- **Chapter 4:** Article 2: The three-year relationship between changes of physical activity and selected health-related fitness in girls and boys: the PAHL study. The manuscript was prepared for publication in the *BioMed central.* The references were prepared in accordance with the guidelines proposed by the *BioMed Central Journal.*

- **Chapter 5:** Article 3: The three year longitudinal relationship between changes in social correlates of physical activity and physical activity in girls and boys: the PAHL study. The manuscript was be prepared for publication in the *Journal of Physical Activity and Health.* The references were prepared in accordance with the guidelines proposed by the *Journal of Physical Activity and Health.*

Chapter 6 Summary, conclusions, limitations and recommendations

6.2 CONCLUSIONS

The conclusions of this study are presented according to the hypotheses of this study as presented in Chapter 1:

Hypothesis 1: Significant developmental changes of social correlates of physical activity in girls and boys over a period three-years from selected high schools in the Tlokwe local municipality will be found.

The results show significant statistical ($p<0.05$) changes and high correlation coefficient developments (ranged from r=0.90 to r=0.97) as well as large partial *E*ta of the effect sizes in BMI, %BF and WHtR over a three year period. Small practical but statistically insignificant statistical ($p>0.05$) changes in social correlates (Encouragement, coactivity, transportation) were found. A significant change (p=0.04) for someone who watched you participate in PA or sport among girls [i.e. changes from; mean, 2.14(*d*=0.60); to mean, 2.02(*d*=0.58)], was revealed. Additionally, in both boys and girls changes in a construct of transportation to do physical activities or sports decreased from a mean of 1.88 to 1.71. There was a statistically significant difference in body mass (X^2 (df=2) = 10.354, p=0.006) and BMI (X^2 (*df*=2) =

11.400) over a period of three years. Post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a statistical significant level set at p<0.017. Median (IQR) for body mass T1, body mass T2 and body mass T3 were 54.17 (47.50 to 63.06), 57.45 (49.27 to 66.78) and 57.50 (50.47 to 66.70), respectively. There was no statistical significant differences between body mass T1 vs body mass measured at point 3 (T3)(Z = -2.241, p=0.025) measurements, despite an overall decrease in the body mass measurements. However, there was a statistical significant decreases between body mass measured at time point 1 (T1) vs body mass measured at point 2 (T2) (Z= -2.451, p=0.014) and between body mass at time 2 (T2) vs body mass at measured at point 3 (T3)(Z= 4.079, p=0.000). No statistical significant differences over a period of three years was found for body stature (X^2 (df=2) = 2.450, p=0.294) and %BF (X^2 (df=2) = 2.425, p=0.297) and WHtR (Z=5.225, p=0.073), as such there was no need to do post-hoc analyses. Median (IQR) for BMI T1, BMI T2 and BMI T3 were 20.61 (18.89 to 23.04), 21.12 (19.21 to 24.80) and 21.53 (19.17 to 24.87), respectively. There was no significant differences between BMI T1 (Z = -2.240, p=0.025) and BMI T2 or between the BMI T1 and BMI T3 (Z= -2.313, p=0.021) measurements, despite an overall decrease in the BMI measurements. However, there was a statistical decrease in BMI measured at time point 1 (T2) and BMI at measurement point 2 (T3) (Z= -3.034, p=0.002). In addition, a variable; *'during a typical week has someone watched you participate in physical activities or sports?'* showed small partial *eta* effect sizes (d=0.007) significant (p=0.04)(X^2 (df=2)=11.539, p=0.003) decrease [mean: 2.21(0.70), 2012; mean: 2.14(0.60), 2013 and mean: 2.02(0.58] in girls at the three measurements of 2012 to 2014 were observed. When a post-hoc followed was performed, the median (IQR) for *"During a typical week has someone watched you participate in physical activities of sports?"*, for measurement at points 2 and 3 was Z=-2.909, p=0.004. There was no statistical significant between measurement point 1 vs measurement 2 (Z= -0.929, p=0.353) and measurement points 3 and 4 (Z= -1.152, p=0.249), respectively. Given the averall results and the insignificant small magnitude, the hypothesis as it was set in Chapter 1 is therefore partially accepted.

<u>Hypothesis 2:</u> There will be three-year significant positive relationship between changes of physical activity and selected health-related fitness for girls and boys in selected schools in the Tlokwe local municipality.

The results showed a strong significant differences (p<0.001) in means of selected health-related fitness of standing broad jump (SBJ), sit-up (SUP) and sit-and-reach (SAR), stature,

and body mass (p=0.002) and BMI among the boys and girls. Results show an increase in stature, body mass and BMI for the entire sample through the three measurement points. The SBJ, SUP and SAR seemed to decrease through the three measurement points. The boys had higher body mass as compared to the girls, while the girls had higher BMI. The partial *E*ta square of the effect size was moderate (*d*=0.66) for SBJ, small (*d*=0.36) and (*d*=0.29) for SUP and SAR respectively. There was a statistically significant differences in body mass over a period of three years, X^2 (df=2) = 10.354, p=0.006. Post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for body mass T1, body mass T2 and body mass T3 were 54.17 (47.50 to 63.06), 57.45 (49.27 to 66.78) and 57.50 (50.47 to 66.70), respectively. There was no significant difference between body mass T1 vs body mass measured at point 3 (T3)(*Z* = -2.241, *p*=0.025) measurements, despite an overall decrease in the body mass measurements. However, there was a statistical significant decreases between body mass measured at time point 1 (T1) vs body mass measured at point 2 (T2) (*Z*= -2.451, *p*=0.014) and between body mass at time 2 (T2) vs body mass at measured at point 3 (T3)(Z= 4.079, p=0.000). No statistical significant difference over a period of three years was found for body stature (X^2(2) = 2.450, p=0.294), as such there was no need to do post-hoc analyses.

There was a statistically significant differences in BMI over a period of three years, X^2 (*df*=2) = 11.400, p=0.003. A post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for BMI T1, BMI T2 and BMI T3 were 20.61 (18.89 to 23.04), 21.12 (19.21 to 24.80) and 21.53 (19.17 to 24.87), respectively. There was no significant difference between BMI T1 (*Z* = -2.240, *p*=0.025) and BMI T2 or between the BMI T1 and BMI T3 (*Z*= -2.313, *p*=0.021) measurements, despite an overall decrease in the BMI measurements. However, there was a statistical decrease in BMI measured at time point 1 (T2) and BMI at measurement point 2 (T3) (*Z*= -3.034, *p*=0.002).

