South African Journal for Research in Sport, Physical Education and Recreation, 2022, 44(1): 1 - 14.
ISBN: 0379-9069

ASSOCIATIONS BETWEEN BODY MASS INDEX, PHYSICAL ACTIVITY AND SOCIO-ECONOMIC STATUS IN ZIMBABWEAN ADOLESCENTS

Khanyile DLAMINI and Jeanne M. GRACE
Discipline of Biokinetics, Exercise & Leisure Sciences, University of KwaZulu-Natal, Durban, Rep. of South Africa

ABSTRACT

Noncommunicable diseases (NCDs) continue to be a global public health challenge for both developed and low and middle-income countries, with inactivity, overweight and obesity contributing to mortality. The study aimed to determine the body mass index (BMI), objectively measured physical activity (PA) levels, and socio-economic status (SES) of Zimbabwean adolescents and to establish the associations between their BMI and their PA and SES, and between their PA and their SES. Participants (N=126) aged 12−19 years were included in the study. BMI was classified according to the WHO BMI z-scores. Participants' PA levels were measured with a pedometer. SES was determined with the Family Affluence Scale III. The groups' mean BMI was 20.45 kg/m^2, with 18.9% of the females and 11.5% of the males being overweight. The groups' mean average number of steps taken per day for seven days was 9 459, and their SES was classified as low. The association between the males, females and groups' BMI with their PA levels was insignificant, negative and weak. There was a significant positive, weak association between BMI and SES for the males ($r = 0.289$; $p < 0.05$) and the group ($r = 0.227$; $p < 0.05$). The association between the females' PA and their SES was significant, negative and weak ($r = -0.338$; $p < 0.05$) with a significant, negative and moderate association between the males' PA and their SES ($r = -0.448$; $p < 0.05$). The higher the participants' BMI, the higher their SES, and the higher their PA levels, the lower their SES.

Keywords: Activity levels, Body composition, Income status, Step count, Z-scores

INTRODUCTION

Non-communicable diseases (NCDs) are among the major health and developmental challenges of the 21st century, particularly in low- and middle-income countries. This challenge affects both developed and developing countries (WHO, 2014). Global statistics show that the prevalence of obesity and overweight increased from 8.1 to 12.9% in adolescent males and from 8.4 to 13.4% in females from 1980–2008 (Finucane *et al*., 2011). Although sound epidemiologic data in Zimbabwe are scarce, NCDs are recognised as an important public health issue in Zimbabwe, listed second on the prioritisation list in the current National Health Strategy (Ministry of Health & Child Care, 2016). Although recent data on the body mass index of Zimbabwean in-school adolescents are absent, researchers indicate that the prevalence of

overweight and obesity in 15- to 19-year-old females in Zimbabwe was 11.5% in 2005/2006, 15.5% in 2010/2011, and 13.7% in 2015 (Mukora-Mutseyekwa *et al*., 2019). The prevalence of overweight and obesity in Zimbabwe has been on the rise in male children and adolescents, with the overweight rate rising from 2% in 2000 to 6.5% in 2016 and the obesity rate rising from 0.2% in 2000 to 1.4% in 2016 (Micha *et al.*, 2020).

Although physical inactivity is the fourth leading cause of death globally (Kohl *et al*., 2014), adolescent activity levels globally vary between genders, with 84% of females and 78% of males not attaining the 60 minutes (11 500–14 000 steps/day) daily moderate to vigorous physical activity (MVPA) recommended by the WHO (WHO, 2014; Adams *et al*., 2013). However, the objectively measured physical activity (PA) levels of in-school Zimbabwean adolescents are currently unknown. In a study of over 4000 Zimbabwean school children (8–16 years), researchers collected self-reported data on PA. They found that 59% of children and youth met the recommended 60 minutes of MVPA per day (Makaza *et al*., 2015). In this regard, two research studies in Canada and Poland showed that female adolescents who reached the recommended number of steps had a lower BMI than those females who did not take a sufficient number of steps (Colley *et al*., 2011; Kantanista *et al*., 2015). While the lay public often associates higher PA levels with body composition changes, studies on the association between PA and body composition in adolescents present inconsistent results (Hallal *et al*., 2012). No research has been published on the association between Zimbabwean adolescents' PA and body mass index. It is therefore essential to determine the current body mass index and objectively measured PA levels of Zimbabwean in-school adolescents, not only to implement preventative measures timeously, but also to prevent the development of NCDs in adulthood.

Socio-economic status (SES) is an important factor that affects the health of an individual or a family (Sharma, 2013). Yet, in the UK, adolescent self-reported health was found to have weak and inconsistent associations with objectively measured SES (Sweeting & Hunt, 2015). In sub-Saharan Africa, most literature focuses on sexual and reproductive health, with a paucity of studies that focus on the association between SES and health in adolescents. However, researchers assert that there is a directly proportional relationship between SES and PA: i.e., a greater level of physical activity when the SES is higher (Arias *et al*., 2018; Sigmundová *et al*., 2019). Researchers concur with the above findings in an Australian study that purported to identify correlates of pedometer-based cut-off points in a cross-section of 10- to 12-year-old adolescents (McCormack *et al*., 2011). The study found that achieving the pedometer-based cut-off points of 15 000 steps per day for males and 12 000 steps per day for females was positively associated with attending a high SES school (McCormack *et al*., 2011).

