Physical activity and sedentary behaviors associated with overweight and obesity among primary school children in Tanzania: a case-control study

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Abstract

Purpose – This study aims at determining the risk of physical inactivity and sedentary behaviors on overweight and obesity among primary school children aged 10–13 years in Tanzania.

Design/methodology/approach – A case-control study was conducted from January to March 2020 involving 69 overweight/obese children as cases and 138 normal weight children as controls. Cases were identified as having body mass index-for-age $\geq +1$ standard deviation (SD) and controls as those having BMI-for-age range between -2 SD to $<+1$ SD. A validated questionnaire was used for data collection on daily physical activities and sedentary behavior types, frequency duration and activity score. An independent sample *t*-test was used to compare means of activity score between cases and controls. Binary logistic regression was used to predict risk factors for overweight/obesity.

Findings – Risk factors for overweight/obesity were listening to music and/or radio for >2 h/week (OR 2.7, 95% CI 1.2–6.1) and walking for exercise <2 h/week (OR 2.1, 95% confidence interval [CI] 1.1–4.1). On the other hand, rope skipping for >2 h/week (OR 0.14, 95% CI 0.03–0.7) was a protective factor against overweight/obesity. Controls had a significantly higher mean score of being active during lunch breaks compared to cases ($p = 0.012$). Cases had higher weight, height and percentage body fat than controls ($p < 0.001$). The home environment provided more avenues for physical activity than the school environment.

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Originality/value – To the best of the authors' knowledge, this is original research work and the first case-control study to predict physical activity and sedentary behaviors as risk factors for overweight and obesity in Tanzanian school children.

Keywords Tanzania, Physical activity, Case-control, Sedentary behavior, Overweight, Obesity, School children, Cases, controls

Paper type Research paper

Background

Overweight and obesity rates among school children are unacceptably high in developed (Leech *et al.*, 2014) and low- and middle-income countries (Diouf *et al.*, 2016; Godakanda *et al.*, 2018). Overweight and/or obesity is a major risk factor for dietary-related chronic problems (Chomba *et al.*, 2019; Mosha *et al.*, 2021). Childhood obesity is reported to perpetuate into adulthood life (Mosha *et al.*, 2021). While for normal child growth and development participating in physical activity is of critical importance (Watts *et al.*, 2018; Štverákova *et al.*, 2021), physical inactivity is reported to increase in children and adolescents (Micklesfield *et al.*, 2014; Esht *et al.*, 2018), partly because of the use of electronic gadgets. In addition, the use of school buses to and from school makes children have lowered energy expenditures (Mosha and Fungo, 2010; Bhuiyan *et al.*, 2013).

Physical activity and diet are modifiable factors in preventing childhood obesity, prevent several non-communicable diseases (NCDs) and improve life expectancy (Diouf *et al.*, 2016; Mashili *et al.*, 2018; Ferrari *et al.*, 2020; Siong and John, 2021). Therefore, understanding the frequency of participation, patterns and details of specific types of sports in children may help determine their contribution to health outcomes (Heitzler *et al.*, 2011). The World Health Organization (WHO) recommends children 5–17 years old participate in moderate-to-vigorous intensity, mostly aerobic physical activity at least for 60 min per day across the week while limiting the amount of time spent in sedentary activities, especially recreational screen time (WHO, 2020). Nevertheless, around 80% of children aged 13–15 years globally do not meet this recommendation (Muntaner-Mas *et al.*, 2017). Recently, some studies from the USA, Czech and Saudi Arabia (Dunton *et al.*, 2020; Tulchin-Francis *et al.*, 2021; Štverákova *et al.*, 2021; Jalal *et al.*, 2021) have reported a decrease in physical activity among school children and university students, respectively, because of COVID-19 pandemic. This situation is likely to exacerbate the rates of overweight and obesity in children. Physical inactivity is the fourth most common cause of global premature mortality with approximately 3.2 million deaths (Muthuri *et al.*, 2014; Mashili *et al.*, 2018).

A sedentary lifestyle behavior that involves less utilization of energy for a substantial amount of time (Godakanda *et al.*, 2018) has now been adopted by most citizens of low- and middle-income countries, which are simultaneously struggling with the double burden of malnutrition (McVeigh and Meiring, 2014). The traditional active lifestyle is replaced by more sedentary lifestyles which support a rapid increase in NCDs hence overload to the health-care systems (Muthuri *et al.*, 2014).