In the total group, decrease was observed in measurement point 2 and an insignificant increase of 4.22 cm from second measurement point (SUP T1=167.56; SUP T2=163.79 & SUP T3=168.01) was found. For SUP show a decrease of 1.18 cm at the third measurement point (SUP T1=25.24, SUP T2=25.68 & SUP T3=24.50), and SAR a decrease of 3.82 cm in the last measurement point (SAR T1=46.69, SAR T2=45.63 & SAR T3=41.81) was observed. There was a statistically significant differences in SBJ (X^2 (*df*=2) =4.621, p=0.099). However, when

a post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for SUP 1, SUP 2 and SUP 3 were 13.50 (2.52 to 26), 25.00 (16.00 to 36.00) and 23.00 (15.25 to 31.00), respectively. Statistical significant was observed for SUP (X^2 (*df*=2)=19.015, p=0.000), and when a post-hoc follow up was done significant differences were SUP 1 vs SUP 2; *Z*= -6.092, p=0.000, SUP 2 vs SUP 3; Z= -4.523, p=0.000; and no significant difference for SUP 3 vs SUP 4, *Z*= -1.857, p=0.063 was found. Additionally, statistical significant differences was found for SAR (X^2 (*df*=2)=18.617, p=0.000) with the difference SAR at measurement points 2 vs 3 (*Z*= -1.421, p=0.000), and measurement points 1 and 3 (*Z*= -5.132), The practical (partial Eta square of the effect size) developmental changes was moderate for SBJ (*d*=0.66), small (*d*=0.36) for sit-up and sit and reach (*d*=0.29) respectively.

Furthermore, the results revealed significant high correlation between body mass and stature, a moderate correlation between stature and body mass. The SUP, SBJ and SAR showed a significantly positive, negative and negative weak correlation respectively with the body mass. The girls showed a significant moderate correlation between stature and SUP T3 (r=0.50; p=<0.001). Significant positive moderate correlation coefficients was found between SUP T2 (r=0.49; p<0.001), and SUPT3 (r=0.37; p=0.05) and TPA2013 respectively for the boys. Statistically insignificant (p > 0.05) correlation coefficient was found between physical activity and body mass and also with BMI. There was a negative correlation between SART3 and Total PA 2013 for the boys (r= -0.18; p= 0.09). The hypothesis is therefore partially accepted.

<u>Hypothesis 3:</u> There will be three-year significant positive longitudinal relationship between changes of social correlates of physical activity and physical activity in girls and boys from selected schools in the Tlokwe local municipality.

The results shows a significant positive changes for vigorous PA, moderate PA and minutes spend watching TV/Sitting (p<0.001) for the period of measurement. The partial *E*ta square of the effect size (ES) results revealed moderate changes for vigorous minutes per week spent doing physical activity (0.11) and moderate minutes spent doing physical activity (0.07). There were large changes observed for minutes spent watching TV/Sitting (0.61). The effect size of the changes was relatively small (*d*= 0.2) for all the the social correlates. The results also reveal a significant relation for "*has someone done a physical activity or played sports with you"*

(p<0.001), *"has someone provided transportation to a place where you can do physical activities or play sports?"*(p=0.03) and "*has someone watched you participate in physical activities of sports?"*(p=0.01). There were high mean values in social correlates and physical activity for the boys as compared to the girls. The results also reveal that a significant relation for "*has someone done a physical activity or played sports with you"* (p<0.001), *"has someone provided transportation to a place where you can do physical activities or play sports?"*(p=0.03) and "*has someone watched you participate in physical activities of sports?"*(p=0.01). There were high mean values in social correlates and physical activity for the boys as compared to the girls. There is a significantly high association between *"During a typical week has someone told you that you are doing well in physical activity?"* and vigmets (r=0.61; p=0.03). There was a statistically significant differences in body mass over a period of three years, X^2 (*df*=2) = 10.354, p=0.006. Post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for body mass T1, body mass T2 and body mass T3 were 54.17 (47.50 to 63.06), 57.45 (49.27 to 66.78) and 57.50 (50.47 to 66.70), respectively. There was no significant difference between body mass T1 vs body mass measured at point 3 (T3)(*Z* = -2.241, *p*=0.025) measurements, despite an overall decrease in the body mass measurements. However, there was a statistical significant decreases between body mass measured at time point 1 (T1) vs body mass measured at point 2 (T2) (*Z*= -2.451, *p*=0.014) and between body mass at time 2 (T2) vs body mass at measured at point 3 (T3)(Z= 4.079, p=0.000). No statistical significant difference over a period of three years was found for body stature (X^2(2) = 2.450, p=0.294), as such there was no need to do post-hoc analyses.

There was a statistically significant differences in BMI over a period of three years, X^2 (*df*=2) = 11.400, p=0.003. A post hoc signed-rank analyses with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significant level set at p<0.017. Median (IQR) for BMI T1, BMI T2 and BMI T3 were 20.61 (18.89 to 23.04), 21.12 (19.21 to 24.80) and 21.53 (19.17 to 24.87), respectively. There was no significant difference between BMI T1 (*Z* = -2.240, *p*=0.025) and BMI T2 or between the BMI T1 and BMI T3 (*Z*= -2.313, *p*=0.021) measurements, despite an overall decrease in the BMI measurements. However, there was a statistical decrease in BMI measured at time point 1 (T2) and BMI at measurement point 2 (T3) (*Z*= -3.034, *p*=0.002).

When ANOVA for repeated measure with Friedman test, statistical significant (p=0.017) was found for the physical activity measure of vigorous (X^2 (*df*=2)=11.382, p=0.003), moderate physical activity (X^2 (*df*=2)=13.446, p=0.001) minutes spent watching TV/sitting (X^2 (*df*=2)=29.531, p=0.000) and total physical activity (X^2 (*df*=2)=29.531, p=0.000). Though no statistical significant differences (p>0.017) in TPA in all the three measurement points (T 1 vs T2, Z= -2.071, p=0.038; T2 vs T3, Z= -0.088, p=0.930 & T1 vs T3, Z= -2.367, p=0.018), total physical activity declined over a period of time.

When a post-hoc followed was performed, the median (IQR) for *"During a typical week has someone watched you participate in physical activities of sports?",* for measurement at points 2 and 3 was *Z*= -2.909, p=0.004. There was no statistical significance between measurement point 1 vs measurement 2 (*Z*= -0.929, p=0.353) and measurement points 3 and 4 (*Z*= -1.152, p=0.249), respectively. The results also show a significant association between modemets and minute spend watching TV or sitting (r=0.67; p=0.01). The hypothesis is therefore partially accepted.

6.3 LIMITATIONS

The present study has several limitations which should be noted when interpreting the results and which could be overcome in future research.

- To control for timing and tempo of physical maturation. This may directly or indirectly influence physical activity.

- There is need to specify whether the social support is related to adolescents' overall out-of-school PA or participation in sports teams and activity classes.

- There is a need to explore the impact of belief and culture on physical activity

- The study did not explore the types of physical activities that enhance performance, or promote physical activity among children and adolescents.

- The use of the IPAQ-SF and the social support for physical activity questionnaire comes with limitations that respondents are unable to recall or to take track of activities that are light to moderate (e.g. Sitting and walking) than vigorous PA. Respondents classify sports and exercise as vigorous physical activity that is controlled and follows a regular schedule. This therefore makes it easy to recall than the light to moderate PA. In terms of the exact hours and minutes spent for activities, respondents can only provide rough estimates.

6.4 RECOMMENDATIONS

From this study, the following recommendations are made.

- The policy to change the PA curriculum with strategy to increasing the duration and intensity of physical activity to improve the quantity and quality of education and physical activities. This may assist in reducing time spent for watching television and sedentary activities along with teaching healthy eating and non-tobacco use.