Researchers addressing the association between SES and obesity report inconsistent findings (Lebel *et al*., 2014). However, researchers concluded that the likelihood of becoming obese increases with lower income and is inversely associated with SES even after adjusting for age (Burkert *et al*., 2013). The above information is disturbing when considering that obese children usually become obese adults (Llewellyn *et al*., 2016) and to date, no information could be found on the relationship between Zimbabwean adolescents' SES and their PA and BMI. The Zimbabwean youth is important, and as stated by Llewellyn *et al*. (2016), the behaviour patterns established during this stage are likely to be carried into adulthood. This data are crucial in convincing the Zimbabwean government, schools and health professionals of the significance of the problem of physical inactivity and overweight/obesity in adolescents from different socioeconomic spheres and of putting strategies in place for the prevention and management of physical inactivity and overweight/obesity.

PURPOSE OF THE STUDY

The study aimed to determine the body mass index (BMI), objectively measured physical activity (PA) levels, and socio-economic status (SES) of Zimbabwean adolescents and to establish the associations between their BMI with their PA and SES and the association between their PA with their SES.

METHODS

Research design

A non-experimental, descriptive, quantitative, correlational research study design was followed. The study sites included three secondary schools located in urban and rural areas of two Zimbabwean provinces, namely Bulawayo, an urban city south-west of Zimbabwe with a population of 99 385, and Matabeleland North, a rural province in western Zimbabwe with a population of 749 017 (Demographics of Zimbabwe, 2020).

Population and sampling

The schools were identified using random sampling from a list of all secondary schools in the two provinces, with a school from each subgroup – high, moderate and low SES schools – forming the final sample. Following informed consent from the parents and assent from the adolescents, a total of 126 adolescents were randomly selected to participate in the study, ranging between the ages of 12 and 19 years (M=16.12, SD=1.71). The Family Affluence Scale III (FAS) was used to measure adolescents' SES (Hartley *et al*., 2016). Potential participants were excluded if they were unable to walk due to ill health or disability, or had mental health problems or limited writing ability.

Research tools and data collection

The participants completed the FAS to determine their socio-economic status, whereafter their height and weight were measured to determine their BMI. A smaller representative subgroup of 22 participants from each school (66 in total) was randomly sampled from the initial sample of 42 participants per school and given an Omron Walking Style Pro 2.0 pedometer to wear for seven consecutive days (Ueno *et al*., 2013).

Family Affluence Scale III

The FAS measures the participants' SES and categorises their SES as low, moderate, or high (Currie *et al*., 2014). The FAS includes a set of items that refer to family expenditure and consumption (affluence). The FAS asks questions like: "How many mobile phones are currently being used in your family?" "In all, how many four-wheeled motor vehicles does your family possess," and "Do you have a bedroom of your own which is unshared?" (None = 0; One = 1; Two = 2; Three or more = 3) (Fokeena & Jeewon, 2012). Answers are ranked on a scale from 0 to 13 and then categorised as low (0–6), moderate (7–9) and high (10–13) family affluence (Currie *et al*., 2014). The FAS is a reliable, valid instrument to measure adolescents' socio-economic status, and it shows a high completion rate of more than 99% compared to other SES indicators (Hobza *et al*., 2017).

Objectively measured physical activity levels

Physical activity was measured using an Omron Pedometer Walking Style Pro 2.0 instrument (OMRON, Kyoto, Japan), worn by the participants for seven consecutive days. The participants received an oral explanation and written instructions. Participants were instructed to wear the pedometer on the right hip during waking hours, except when bathing or engaging in other activities exposed to water. They were encouraged to maintain their usual daily routines during the measurement period. The participants were given an activity diary in which they recorded the times they put on and took off the pedometer during the seven days. After a week, the instrument was returned to the researcher. When the accompanying diary reported at least 10 hours of pedometer wear time, the day in question was considered valid for evaluation. Data on any participant not recorded for more than four consecutive diary dates were excluded from the final data analysis. The pedometers were deemed valid indicators of physical activity at moderate and fast speeds, and the accumulated evidence suggests that they are highly reliable (McNamara *et al*., 2010).

Body mass index

Height (SECA model 217, Medicare) and weight (SECA 877, Medicare) was measured according to the standards of the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones *et al*., 2012). The WHO BMI-for-age z-score categories were used to calculate BMI in this study. BMI categories were divided into four categories, namely thinness (underweight), normal weight, overweight, and obesity. Obesity is a BMI z-score greater than or equal to two standard deviations (≥ +2SD); it is equivalent to a BMI of 30 kg/m^2 at 19 years of age. Overweight is a BMI z-score greater than 1 standard deviation (> +1SD); it is equivalent to a BMI of 25 kg/m^2 at 19 years of age. Thinness is a BMI z-score of less than two standard deviations (< -2SD) (WHO, 2006).