- Interventions to increase physical activity among adolescents should include actions to stimulate the participation of parents and friends in physical activities with adolescents. Teachers' and peers' social support significant for adolescents school PA and perceived parental support is significant for leisure time physical activity, especially for girls who appear to be lagging behind. Clear school and home intervention programmes including periods for exercising, condusive environment and family support may foster participation in PA and reduce sedentary behaviour.

- It is essential to ensure the facilitation and creation of opportunities for joint practices of these groups (parents and peers) with adolescents, education regarding the importance of their social support for the physical activity of adolescents, and guidance on how to provide different forms of social support. Include strategies for capacity building, providing sports facilities and other cooperation from the community and families

- Creation of extracurricular activities including entertainment programmes in the form of games, holding regular competitions and summer camps where teachers and even parents can participate in is recommended. Government to provide appropriate facilities in schools and communities to promote physical activity. To develop programmes in communities that will promote cohesion between the adolescents, parents and the community at large.

- Intervention programmes that are fun and yet yield the health-related fitness needs to be designed. Unlike the boys girls enjoy programmes that are fun and not competitive as boys would prefer.

6.5. FURTHER RESEARCH

Following the findings, there is a specific need for further research on the changes of social correlates of physical activity and health-related fitness.

- Studies should be developed exploring the mediators of change in child and adolescent physical activity. These would strengthen the evidence base informing the development and targeting effective intervention.

- It would also be important to develop studies to explore the type of physical activity likely to improve participation, because a person's physical activity behaviour is a function of the specific types of physical activity in which he/she chooses to engage.

- Develop studies to explore how a child or adolescent's social circle contributes to physical activity behaviour. Studies have found out that friends were more likely to contribute more to positive experiences in physical education or organised physical activities than the parents. While the parents could create a foundation for lifelong habits in PA in their children at an early age and provide support for their ongoing participation in PA during adolescence.

- Examine how teachers may influence participation in physical activity among adolescents.

- Promote the use of objective measures of physical activity (e.g. use of accelerometer and pedometers), which are feasible for use in longitudinal and large scale epidemiologic studies that intends to relate physical activity to the development of clinical outcomes. These methods also increases methodological transparency and facilitates the comparison of data across studies.

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Appendices

APPENDIX A

INFORMED CONSENT LETTER AND LETTER/FLYER FOR RECRUITMENT

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

School of Biokinetics, Recreation and Sport Science

Private Bag x6001,

Potchefstroom

2520

South Africa

INFORMATION LETTER TO THE PARENTS AND CONSENT AND ASSENT FORMS: *PAHLS STUDY*

Dear Parent or Guardian,

Your child is been invited to participate in a study entitled – Five year Longitudinal Study of Physical Activity status and the Determinants of Health in Adolescents attending high school in Potchefstroom areas of South Africa (*PAHLS-Study, 2010–2014*).

My name is Professor Makama Andries Monyeki (from Potchefstroom Campus of the North-West University) principal investigator in the project together with the research team would like to ask your permission to allow your child (or a child under your care) to participate in our study. To give the background of the study, research revealed that physical activity in adolescents is drastically declining. The decline in the level of physical activity of human populations has been observed, and such decline is been associated with increased mechanization, reliance on technology and urbanization, and the high rate of crime in South Africa. Physical inactivity is thought to be one of the main risk factors for the development of obesity, diabetes, cardiovascular disease, osteoporosis and psychological constraints or risks of behavioral health. Therefore, the purpose of this study is to gather information about physical activity (i.e. by questionnaire & ActiHeart rate monitor) and health determinants (i.e. through measurements of athropometry, maturation, blood pressure measurement, health-related physical fitness, social and self-efficacy questionnaire, resting metabolic rate, oxygen consumption (by the use of a portable gas analyser apparatus), blood sampling, leisure and recreation constraint questionnaires, nutritional intake questionnaire as questionnaire on risk factors of life) over a period of five years (2010–2014).

Participation in this study is not part of the child's regular classroom work; it is an optional activity in which the learner can choose to participate. The study will assess and test the following variables: athropometric measurements, maturation, blood pressure measurement, health-related physical fitness, social and self-efficacy questionnaire, resting metabolic rate, oxygen consumption, blood sampling, leisure and recreation constraint questionnaires, nutritional intake questionnaire as questionnaire on risk factors of life. Blood samples will be collected by a registered professional nurse who will obliged to health profession practices at all times.

The data of the study will be used for research purpose only. The measurements will not be shared with your child classmates or teacher. All information collected in this study will be kept confidential. Your child's participation is important because the information that shall be gathered on him/her will help him/her with knowledge for personal development and life skills.

Your child participation in the project is very important, but it is entirely your choice. If your child choose to refuse to participate in any part of the study or withdraw from the study at any time, for any reason, this will not cause anyone to be upset or angry, and this will not results in any type of penalty.

There are no costs required from your child (or a child under your care) to participate in the study. Further, no payment will be granted to your child (or a child under your care) for participating in the study.

If you have any question regarding this study, please feel free to call me at (018) 2991790 / e-mail:andries.monyeki@nwu.ac.za or the PHASrec Niche Area Leader Dr Hanlie Moss at (018) 2991821 / e-mail:hanlie.moss@nwu.ac.za. If you have any questions regarding your rights or your child's rights as participants in this study you can call Ms Hannekie Botha at (018) 299 4850 from Potchefstroom Campus of the North-West University Research Ethics Office.

Thank you, in advance, for considering your child participation in this study. Should you choose that your child participate, please read and sign the attached consent form. Keep one consent form for your records and return the other copy. All received consent form will be kept locked during the entire period of the study. In addition, your child is requested to bring along his/her birth clinic card. The card will be given back to the child immediately after colleting information on birth date and birth weight. A child who shall have returned a completed and signed consent form will participate in the study.

Sincerely,

Prof. Makama Andries Monyeki
Principal Investigator – PAHLS Study

CONSENT FORM
(Parent/Guardian Copy)

FIVE YEAR LONGITUDINAL STUDY OF PHYSICAL ACTIVITY STATUS AND THE DETERMINANTS OF HEALTH IN ADOLESCENTS ATTENDING HIGH SCHOOL IN POTCHEFSTROOM AREAS OF SOUTH AFRICA (*PAHLS-STUDY, 2010–2014*).

I, ..., father/mother/guardian of .....
agree to permit my child to provide the information on physical activity (i.e. by questionnaire & ActiHeart rate monitor) and health determinants (i.e. through measurements of athropometry, maturation, blood pressure measurement, health-related physical fitness, social and self-efficacy questionnaire, resting metabolic rate, oxygen consumption (by the use of a portable gas analyser apparatus), blood sampling, leisure and recreation constraint questionnaires, nutritional intake questionnaire as questionnaire on risk factors of life), by the researchers at my child school. I understand that the results of this study of Five year longitudinal study of physical activity status and the determinants of health in adolescents attending high school in Potchefstroom areas of South Africa (*PAHLS-STUDY NWP*) will be used for research purpose and nothing else. I am aware that if I have any question or concerns about the study I can contact the researcher at (018) 299 1790 or the PHASRec Niche Area Leader at (018) 299 1821. Any questions or concerns regarding my child rights as a participant in this study can be addressed to Ms Hannekie Botha at (018) 299 4850 from Potchefstroom Campus of the North-West University Research Ethics Office. I understand that there will be no discomfort or foreseeable risks for my child to participate in the study. I understand that all information my child provide will remain strictly confidential. I have read and understand the information provided above and in the information letter. I have been provided with the opportunity to ask questions and my questions have been answered satisfactorily. I consent to have my child participate in the study described above, understanding that he/she may refuse to participate in any part of the study and can withdraw from the study at any time. I have kept one copy of this consent for my records and will return the second copy with the **clinic birth card**. I am aware that by giving consent my child can participate in the study. The return consent form will be kept locked during the entire period of the study.

Child's Age:.....
Grade:.....
Teacher:.....
School Name:.....

Name of Child:.....
Name of Parent/Guardian:.....

....
(Signature of Child) (Signature of Parent/Guardian)

....
(Date) (Date)

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

CONSENT FORM (*PAHLS*)

(Return this copy with the demographic questionnaire)

FIVE YEAR LONGITUDINAL STUDY OF PHYSICAL ACTIVITY STATUS AND THE DETERMINANTS OF HEALTH IN ADOLESCENTS ATTENDING HIGH SCHOOL IN POTCHEFSTROOM AREAS OF SOUTH AFRICA (*PAHLS-STUDY, 2010–2014*).

I, ..., father/mother/guardian of .....
agree to permit my child to provide the information on physical activity (i.e. by questionnaire & ActiHeart rate monitor) and health determinants (i.e. through measurements of athropometry, maturation, blood pressure measurement, health-related physical fitness, social and self-efficacy questionnaire, resting metabolic rate, oxygen consumption (by the use of a portable gas analyser apparatus), blood sampling, leisure and recreation constraint questionnaires, nutritional intake questionnaire as questionnaire on risk factors of life), by the researchers at my child school. I understand that the results of this study of Five year longitudinal study of physical activity status and the determinants of health in adolescents attending high school in Potchefstroom areas of South Africa (*PAHLS-STUDY NWP*) will be used for research purpose and nothing else. I am aware that if I have any question or concerns about the study I can contact the researcher at (018) 299 1790 /e-mail:andries.monyeki@nwu.ac.za or the PHASRec Niche Area Leader at (018) 299 1821 /e-mail:hanlie.moss@nwu.ac.za. Any questions or concerns regarding my child rights as a participant in this study can be addressed to Ms Hannekie Botha at (018) 299 4850 from Potchefstroom Campus of the North-West University Research Ethics Office. I understand that there will be no discomfort or foreseeable risks for my child to participate in the study. I understand that all information my child provide will remain strictly confidential. I have read and understand the information provided above and in the information letter. I have been provided with the opportunity to ask questions and my questions have been answered satisfactorily. I consent to have my child participate in the study described above, understanding that he/she may refuse to participate in any part of the study and can withdraw from the study at any time. I have kept one copy of this consent for my records and will return the second copy with the clinic birth card. I am aware that by giving consent my child can participate in the study. The return consent form will be kept locked during the entire period of the study.

Child's Age:.....
Grade:.....
Teacher:.....
School Name:.....

Name of Child:.....
Name of Parent/Guardian:.....

.....	.....
(Signature of Child)	(Signature of Parent/Guardian)
.....	.....
(Date)	(Date)

APPENDIX B

YOUTH ASSENT FORM (PAHLS)

(Please read the information letter before signing the assent form)

RETURN THE COPY

(FIVE YEAR LONGITUDINAL STUDY OF PHYSICAL ACTIVITY STATUS AND THE DETERMINANTS OF HEALTH IN ADOLESCENTS ATTENDING HIGH SCHOOL IN POTCHEFSTROOM AREAS OF SOUTH AFRICA (*PAHLS-STUDY, 2010–2014*).

You are invited to participate in a research study conducted by **(Prof. M.A. Monyeki, PhD, Principal investigator, research director PHASReC, Prof. S.J. Moss)**, from the Potchefstroom Campus of the North-West University. Your participation is voluntary. You should take as much time to read the information above, and ask questions about anything you do not understand before deciding whether to participate.

The overall aim of the Physical Activity and Health Longitudinal Study (PAHLS) is to investigate over a five year period a follow-up longitudinal development of physical activity and determinants of health risk factors of health behavior in 14 years-old adolescents attending high schools in Potchefstroom areas of the North West Province of South Africa. In addition to compare the development of lifestyle and health changes over a period of time.

The research objectives of this study are:

1. Determine the patterns (directions and magnitude) of physical activity in 14 years-old adolescents attending high schools in the Potchefstroom areas of the North West province of South Africa over a period of time (2010-2015).
2. To describe the physical development in terms of body composition, diet, body build, body posture, physical activity, physiological profile, personality traits, behavioral risk factors, attitudes, sport and recreation participation, and social interaction in adolescents aged 14 years.
3. To explain development and changes in body composition, diet, body build, body posture, personality traits, behavioral risk factors, attitudes, sport and recreation participation and social interaction over a period of time (2010-2015).
4. To determine the relationships between lifestyle factors and health factors.
5. To determine factors (in the first year of the study) which predict an adverse development in obesity (and other health factors).
6. To determine the interrelationships between insulin-like growth factor 1 (IGF-1), fatness, lipid parameters, and physical activity among adolescent learners attending schools within the Tlokwe Local Municipality, North West Province from 2011 to 2014.
7. To determine the longitudinal changes between cardiorespiratory fitness and insulin-like growth factor 1 (IGF-1), fatness, lipid parameters, and physical activity among adolescent learners attending schools within the Tlokwe Local Municipality, North West Province from 2011 to 2014.

Your responses will be strictly confidential. There will be no way for us to know which responses belong to you or someone else. As such, given the longitudinal nature of the study you will therefore be given a number which will be used through all test measurements points. The data gathered will be used for research purpose and will be presented in various formats such as research thesis, journal, individual report or summary report for all and national and international conference presentations.

We will also ask your parents for their permission for you to participate in the study. Please discuss this with them before you decide whether or not to participate.

If you have any questions at any time, please ask one of the researchers.

_____ _____
Signature of participant Date

_____ _____
Signature of Investigator Date

INVESTIGATOR
Prof. M.A. Monyeki, PhD Office: 018 2991790 Mobile: 082 6444342

YOUTH ASSENT FORM (PAHLS)

(Please read the information letter before signing the assent form)

KEEP THE COPY

(FIVE YEAR LONGITUDINAL STUDY OF PHYSICAL ACTIVITY STATUS AND THE DETERMINANTS OF HEALTH IN ADOLESCENTS ATTENDING HIGH SCHOOL IN POTCHEFSTROOM AREAS OF SOUTH AFRICA (*PAHLS-STUDY, 2010–2014*).

You are invited to participate in a research study conducted by **(Prof. M.A. Monyeki, PhD, Principal investigator, research director PHASReC, Prof. S.J. Moss)**, from the Potchefstroom Campus of the North-West University. Your participation is voluntary. You should take as much time to read the information above, and ask questions about anything you do not understand before deciding whether to participate.