Statistical analysis

Descriptive statistics were reported as means and standard deviations, frequencies and percentages. ANOVA was used to compare the PA levels of the three school groups, with post hoc tests (Tukey's test and the LSD test) being used to see statistically significant differences in their PA. The Dunn's Bonferroni pairwise comparison test was conducted to see exactly where the differences were with reference to the socio-economic groups. To determine the associations between the objectively measured PA levels, BMI and SES, inferential statistics (Pearson Chi-square test) were used. Data were analysed using the Statistical Package for the Social Sciences (SPSS version 20.0, Chicago. IL, USA).

Ethical considerations

The Biomedical Research and Ethics Committee of the University of KwaZulu-Natal (BE261-18) and the Medical Research Council of Zimbabwe approved the study. All procedures performed in this study involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

RESULTS

Demographics

A total of 126 adolescents participated in the study, ranging from 12 to 19 years in age (M=16.12, SD=1.71). Their age distribution indicates that 94% were between the ages of 14

and 18. The majority of the participants were females (58.7%, n=74), with 41.3%, (n=52) being male.

Body mass index

As portrayed in Table 1, the mean BMI of the females (n=74) was 20.52 kg/m^2 (SD=4.15), which lies in the -1SD and < +1SD normal category of the WHO BMI for age z-score for females. The males' BMI (n=52) was 19.97 kg/m^2 (SD=2.95), which lies in the 1SD and < +1SD (normal category) of the WHO BMI for age z-score for males. The groups' mean BMI (N=126) was 20.45 kg/m^2 (SD=3.38), which lies in the -SD and < +1SD (normal category) of the WHO BMI for age z-score (Table 1). Further analysis showed that 77.1% of the females' BMI was in the healthy or normal range (n=42), 18.9% (n=14) within the overweight category, while 1.4% (n=1) of the females was in the obese category, as shown in Figure 1. Regarding the males' BMI, 80.8% (n=42) was in the healthy or normal range, 11.5% (n=6) in the overweight category, while 7.7% (n=4) was in the underweight/thin category, with no males in the obese category.

Table 1. **BODY MASS INDEX OF PARTICIPANT WITH Z-SCORES (N=126)**

Participants	n	Mean BMI (kg/m^2)	SD	BMI z-score
Female	74	20.52	4.15	≥ −1SD and < +1SD
Male	52	19.97	2.95	≥ −1SD and < +1SD
Group	126	20.45	3.38	≥ −1SD and < +1SD

BMI = body mass index; SD = standard deviation

Figure 1 shows that 77.1% of the females and 80.8% of the males were categorised as normal weight, 18.9% of the females and 11.5% of the males as overweight, 1.4% of the females and 0% of the males as obese.

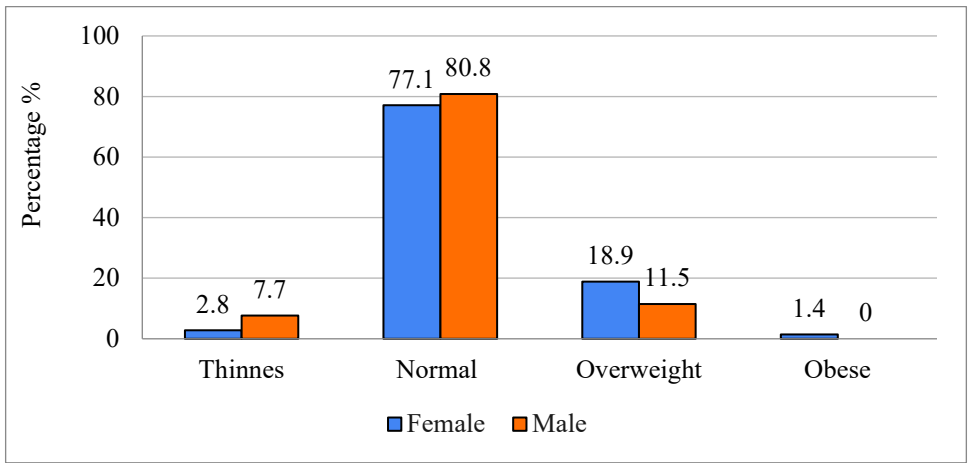


Figure 1. **FREQUENCY DISTRIBUTION OF BODY MASS INDEX**

Physical activity levels

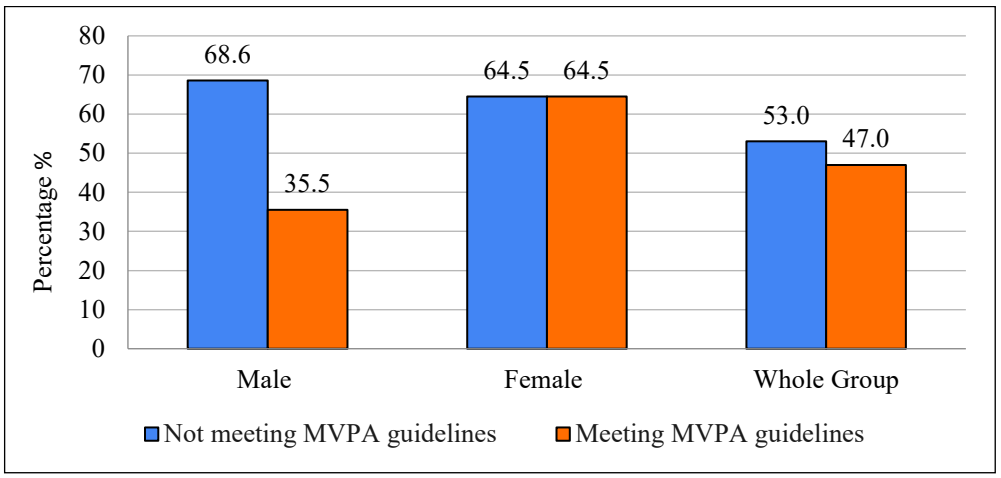
As displayed in Table 2, the average minimum and the maximum number of steps taken per day for the seven days by the group were 1 010 and 22 303.6 (M=9,459.2, SD=4,851.8), respectively. The males' average number of steps per day in seven days (M=10,838.7; SD=5,375.7) was significantly higher (p = 0.04) than the females' average number of steps in seven days (M=8,377.9; SD=4,158.3) (Table 2).

Table 2. **PARTICIPANTS' TOTAL AND AVERAGE NUMBER OF STEPS FOR SEVEN DAYS**

Tracking of Steps	Min	Max	Mean	SD
Average number of steps per day in 7 days (Group; n=66)	1010.0	22303.6	9459.2	4851.8
Average number of steps per day in 7 days (Males; n=29)	1010.0	22303.6	10838.7*	5375.7
Average number of steps per day in 7 days (Females; n=37)	2613.57	19259.1	8377.9	4158.3

*p < 0.05; SD: standard deviation

Figure 2 shows that 68.6% of the females, 31.4% of the males, and 53% of the whole group did not meet the MVPA guidelines.



MVPA = Moderate-to-vigorous physical activity

Figure 2. **PARTICIPANTS MEETING MVPA GUIDELINES**

Socio-economic status

As displayed in Table 3, the mean SES 6.17 (SD=3.22) of the females (n=74) and the males 5.82 (SD=3.33) (n=52) was categorised as low. The groups' (N=126) mean SES of 6.03 (SD=3.27) is also categorised as low (Table 3).

Table 3. **PARTICIPANTS' SOCIOECONOMIC STATUS**

Participants	n	Mean SES	SD	Mean SES Category
Female	74	6.17	3.22	Low
Male	52	5.82	3.33	Low
Group	126	6.03	3.27	Low

SD = standard deviation SES = socio-economic status

Association between the BMI and objectively measured physical activity levels

Table 4 shows a statistically insignificant negative and weak association between the average number of steps and BMI for the females (r = -0.180; p = 0.286) and the males (r = -0.242; p = 0.206). There was a statistically insignificant negative, weak association (r = -0.232; p = 0.061) between the average number of steps and BMI for the whole group, i.e., the higher the BMI, the lower their physical activity levels as reflected by their average number of steps in seven days (Table 4).

Table 4. **ASSOCIATION BETWEEN BODY MASS INDEX AND OBJECTIVELY MEASURED PHYSICAL ACTIVITY LEVELS**

Participants	n	BMI (kg/m^2) [M (SD)]	Average no. of steps over 7 days [M (SD)]	r	p-value
Female	37	20.52±4.15	8377.87±4158.27	-0.180	0.286
Male	29	19.97±2.95	10838.72±5375.73	-0.242	0.206
Group	66	20.45±3.28	9459.15±4851.79	-0.232	0.061

M = Mean; SD = standard deviation; BMI = Body mass index

Association between BMI and socio-economic status and between PA and SES

Table 5 shows a statistically insignificant weak association (r = 0.183; p = 0.118) between the BMI and their SES for females. A statistically significant positive, weak association was noted between the BMI and SES of the males (r = 0.289; p = 0.038), and for the whole group (r = 0.227; p = 0.011), i.e., the higher the BMI, the higher the SES.

Table 5 shows a statistically significant negative, weak association (r = -0.338; p = 0.041) between females' average number of steps and their SES. A statistically significant negative, moderate association between the average number of steps and SES for the males (r = -0.448; p = 0.015) and for the whole group was noted (r = -0.410; p = 0.001), i.e., the higher their physical activity levels as reflected in their average number of steps in seven days, the lower their SES.

Table 5. **ASSOCIATION BETWEEN BODY MASS INDEX AND SOCIO-ECONOMIC STATUS AND PHYSICAL ACTIVITY AND SOCIO-ECONOMIC STATUS**

Participants	BMI and SES			PA and SES		
	n	r	p-value	n	r	p-value
Female	74	0.183	0.118	37	-0.338*	0.041
Male	52	0.289*	0. 038	29	-0.448*	0.015
Group	126	0.227*	0.011	66	-0.410**	0.001