The overall aim of the Physical Activity and Health Longitudinal Study (PAHLS) is to investigate over a five year period a follow-up longitudinal development of physical activity and determinants of health risk factors of health behavior in 14 years-old adolescents attending high schools in Potchefstroom areas of the North West Province of South Africa. In addition to compare the development of lifestyle and health changes over a period of time.

Your responses will be strictly confidential. There will be no way for us to know which responses belong to you or someone else. As such, given the longitudinal nature of the study you will therefore be given a number which will be used through all test measurements points. The data gathered will be used for research purpose and will be presented in various formats such as research thesis, journal, individual report or summary report for all and national and international conference presentations.

We will also ask your parents for their permission for you to participate in the study. Please discuss this with them before you decide whether or not to participate.

If you have any questions at any time, please ask one of the researchers.

_____ _____

Signature of participant Date

_____ _____

Signature of Investigator Date

INVESTIGATOR
Prof. M.A. Monyeki, PhD Office: 018 2991790 Mobile: 082 6444342

APPENDIX C

QUESTIONNAIRES

PAHLS Project - Anthropometry Proforma

Subject number:	

Name: …… Sport: ……

Surname first names

Date of Birth:			
	Day	Month	Year

Test Date:			
	Day	Month	Year

Box height: ..... Gender: M F

	ID	*Site*	*Trail 1*	*Trail 2*	*Trail 3*	*Mean/ Median*

Basic	1	Body mass				
	2	Stature				
	3	Sitting height				
	4	Armspan				

Skinfolds	5a	Triceps : R				
(SF)	5b	Triceps : L				
(mm)	6a	Subscapular : R				
	6b	Subscapular : L				
	7a	Biceps : R				
	7b	Biceps : L				
	8a	Supraspinale : R				
	8b	Supraspinale : L				
	9	Abdominal : R				
	10a	Front thigh : R				
	10b	Front thigh : L				
	11a	Medial calf : R				
	11b	Medial calf : L				

Girths	12	Head				
GR	13a	Arm (relaxed) : R				
(cm)	13b	Arm (relaxed) : L				
	14a	Arm (flexed & tensed) : R				

	14b	Arm (flexed & tensed) : L				
	15	Waist (minimum)				
	16	Gluteal (hips)				
	17a	Thigh (mid) : R				
	17b	Thigh (mid) : L				
	18a	Calf (maximum) : R				
	18b	Calf (maximum) : L				

Breadths	19	Wrist				
BR	20	Ankle				
(cm)	21	Foot length				
	22	Humerus				
	23	Femur				

PAHLS PHYSICAL FITNESS DATA FORM

NAME OF LEARNER: _____ SUBJECT NO. __

TEST COMPONENT	**1ST TIME**							
POLE HEIGHT (CM)								
Vertical jump Reaching height (cm)	**A**							
FINAL VERTICAL JUMP HEIGHT A-B (cm)								
TEST COMPONENT	**1ST READING**		**2ND READING**		**HIGHEST**			
Vertical jump height (cm)					**B**			
Tendo peak power (W)								
Tendo speed (m/sec)								
TEST COMPONENT	**1ST READING**		**2ND READING**		**HIGHEST**			
horizontal jump distance (cm)								
TEST COMPONENT	**1ST READING**		**2ND READING**		**HIGHEST**			
basketball throw distance (m)								
TEST COMPONENT	**1ST READING**		**2ND READING**		**HIGHEST**			
L: hand grip strength (kg)								
R: hand grip strength (kg)								
TEST COMPONENT	**1ST READING**							
ABDOMINAL STRENGTH TEST (LEVEL)	0	1	2	3	4	5	6	7
TEST COMPONENT	**1ST TIME**							
bent arm hang (sec)								
TEST COMPONENT	**1ST TIME**							
sit ups (reps)								
TEST COMPONENT	**1ST READING**		**2ND READING**		**LOWEST**			
5m Speed (sec)								
10m speed (sec)								
40m speed (sec)								
TEST COMPONENT	**1ST READING**		**2ND READING**		**LOWEST**			

L: agility 505-test (sec)			
R: agility 505-test (sec)			

TEST COMPONENT	**1ST READING**
gender	**M / F**
birth date	**year / month / day**

20M SHUTTLE RUN

LEVEL	**SHUTTLE NUMBER AND HEART RATES**													
1	1	2	3	4	5	6	7							
2	1	2	3	4	5	6	7	8						
3	1	2	3	4	5	6	7	8						
4	1	2	3	4	5	6	7	8	9					
5	1	2	3	4	5	6	7	8	9					
6	1	2	3	4	5	6	7	8	9	10				
7	1	2	3	4	5	6	7	8	9	10				
8	1	2	3	4	5	6	7	8	9	10	11			
9	1	2	3	4	5	6	7	8	9	10	11			
10	1	2	3	4	5	6	7	8	9	10	11			
11	1	2	3	4	5	6	7	8	9	10	11	12		
12	1	2	3	4	5	6	7	8	9	10	11	12		
13	1	2	3	4	5	6	7	8	9	10	11	12	13	
14	1	2	3	4	5	6	7	8	9	10	11	12	13	
15	1	2	3	4	5	6	7	8	9	10	11	12	13	
16	1	2	3	4	5	6	7	8	9	10	11	12	13	14
17	1	2	3	4	5	6	7	8	9	10	11	12	13	14
18	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

TEST COMPONENT	**1ST TIME**
vo_{2MAX} (ML/KG/MIN) - INDIRECT	
vo_{2MAX} (ML/KG/MIN) - DIRECT	
ve_{MAX} (l/MIN) - DIRECT	
r_{MAX} - DIRECT	
hr_{MAX} (BEATS/MIN) - DIRECT	

PHYSICAL ACTIVITY QUESTIONNAIRE (PAHLS-IPAQ)

A: GENERAL INFORMATION ABOUT YOU

School:	
Grade:	
School number:	
Name of the participant:	
Subject number:	
Address:	
Race	

Date of Survey			**Grade**	**Sex (mark with a X)**		**Date of birth**			**Age**
dd	**mm**	**Yy**		**F**	**M**	**dd**	**mm**	**yy**	

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at school, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous/ very hard** activities that you did in the **last 7 days**. **Vigorous/ Very hard** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **very hard** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

☐ No very hard physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **very hard** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

☐

No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don’t know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**? (watching TV, Videogames/Internet, Listening to music, reading)

_____ **hours per day**

_____ **minutes per day**

☐ Don’t know/Not sure

SOCIAL SUPPORT FOR PHYSICAL ACTIVITY

This section asks you about the social support for participation in physical activity. Answer all questions. Answer these questions by putting a **Tick (√)** or **Cross (X)** in an appropriate box.