*p < 0.05 **p < 0.01

DISCUSSION

This study is the first of its kind to report on the objectively measured physical activity levels of Zimbabwean in-school adolescents and the associations between their body mass index, physical activity, and socio-economic status. Previous research reported a rise in the prevalence of overweight and obesity in Zimbabwean females 15 to 19 years old, where the prevalence was 11.5% in 2005/2006, 15.5% in 2010/2011, and 13.7% in 2015 (Mukora-Mutseyekwa *et al*., 2019). Consistent with this, our results show that 20.3% of the females were overweight and obese. However, although only 11.5% of males were overweight, it is consistent with a previous Zimbabwean study that reported a rise in the prevalence of overweight in male children and adolescents; the overweight rate rose from 2% in 2000 to 6.5% in 2016 (Micha *et al*., 2021). More females in this study were overweight than males, which corresponds with findings in other studies on adolescents (Negash *et al*., 2017). However, some researchers reported inconsistent findings on obesity/overweight prevalence in adolescents (Adom *et al*., 2019), with some researchers reporting that obesity/overweight prevalence does not differ between males and females (O'Dea, 2008). Nonetheless, some researchers report a higher prevalence in females (Negash *et al*., 2017), with other researchers, in contrast, showing higher estimates in males (Ogden *et al*., 2018). In South Africa, approximately 27% of females and 9% of males from the 15–19 years age group are overweight or obese (National Department of Health, Statistics South Africa, South African Medical Research Council (2017).

The current study found a lower average number of steps per day over seven days for males (10 839) and females (8 378) than those for Moroccan adolescent males (11 558) and females (8 869) (Baddou *et al*., 2018). The average number of steps per day reported for Indian adolescent males (11 062) and females (9 619) (Contractor *et al*., 2014) and Canadian adolescent males (12 100) and females (10 300) (Colley *et al*., 2011) were higher compared to the adolescents in the current study. The significantly higher average step count for males compared to females in the present study concurs with other researchers who found that males take more steps per day than females (Colley *et al*., 2011; Contractor *et al*., 2014). Researchers looked into translating 60 minutes/day MPVA into steps per day, and found that for adolescents aged 12–17 years with 60 minutes/day of MVPA, 11 500–14 000 uncensored steps/day as measured by an accelerometer, was optimal (Adams *et al*., 2013). When translated to a pedometer-based scaling, it reduced these minimum values by 2 500 steps/day to 9 000 and 11 500 steps/day (Adams *et al*., 2013). Although the adolescents from the current study met the pedometer-based scaled 9 000 pedometer steps per day (Adams *et al*., 2013), they did not meet the US President's Council on Fitness, Sports, and Nutrition's daily step goal of 12 000 steps per day for youth aged 6–17 years (President's Council on Sports, Fitness and Nutrition,

2016), or at least 10 000–11 700 steps/day as suggested by other researchers (Tudor-Locke *et al*., 2011). In sub-Saharan Africa researchers indicate that children and adolescents are experiencing a PA transition that is marked by a decrease in levels of activity and increased sedentary behaviour (Onywera *et al*., 2016). For instance, the Mozambique PA 2016 report card indicates that only 36.8% of boys and 19.9% of girls completed more than 60 minutes per day of MVPA (Prista *et al*., 2016), with 36% of Kenyan children reporting 60 or more minutes of PA on three or more days per week (Onywera *et al*., 2012).

This study showed a statistically insignificant negative and weak association between the average number of steps and females' BMI. A study on Polish female adolescents (Kantanista *et al*., 2015) and another on Canadian female adolescents (Colley *et al*., 2011) found that females who reached the recommended number of steps had a lower BMI than those females who did not take a sufficient number of steps (Colley *et al*., 2011; Kantanista *et al*., 2015). The statistically insignificant negative, weak association between the average number of steps and BMI for males as well as for the whole group (i.e., the higher their BMI, the lower their PA levels as reflected by their average number of steps per day) concurs with a Mauritian study that established a negative, small and insignificant correlation between PA and BMI (Fokeena & Jeewon, 2012). The current studies' findings agree with a study that found that in fully adjusted models, there was no statistically significant prospective association between physical activity and body composition (Hallal *et al*., 2012).

The present study showed a statistically insignificant positive, weak association between the BMI for females and SES. In this regard, Mizuta *et al*. (2016) showed that low SES was significantly associated with high BMI z-scores among Japanese females. However, the current study's findings for the males contrast the results on Japanese males, where low SES was not associated with high BMI z-scores (Mizuta *et al*., 2016). The statistically significant positive, weak association between the BMI for the whole group and their low SES contrast the findings on Mauritian adolescents, which reported a negative association between SES and BMI (Fokeena & Jeewon 2012). This is also in contrast with an American study that found that low SES was positively associated with being overweight/obese (Rogers *et al*., 2015).

The statistically significant negative, weak association between the average number of steps taken over seven days for the females and their low SES, as well as the significant negative, moderate association between the average number of steps and the low SES for the males and the whole group (i.e., the higher their PA levels as replicated by their average number of steps taken over 7 days, the lower their SES), are contrary to a review done by Stalsberg and Pedersen (Stalsberg & Pedersen, 2010). Their review found that the majority of studies reported a positive relationship between high SES and PA (Stalsberg & Pedersen, 2010). More than 40% of the studies on adolescents found no differences in PA across SES categories, while a few even reported opposite results with the low-SES group as more active (Stalsberg & Pedersen, 2010). However, the current study's findings correspond with a Swedish study that showed that children from low-SES families were more physically active than their higher SES counterparts (Beckvid-Henriksson *et al*., 2016).

The study's findings have to be interpreted in the light of some limitations: First, the FAS was conceptualised and validated in European contexts and there is no validity study for African contexts in the literature. In an effort to ensure the schools selected represented high, moderate and low SES schools, the schools included in the study were randomly sampled from a list of all secondary schools in the two Zimbabwean provinces. Second, the data were collected during the last term of the year when schools are more focused on preparing students

for exams, and as such extracurricular activities are reduced, adversely affecting the PA levels of the participants.

CONCLUSION

The present study's findings reveal no association between Zimbabwean in-school adolescents' BMI and their PA levels as reflected by their average number of steps per day over seven days, and the higher their BMI, the higher their SES. It also showed that the higher their physical activity levels, the lower their SES. This means that lower-income families in Zimbabwe might be less at risk of developing non-communicable diseases such as obesity, as the current study reports that Zimbabwean adolescents' BMI is positively associated with SES. The negative association between physical activity and SES points towards a need for schools with high SES adolescents to encourage adolescents to engage more in physical activities.

REFERENCES

ADAMS, M.A.; JOHNSON, W.D. & TUDOR-LOCKE, C. (2013). Steps/day translation of the moderate-to-vigorous physical activity guideline for children and adolescents. *International Journal of Behavioral Nutrition and Physical Activity*, 10(1): 1-11. https://doi.org/10.1186/1479-5868-10-49

ADOM, T.; DE VILLIERS, A.; PUOANE, T. & KENGNE, A.P. (2019). School-based interventions targeting nutrition and physical activity, and body weight status of African children: A systematic review. *Nutrients*, 12(1): 5. https://doi.org/10.1002/osp4.355

ARIAS, N.; CALVO, M.D.; BENÍTEZ-ANDRADES, J.A.; ÁLVAREZ, M.J.; ALONSO-CORTÉS, B. & BENAVIDES, C. (2018). Socio-economic status in adolescents: A study of its relationship with overweight and obesity and influence on social network configuration. *International Journal of Environmental Research and Public Health*, 15(9): 2014. https://doi.org/10.3390/ijerph15092014

BADDOU, I.; EL HAMDOUCHI, A.; EL HARCHAOUI, I.; BENJEDDOU, K.; SAEID, N.; ELMZIBRI, M.; EL KARI, K. & AGUENAOU, H. (2018). Objectively measured physical activity and sedentary time among children and adolescents in Morocco: A cross-sectional study. *BioMed Research International*, 2018: online. https://doi.org/10.1155/2018/8949757

BECKVID HENRIKSSON, G.; FRANZÉN, S.; ELINDER, L.S. & NYBERG, G. (2016). Low socio-economic status associated with unhealthy weight in six-year-old Swedish children despite higher levels of physical activity. *Acta Paediatrica*, 105(10): 1204-1210. https://doi.org/10.1111/apa.13412

BURKERT, N.T.; RÁSKY, E.; GROßSCHÄDL, F.; MUCKENHUBER, J. & FREIDL, W. (2013). The influence of socioeconomic factors on health parameters in overweight and obese adults. *PLoS One*, 8(6): e65407. https://doi.org/10.1371/journal.pone.0065407

COLLEY, R.C.; GARRIGUET, D.; JANSSEN, I.; CRAIG, C.L.; CLARKE, J. & TREMBLAY, M.S. (2011). Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports*, 22(1): 7. https://www.ncbi.nlm.nih.gov/pubmed/21510586

CONTRACTOR, A.; BHANUSHALI, A.; CHANGRANI, J.; ANGADI, S. & DAS, B.R. (2014). Pedometer assessed physical activity in urban pubertal children: first report from india. *Journal of Physical Activity and Health*, 11(8): 1475-1481. https://doi.org/10.1123/jpah.2012-0502

CURRIE, C.; INCHLEY, J.; MOLCHO, M.; LENZI, M.; VESELSKA, Z. & WILD, F. (2014). Health behaviour in school-aged children (HBSC) study protocol: background, methodology and mandatory items for the 2013/14 survey, Child and Adolescent Health Research Unit (CAHRU), St Andrews.

DEMOGRAPHICS OF ZIMBABWE. Hyperlink: [https://www.worldometers.info/demographics/zimbabwe-demographics/] Retrieved on: January 11, 2020.

FINUCANE, M.M.; STEVENS, G.A.; COWAN, M.J.; DANAEI, G.; LIN, J.K.; PACIOREK, C.J.; SINGH, G.M.; GUTIERREZ, H.R.; LU, Y.; BAHALIM, A.N. & FARZADFAR, F. (2011). National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 91 million participants. *The Lancet*, 377(9765): 557-567. https://doi.org/10.1016/S0140-6736(10)62037-5

FOKEENA, W.B. & JEEWON, R. (2012). Is there an association between socio-economic status and body mass index among adolescents in Mauritius? *The Scientific World Journal*, 2012(1):1-9. https://doi.org/10.1100/2012/750659

HALLAL, P.C.; REICHERT, F.F.; EKELUND, U.; DUMITH, S.C.; MENEZES, A.M.; VICTORA, C.G. & WELLS, J. (2012). Bidirectional cross-sectional and prospective associations between physical activity and body composition in adolescence: birth cohort study. *Journal of Sports Sciences*, 30(2): 183-190. http://doi.org/10.1080/02640414.2011.631570