For an example:

During a typical week, how often	**NEVER**	**SOMETIMES**	**EVERY DAY**
do my friend play soccer with me		√	

Now is your term **ANSWER THESE QUESTIONS, and Remember no answer is WRONG**

DURING A TYPICAL WEEK, HOW OFTEN.....	**NEVER**	**SOMETIMES**	**EVERY DAY**
do you encourage your friends to do physical activities or play sports?			
do your friends encourage you to do physical activities or play sports?			
do your friends do physical activities or play sports with you?			
do your friends tell you that you are doing a good job at physical activity?			
has someone encouraged you to do physical activities or sports?			
has someone done a physical activity or played sports with you?			
has someone provided transportation to a place where you can do physical activities or play sports?			

has someone watched you participate in physical activities or sports?			
has someone told you that you are doing well in physical activity?			

THIS IS THE END OF THE QUESTIONNAIRE, THANK YOU FOR PARTICIPATING

APPENDIX D

Authorship Guidelines

The Journals Division at Human Kinetics adheres to the criteria for authorship as outlined by the International Committee of Medical Journal Editors*:

Each author should have participated sufficiently in the work to take public responsibility for the content. Authorship credit should be based only on substantial contributions to:

a. Conception and design, or analysis and interpretation of data; and
b. Drafting the article or revising it critically for important intellectual content; and
c. Final approval of the version to be published.

Conditions a, b, and c must all be met. Individuals who do not meet the above criteria may be listed in the acknowledgments section of the manuscript.
*Uniform requirements for manuscripts submitted to biomedical journals. *New England Journal of Medicine*, 1991, 324, 424–428.

Open Access

Human Kinetics is pleased to allow our authors the option of having their articles published Open Access within *JPAH*. In order for an article to be published Open Access, authors must complete and return the Request for Open Access form and provide payment for this option. To learn more and request Open Access, click here.

Manuscript Guidelines

JPAH is a peer-reviewed journal. Manuscripts reporting Original Research, Public Health Practice, Technical Notes, Brief Reports, or Reviews will be reviewed by at least two reviewers with expertise in the topical field, and the review process usually takes 6 to 8 weeks. A double-blind method is used for the review process, meaning authors and reviewers remain unknown to each other.

All types of manuscripts submitted to *JPAH* are judged on the following primary criteria: adherence to accepted scientific principles and methods, the significant or novel contribution

to research or practice in the field of physical activity, clarity and conciseness of writing, and interest to the readership. There are no page charges to contributors.

Manuscripts generally should not exceed 25 pages (~5,000 words including everything *except* title and abstract pages; the word limit includes the reference section). Reviews should not exceed a total of 30 pages and Brief Reports should not exceed 15 pages. Major exceptions to these criteria must be approved through the Editorial Office before submission. Submissions should not include more than 10 tables/graphics, and should follow the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (visit ICMJE for more detail). *JPAH* welcomes and encourages the submission of supplementary materials to be included with the article. These files are placed online and can be accessed from the *JPAH* website. Supplemental material can include relevant appendices, tables, details of the methods (e.g., survey instruments), or images. Contact the Editorial Office for approval of any supplemental materials.

Standardized Publication Reporting Guides

JPAH highly recommends that authors refer to relevant published reporting guidelines for different types of research studies. Examples of reporting guidelines include:

1. Consolidated Standards of Reporting Trials (CONSORT)
2. Meta-analysis of Observational Studies in Epidemiology (MOOSE)
3. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
4. STrengthening the Reporting of OBservational studies in Epidemiology (STROBE)
5. Improving the Quality of Web Surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES)

Manuscripts must be submitted in Microsoft Word® (*.doc) or rich text (*.rtf) format only. Do not submit a .pdf file. Graphics should be submitted in .tif or .jpg formats only. Before submitting, authors should complete the Manuscript Submission Checklist (see below). Authors may be asked to provide Human Kinetics with photo-ready graphics and/or a hard copy of the text. Authors are responsible for confirming the accuracy of the final copy,

particularly the accuracy of references, and to retain a duplicate copy to guard against loss. Final review of the pre-published text is the responsibility of the authors. Authors of manuscripts accepted for publication must transfer copyright to Human Kinetics, as applicable.

Cover letter. Submissions must include a cover letter stating that the manuscript has not been previously published (except in abstract form), is not presently under consideration by another journal, and will not be submitted to another journal before a final editorial decision from *JPAH* is rendered. Full names, institutional affiliations, and email addresses of all authors, as well as the full mailing address, telephone number, and fax number of the corresponding author, must be provided. Authors must also provide a statement disclosing any relevant financial interests related to the research.

Manuscript Types

Original Research. A manuscript describing the methods and results of a research study (quantitative or qualitative), including the background and purpose of the study, a detailed description of the research design and methods, clear and comprehensive presentation of results, and discussion of the salient findings.

Public Health Practice. A manuscript describing the development or evaluation of a public health intervention to increase or promote physical activity in a community setting, or a study that describes translation of research to practice.

Technical Note. A short article that presents results related to a new or modified method or instrument related to physical activity measurement or an important experimental observation.

Brief Reports. A short article (15 or fewer pages), usually presenting the preliminary or novel results of an original research study or public health practice program.

Reviews. Manuscripts that succinctly review the scientific literature on a specific topic. Traditional narrative reviews are discouraged. However, well-conducted systematic reviews and meta-analyses are highly encouraged. The Editorial Office may recruit reviews on specific topics. All review articles must have approval from the Editorial Office prior to submission.

Manuscript Sections

The order of submission must be (1) Title page, (2) Abstract, (3) Text, (4) Acknowledgments, (5) Funding source, (6) References, (7) Tables, (8) Figures/Graphics.

Title page. The manuscript must include a title page that provides the full title, a brief running head, manuscript type (see definitions above), three to five key words not used in the title of the manuscript, abstract word count, manuscript word count (inclusive of all pages except the abstract and title page), and date of manuscript submission. *Do not include author names on the title page.*

Abstract. All manuscripts must have a structured abstract of no more than 200 words. Required headings are (1) Background, (2) Methods, (3) Results, and (4) Conclusions.

Text. The entire manuscript must be double-spaced, including the abstract, references, and tables. Line numbers must appear on each page in the left margin. A brief running head is to be included on the upper right corner of each page; page numbers must appear on the bottom right corner of each page.

For studies involving human subjects, the Methods section must include statements regarding institutional approval of the protocol and obtaining informed consent. For studies using animals, the Methods section must include a statement regarding institutional approval and compliance with governmental policies and regulations regarding animal welfare.

Acknowledgments. Provide the names, affiliations, and the nature of the contribution for all persons not included as an author who played a critical role in the study.

Funding source/trial registration. Details of all funding sources for the work should be provided (including agency name, grant numbers, etc.). Provide the registry name and registration number for all clinical trials (see JPAH Ethics Policies below).

Example: “This work was supported by a grant (grant #) from the National Cancer Institute, National Institutes of Health. This study is registered at www.clinicaltrials.gov (No. xxxxx).”

References. For reference lists, authors must follow the guidelines found in the *American Medical Association Manual of Style: A Guide for Authors and Editors* (10th ed.). Examples of reference style:

Journal articles: Surname of first author, initials, then surname and initials of each coauthor; title of article (capitalize only the first word and proper nouns), name of the journal (italicized and abbreviated according to style of Index Medicus), year, volume, and inclusive page numbers.

Melby CL, Osterberg K, Resch A, Davy B, Johnson S, Davy K. Effect of carbohydrate ingestion during exercise on post-exercise substrate oxidation and energy intake. *Int J Sport Nutr Exerc Metab*. 2002;12:294–309.

Book references: Author(s) as above, title of book (italicized and all major words capitalized), city and state/province of publication, publisher, and year.

Pearl AJ. *The Female Athlete*. Champaign, Ill: Human Kinetics; 1993.

Chapter in an edited book: Same as book references, but add the name of the chapter author(s) and title of chapter (capitalize first word and proper nouns) before the book information and inclusive page numbers.

Perrin DH. *The evaluation process in rehabilitation*. In: Prentice WE, ed. *Rehabilitation Techniques in Sports Medicine*. 2nd ed. St Louis, Mo: Mosby Year Book; 1994:253–276.

Tables. Each table must be accompanied by an explanatory title so that it is intelligible without specific reference to the text. Column headings and all units of measure must be labeled clearly within each table; abbreviations and acronyms must be fully explained in the table or footnotes without reference to the text.

Figures/Graphics. Graphics should be prepared with clean, crisp lines, and be camera-ready. For shading, stripe patterns or solids (black and white) are better choices than colors. Graphics created on standard computer programs will be accepted. Graphics should be submitted in .tif or .jpg formats only. Each figure and photo must be properly identified. A hard copy may be requested. If photos are used, they should be black and white, clear, and show good contrast.

Manuscript Submission Checklist

Before submitting a first or revised manuscript, the following criteria must be met:

- All sections are double-spaced
- Line numbers appear in left margin
- Page numbers appear in bottom right corner
- Brief running head appears in upper right corner
- Title page does not include author names or affiliations
- Abstract is formatted and contains fewer than 200 words
- Page count under limit for the manuscript type (15, 25, or 30 pages)
- Fewer than 10 tables/figures
- References are formatted per AMA guidelines

Submitting Author Revisions

Authors often submit their responses to reviewer comments and the modifications in the manuscript in a variety of different ways, making it quite difficult for reviewers and the Senior Associate Editors to review revisions. When submitting a revised manuscript, the author must be certain to answer all reviewer questions, comments, and concerns by including a separate response document in addition to the revised manuscript. The response document should follow the format of the Revision Template, including the reviewer comment, the author response, and the modification made to the revised manuscript (including page and line number). All modifications to the manuscript should be highlighted in yellow. Authors NOT following these guidelines when submitting their revision will have their manuscript rejected from further consideration.

Notice to Authors Wishing to Submit to JPAH

The *Journal of Physical Activity and Health* is becoming increasingly competitive. We

continue to receive many more manuscripts than we can possibly publish. Therefore, in order to reduce any delay in publishing the best science, the following guidelines should be considered prior to submitting a manuscript.

The following types of manuscripts will be given the *lowest priority* and are the most likely to be rejected without review:

- Small, cross-sectional, descriptive studies without any innovative features (e.g., the association between physical activity and body mass index)
- Pilot studies
- Studies having no control or reference group
- Studies in which physical activity is merely a covariable of interest
- Methodological studies with no health-related outcome (e.g., associations among three types of accelerometers)

The types of studies given the *highest priority* are the following:

- Etiologic or experimental studies testing a specific hypothesis or highlighting a specific mechanism relating physical activity or inactivity to health and function
- Prospective or longitudinal studies
- Evaluation studies of effective public health practice
- Studies that are truly innovative and reflect progressive thinking

JPAH Ethics Policies

The Committee on Publication Ethics (COPE), International Committee of Medical Journal Editors (ICMJE), and the Council of Science Editors (CSE) are excellent sources of information regarding misconduct in scientific publication. *JPAH* ethics policies are modeled after guidance from these three organizations.

Authorship Criteria. As noted earlier, *JPAH* adheres to the criteria for authorship as outlined by the ICMJE. Each author must provide any relevant information upon request to substantiate their contributions.

Duplicate Publication. All manuscripts must not have been published previously in any format (internet website, journal, newsletter, etc.), with the exception of abstracts presented at scientific meetings.

Trial Registration. *JPAH* complies with the ICMJE requirement regarding registration of all prospective clinical trial studies prior to subject enrollment (to learn more visit ICMJE Clinical Trials Registration). The ICMJE defines a trial as "any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes." Health-related interventions include behavioral treatments (e.g., physical activity).

Compliance with NIH Public Access Policy Requirements. The National Institutes of Health (NIH), as well as other research funding agencies, require open access of all publications they fund. *JPAH* and Human Kinetics, Inc., will work with authors on a case-by-case basis to be compliant with NIH Public Access Policy.

Violations of Journal Ethics Policies. Falsification of data, duplicate publication, breach of confidentiality, abuse of research subjects, and so on are considered violations of the ethical conduct of research. *JPAH* reserves the right to investigate and impart punishment for any such violation. All allegations of potential misconduct will be investigated by the *JPAH* editorial team, Human Kinetics, Inc., and possibly external experts on a case-by-case basis and final decisions will be agreed upon by the Editors in consultation with the *JPAH* Editorial Board and guided by the COPE, ICMJE, and CSE standards.

Submit a Manuscript

Articles are to be submitted electronically via ScholarOne (see submission button at the top of this page). First-time authors will create an account by following the directions on the ScholarOne page. Authors will be asked to submit a "blinded" version of their article and a separate cover sheet with names, institutional affiliations, and contact information.

Please visit ScholarOne to download *JPAH*'s copyright form, located under the "Instructions & Forms" link in the upper right corner. You do not need an account to access this information.

APPENDIX E

Criteria

Research articles should report on original primary research, but may report on systematic reviews of published research provided they adhere to the appropriate reporting guidelines which are detailed in our editorial policies. Please note that non-commissioned pooled analyses of selected published research will not be considered.

BMC Public Health strongly encourages that all datasets on which the conclusions of the paper rely should be available to readers. We encourage authors to ensure that their datasets are either deposited or in publicly available repositories (where available and appropriate) or presented in the main manuscript or additional supporting files whenever possible. Please see Springer Nature's information on recommended repositories.

Preparing your manuscript

The information below details the section headings that you should include in your manuscript and what information should be within each section.

Please note that your manuscript must include a 'Declarations' section including all of the subheadings (please see below for more information).

Title page

The title page should:

- present a title that includes, if appropriate, the study design e.g.:
    - "A versus B in the treatment of C: a randomized controlled trial", "X is a risk factor for Y: a case control study", "What is the impact of factor X on subject Y: A systematic review"

    - or for non-clinical or non-research studies a description of what the article reports

- list the full names, institutional addresses and email addresses for all authors

    - if a collaboration group should be listed as an author, please list the Group name as an author. If you would like the names of the individual members of the Group to be searchable through their individual PubMed records, please include this information in the “Acknowledgements” section in accordance with the instructions below

- indicate the corresponding author

Abstract

The Abstract should not exceed 350 words. Please minimize the use of abbreviations and do not cite references in the abstract. Reports of randomized controlled trials should follow the CONSORT extension for abstracts. The abstract must include the following separate sections:

- Background: the context and purpose of the study

- Methods: how the study was performed and statistical tests used

- Results: the main findings

- Conclusions: brief summary and potential implications

- Trial registration: If your article reports the results of a health care intervention on human participants, it must be registered in an appropriate registry and the registration number and date of registration should be in stated in this section. If it was not registered prospectively (before enrollment of the first participant), you should include the words 'retrospectively registered'. See our editorial policies for more information on trial registration

Keywords

Three to ten keywords representing the main content of the article.