HARTLEY, J.E.; LEVIN, K. & CURRIE, C. (2016). A new version of the HBSC family affluence scale-FAS III: Scottish qualitative findings from the international FAS development study. *Child Indicators Research*, 9(1): 233-245. http://doi.org/10.1007/s12187-015-9325-3

HOBZA, V.; HAMRIK, Z.; BUCKSCH, J. & DE CLERCQ, B. (2017). The Family Affluence Scale as an indicator for socio-economic status: validation on regional income differences in the Czech Republic. *International Journal of Environmental Research and Public Health*, 14(12): 1540. https://doi.org/10.3390/ijerph14121540

KANTANISTA, A.; KRÓL-ZIELIŃSKA, M.; BOROWIEC, J.; GLAPA, A.; LISOWSKI, P. & BRONIKOWSKI, M. (2015). Physical activity of female children and adolescents based on step counts: meeting the recommendation and relation to BMI. *Biomedical Human Kinetics*, 7(1): 1-8. http://doi.org/10.1515/bhk-2015-0011

KOHL 3RD, H.W.; CRAIG, C.L.; LAMBERT, E.V.; INOUE, S.; ALKANDARI, J.R.; LEETONGIN, G.; KAHLMEIER, S. & LANCET PHYSICAL ACTIVITY SERIES WORKING GROUP. (2012). The pandemic of physical inactivity: global action for public health. *The Lancet*, 380(9838): 294-305. http://dx.doi.org/10.1016/S0140-6736(12)60898-8

LEBEL, A.; KESTENS, Y.; CLARY, C.; BISSET, S. & SUBRAMANIAN, S.V. (2014). Geographic variability in the association between socio-economic status and BMI in the USA and Canada. *PLoS One*, 9(6): e99158. https://doi.org/10.1371/journal.pone.0099158

LLEWELLYN, A.; SIMMONDS, M.; OWEN, C.G. & WOOLACOTT, N. (2016). Childhood obesity as a predictor of morbidity in adulthood: a systematic review and meta-analysis. *Obesity Reviews*, 17(1): 56-67. https://doi.org/10.1111/obr.12316

MAKAZA, D.; KHUMALO, B.; MAKONI, P.; MAZULA, M.; DLAMINI, K.; TAPERA, E.M.; BANDA, M.; MLALAZI, T.F.; GUNDANI, P.D. & CHAIBVA, C.N. (2015). Nutritional status and physical fitness profiles, knowledge, attitudes, nutritional and physical activity practices of Zimbabwean primary school children: The Zimbabwe Baseline Study. Unpublished manuscript, Bulawayo, Zimbabwe, National University of Science and Technology.

MARFELL-JONES, M.J.; STEWART, A.D. & DE RIDDER, J.H. (2012). *International standards for anthropometric assessment.* Wellington, New Zealand: International Society for the Advancement of Kinanthropometry.

MCCORMACK, G.R.; GILES-CORTI, B.; TIMPERIO, A.; WOOD, G. & VILLANUEVA, K. (2011). A cross-sectional study of the individual, social, and built environmental correlates of pedometer-based physical activity among elementary school children. *International Journal of Behavioral Nutrition and Physical Activity*, 8(1): 1-11. https://doi.org/10.1186/1479-5868-8-30

MCNAMARA, E.; HUDSON, Z. & TAYLOR, S.J. (2010). Measuring activity levels of young people: the validity of pedometers. *British Medical Bulletin*, 95(1): 121-137. https://doi.org/10.1093/bmb/ldq016

MICHA, R.; MANNAR, V.; AFSHIN, A.; ALLEMANDI, L.; BAKER, P.; BATTERSBY, J.; BHUTTA, Z.; CHEN, K.; CORVALAN, C.; DI CESARE, M. & DOLAN, C. (2020). 2020 global nutrition report: action on equity to end malnutrition, Development Initiatives, Bristol, UK.

MINISTRY OF HEALTH AND CHILD CARE. (2016). The Zimbabwe population-based HIV impact assessment (ZIMPHIA). Harare: Ministry of Health and Child Welfare.

MIZUTA, A.; FUJIWARA, T. & OJIMA, T. (2016). Association between economic status and body mass index among adolescents: a community-based cross-sectional study in Japan. *BMC Obesity*, *3*(1), pp.1-9. http://10.1186/s40608-016-0127-z

MUKORA-MUTSEYEKWA, F.; ZEEB, H.; NENGOMASHA, L. & KOFI ADJEI, N. (2019). Trends in prevalence and related risk factors of overweight and obesity among women of reproductive age in Zimbabwe, 2005–2015. *International Journal of Environmental Research and Public Health*, 16(15): 2758. https://doi.org/10.3390/ijerph16152758.

NATIONAL DEPARTMENT OF HEALTH; STATISTICS SOUTH AFRICA; SOUTH AFRICAN MEDICAL RESEARCH COUNCIL. (2017). South Africa Demographic and Health Survey 2016: key indicators. Hyperlink: [http://dhsprogram.com/pubs/pdf/PR84/PR84.pdf]. Retrieved on: January 15, 2020.

NEGASH, S.; AGYEMANG, C.; MATSHA, T.E.; PEER, N.; ERASMUS, R.T. & KENGNE, A.P. (2017). Differential prevalence and associations of overweight and obesity by gender and population group among school learners in South Africa: a cross-sectional study. *BMC Obesity*, 4(1): 1-8. https://doi.org/10.1186/s40608017-0165-1

O'DEA, J.A. (2008). Gender, ethnicity, culture and social class influences on childhood obesity among Australian schoolchildren: implications for treatment, prevention and community education. *Health & Social Care in the Community*, 16(3): 282-290. https://doi.org/10.1111/j.1365-2524.2008.00768.x

OGDEN, C.L.; FRYAR, C.D.; HALES, C.M.; CARROLL, M.D.; AOKI, Y. & FREEDMAN, D.S. (2018). Differences in obesity prevalence by demographics and urbanization in US children and adolescents, 2013-2016. *Journal of the American Medical Association*, 319(23): 2410-2418. https://doi.org/10.1001/jama.2018.5158

ONYWERA, V.O.; ADAMO, K.B.; SHEEL, A.W.; WAUDO, J.N.; BOIT, M.K. & TREMBLAY, M.S. (2012). Emerging evidence of the physical activity transition in Kenya. *Journal of Physical Activity and Health,* 9(4): 554-562. http://dx.doi.org/10.1038/ijo.2009.211

ONYWERA, V.O.; MUTHURI, S.K.; HAYKER, S.; WACHIRA, L.M.; KYALLO, F.; MANGENI, R.O.; BUKHALA, P. & MIRERI, C. (2016). Kenya report card on physical activity for children and youth. *Journal of Physical Activity and Health*, 13(2): S195-S200. https://doi.org/10.1123/jpah.2016-0359

PRISTA, A.; DACA, T.; TCHONGA, F.; MACHAVA, E.; MACUCULE, C. & RIBEIRO, E. (2016). Results from the Mozambique 2016 report card on physical activity for children and adolescents. *Journal of Physical Activity and Health,* 13(s2): S213-S217. http://dx.doi.org/10.1123/jpah.2016-0526

ROGERS, R.; EAGLE, T.F.; SHEETZ, A.; WOODWARD, A.; LEIBOWITZ, R.; SONG, M.; SYLVESTER, R.; CORRIVEAU, N.; KLINE-ROGERS, E.; JIANG, Q. & JACKSON, E.A. (2015). The relationship between childhood obesity, low socio-economic status, and race/ethnicity: lessons from Massachusetts. *Childhood Obesity*, 11(6): 691-695. https://doi.org/10.1089/chi.2015.0029

SHARMA, R. (2013). Revision of Prasad's social classification and provision of an online tool for real-time updating. *South Asian Journal of Cancer*, 2(3): 157. https://doi.org/10.4103/2278-330X.114142

SIGMUNDOVÁ, D.; SIGMUND, E.; TESLER, R.; NG, K.W.; HAMRIK, Z.; MATHISEN, F.K.S.; INCHLEY, J. & BUCKSCH, J. (2019). Vigorous physical activity in relation to family affluence: time trends in Europe and North America. *International Journal of Public Health*, 64(7): 1049-1058. https://doi.org/10.1007/s00038-01901271-8

STALSBERG, R. & PEDERSEN, A.V. (2010). Effects of socio-economic status on the physical activity in adolescents: a systematic review of the evidence. *Scandinavian Journal of Medicine & Science in Sports*, 20(3): 368-383. https://doi.org/10.1111/j.1600-0838.2009.01047.x.

SWEETING, H. & HUNT, K. (2015). Adolescent socio-economic and school-based social status, smoking, and drinking. *Journal of Adolescent Health*, 57(1): 37-45. https://doi.org/10.1016/j.socscimed.2014.09.037

PRESIDENT'S COUNCIL ON SPORTS, FITNESS & NUTRITION. (2016). The President's challenge: Physical Activity & Fitness Awards Program. http://www.presidentschallenge.org

TUDOR-LOCKE, C.; CRAIG, C.L.; BEETS, M.W.; BELTON, S.; CARDON, G.M.; DUNCAN, S.; HATANO, Y.; LUBANS, D.R.; OLDS, T.S.; RAUSTORP, A. & ROWE, D.A. (2011). How many steps/day are enough for children and adolescents? *International Journal of Behavioral Nutrition and Physical Activity*, 8(1): 1-14. http://www.ijbnpa.org/content/8/1/78

UENO, D.T.; SEBASTIÃO, É.; CORAZZA, D.I. & GOBBI, S. (2013). Methods for assessing physical activity: a systematic review focused on older adults. *Revista Brasileira de Cineantropometria & Desempenho Humano*, 15(2): 256-265. https://doi.org/10.5007/1980-0037.2013v15n2p256

WORLD HEALTH ORGANIZATION. (2006). *WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development.* World Health Organization. Available at: https://www.who.int/childgrowth/standards/Technical_report.pdf Accessed on October 2, 2020.

WORLD HEALTH ORGANIZATION. (2014). Global status report on non-communicable diseases. Geneva: WHO. Available at: https://www.who.int/nmh/publications/ncd-status-report-2014/en/ Accessed on October 2, 2020.

Corresponding author: Prof. Jeanne Grace; **Email:** gracej@ukzn.ac.za

(*Subject editor: Prof. Hanlie Moss*)