Background

The Background section should explain the background to the study, its aims, a summary of the existing literature and why this study was necessary or its contribution to the field.

Methods

The methods section should include:

- the aim, design and setting of the study
- the characteristics of participants or description of materials
- a clear description of all processes, interventions and comparisons. Generic drug names should generally be used. When proprietary brands are used in research, include the brand names in parentheses
- the type of statistical analysis used, including a power calculation if appropriate

Results

This should include the findings of the study including, if appropriate, results of statistical analysis which must be included either in the text or as tables and figures.

Discussion

This section should discuss the implications of the findings in context of existing research and highlight limitations of the study.

Conclusions

This should state clearly the main conclusions and provide an explanation of the importance and relevance of the study reported.

List of abbreviations

If abbreviations are used in the text they should be defined in the text at first use, and a list of abbreviations should be provided.

Declarations

All manuscripts must contain the following sections under the heading 'Declarations':

- Ethics approval and consent to participate
- Consent for publication
- Availability of data and material
- Competing interests
- Funding
- Authors' contributions
- Acknowledgements
- Authors' information (optional)

Please see below for details on the information to be included in these sections.

If any of the sections are not relevant to your manuscript, please include the heading and write 'Not applicable' for that section.

Ethics approval and consent to participate

Manuscripts reporting studies involving human participants, human data or human tissue must:

- include a statement on ethics approval and consent (even where the need for approval was waived)

- include the name of the ethics committee that approved the study and the committee's reference number if appropriate

Studies involving animals must include a statement on ethics approval.

See our editorial policies for more information.

If your manuscript does not report on or involve the use of any animal or human data or tissue, please state "Not applicable" in this section.

Consent for publication

If your manuscript contains any individual person's data in any form (including individual details, images or videos), consent for publication must be obtained from that person, or in the case of children, their parent or legal guardian. All presentations of case reports must have consent for publication.

You can use your institutional consent form or our consent form if you prefer. You should not send the form to us on submission, but we may request to see a copy at any stage (including after publication).

See our editorial policies for more information on consent for publication.

If your manuscript does not contain data from any individual person, please state "Not applicable" in this section.

Availability of data and materials

All manuscripts must include an 'Availability of data and materials' statement. Data availability statements should include information on where data supporting the results reported in the article can be found including, where applicable, hyperlinks to publicly archived datasets analysed or generated during the study. By data we mean the minimal dataset that would be necessary to interpret, replicate and build upon the findings reported in the article. We recognise it is not always possible to share research data publicly, for instance when

individual privacy could be compromised, and in such instances data availability should still be stated in the manuscript along with any conditions for access.

Data availability statements can take one of the following forms (or a combination of more than one if required for multiple datasets):

- The datasets generated and/or analysed during the current study are available in the [NAME] repository, [PERSISTENT WEB LINK TO DATASETS]

- The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

- All data generated or analysed during this study are included in this published article [and its supplementary information files].

- The datasets generated and/or analysed during the current study are not publicly available due [REASON WHY DATA ARE NOT PUBLIC] but are available from the corresponding author on reasonable request.

- Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

- The data that support the findings of this study are available from [third party name] but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of [third party name].

- Not applicable. If your manuscript does not contain any data, please state 'Not applicable' in this section.

More examples of template data availability statements, which include examples of openly available and restricted access datasets, are available here.

BioMed Central also requires that authors cite any publicly available data on which the conclusions of the paper rely in the manuscript. Data citations should include a persistent

identifier (such as a DOI) and should ideally be included in the reference list. Citations of datasets, when they appear in the reference list, should include the minimum information recommended by DataCite and follow journal style. Dataset identifiers including DOIs should be expressed as full URLs. For example:

Hao Z, AghaKouchak A, Nakhjiri N, Farahmand A. Global integrated drought monitoring and prediction system (GIDMaPS) data sets. figshare. 2014. http://dx.doi.org/10.6084/m9.figshare.853801

With the corresponding text in the Availability of data and materials statement:

The datasets generated during and/or analysed during the current study are available in the [NAME] repository, [PERSISTENT WEB LINK TO DATASETS].[Reference number]

Competing interests

All financial and non-financial competing interests must be declared in this section.

See our editorial policies for a full explanation of competing interests. If you are unsure whether you or any of your co-authors have a competing interest please contact the editorial office.

Please use the authors initials to refer to each author's competing interests in this section.

If you do not have any competing interests, please state "The authors declare that they have no competing interests" in this section.

Funding

All sources of funding for the research reported should be declared. The role of the funding body in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript should be declared.

Authors' contributions

The individual contributions of authors to the manuscript should be specified in this section. Guidance and criteria for authorship can be found in our editorial policies.

Please use initials to refer to each author's contribution in this section, for example: "FC analyzed and interpreted the patient data regarding the hematological disease and the transplant. RH performed the histological examination of the kidney, and was a major contributor in writing the manuscript. All authors read and approved the final manuscript."

Acknowledgements

Please acknowledge anyone who contributed towards the article who does not meet the criteria for authorship including anyone who provided professional writing services or materials.

Authors should obtain permission to acknowledge from all those mentioned in the Acknowledgements section.

See our editorial policies for a full explanation of acknowledgements and authorship criteria.

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Online document

Doe J. Title of subordinate document. In: The dictionary of substances and their effects. Royal Society of Chemistry. 1999. http://www.rsc.org/dose/title of subordinate document. Accessed 15 Jan 1999.

Online database

Healthwise Knowledgebase. US Pharmacopeia, Rockville. 1998. http://www.healthwise.org. Accessed 21 Sept 1998.

Supplementary material/private homepage

Doe J. Title of supplementary material. 2000. http://www.privatehomepage.com. Accessed 22 Feb 2000.

University site

Doe, J: Title of preprint. http://www.uni-heidelberg.de/mydata.html (1999). Accessed 25 Dec 1999.

FTP site

Doe, J: Trivial HTTP, RFC2169. ftp://ftp.isi.edu/in-notes/rfc2169.txt (1999). Accessed 12 Nov 1999.

Organization site

ISSN International Centre: The ISSN register. http://www.issn.org (2006). Accessed 20 Feb 2007.

Dataset with persistent identifier

Zheng L-Y, Guo X-S, He B, Sun L-J, Peng Y, Dong S-S, et al. Genome data from sweet and grain sorghum (Sorghum bicolor). GigaScience Database. 2011. http://dx.doi.org/10.5524/100012.

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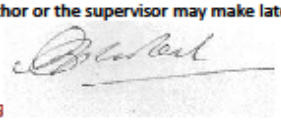

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