Studies linking physical activity, sedentary behaviors and occurrence of overweight and obesity in school children are scarce in developing countries and no adequate data in Tanzania in this context. The national data are currently unavailable while previous individual studies have reported an increase in the prevalence of overweight and obesity to >20%. However, this prevalence has not been adequately associated with physical activity and sedentary behaviors among school children. One study (Tluway *et al.*, 2018) in northern Tanzania associated dietary factors, physical activity and body mass index (BMI) among secondary school adolescents in rural areas. A recent study in Kilimanjaro associated overweight and obesity in primary school children with dietary factors, availability of playgrounds at school and home neighborhood and

presence of electronic devices at home (Mosha *et al.*, 2021). Mwaikambo *et al.* (2015) related a few sedentary behaviors, such as television viewing, computer games and mode of transport to and from school, with overweight and obesity in school children in Dar-es-Salaam. A study by John *et al.* (2017) compared gender differences in physical activity among adults in North West Tanzania. The Tanzania STEPS survey of 2012 only reported the participation in physical activity among the adult population.

Little is known about overall levels, patterns and duration of physical activities and sedentary behaviors in school children and their association with nutrition status. The current study aimed at characterizing physical activity and sedentary behaviors of school children based on their weight status. Furthermore, associating physical activity and sedentary behaviors with overweight/obesity will be crucial in developing relevant interventions to reduce the future burden of NCDs among children in Tanzania. To the best of our knowledge, there is no other case control study in Tanzania in the area of nutrition status and physical activities of school children.

Methods

Study design, sites and population

A case-control study was conducted in nine primary schools, four public and five private schools from Ilala and Mkuranga districts. Ilala district is located in Dar-es-salaam region, whereas Mkuranga district is located in Pwani region, Eastern Tanzania. Study participants were school children aged 10–13 years in Grades 5 and 6 who participated in the baseline survey. The survey involved 406 children of which 189 were from Ilala district and 217 were from Mkuranga district. Again, 224 children were from public schools and 182 children were from private schools. The class registry was used to select randomly desired number of school children from each school. Cases in this study were overweight/obese children, whereas controls were the children identified with normal weight status. The WHO growth references for children aged 5–19 years were used to define cases and controls, applying the BMI-for-age Z-scores (BAZ) categories as $>+2$ SD (obese), $>+1$ SD (overweight) and >-2 SD to $+1$ SD normal BMI-for-age (Alqahtan and Scott, 2015).

Ethical clearance was obtained from the Kibong'oto Infectious Diseases Hospital, the Nelson Mandela African Institution of Science and Technology and the Centre for Educational Development in Health, Arusha Health Research Ethics Committee (KNCHREC0016). Permission was also obtained from district educational authorities to conduct the study in selected primary schools. Parents and/or guardians signed consent forms and school children assented to participate.

Sample size calculation and selection of participants

The sample size was calculated based on Charan and Biswas (2013) formula $n = \frac{r+1}{r} * \frac{Sd^2(Z\beta + Z\alpha_2)^2}{d^2}$ whereby: n = minimum sample size, r = ratio of control to cases, SD = standard deviation (mean BMI for school children $16.6 \pm 4.0\,kg/m^2$ from a study by Muhihi *et al.*, 2013), d = expected mean difference between cases and control = SD/2, Z_β = standard normal variate for 80% power (equal to 0.84), Z_α = standard normal variate for the level of significance of 1.96 corresponding to 95% confidence interval (CI). From the formula, 63 cases were obtained. By considering the ratio of 1:2, the number for controls is $63 \times 2 = 126$, and 10% was added to adjust for non-response rate/drop-outs. Finally, 207 children assented to participate in the study. These children were drawn from 406 children who participated in the baseline survey. Matching of cases to controls considered age, gender and school type criteria. The random sampling method (according to European Centre for Disease Prevention and Control, 2009;

WHO, 2014) was used to select controls from a list of normal weight children. All overweight/obese children and normal weight children who met the specified criteria above were eligible for the study. Exclusion involved malnourished children, unmatched criteria with cases and those who did not accept to participate.

Data collection

Anthropometric measurements

Weight and height data were measured by trained researchers using standard procedures (WHO, 2008). An electronic digital scale (Digital SECA™) was used to measure children's weight while wearing light clothes and recorded to the nearest 0.1 kg. Children's height was measured by SECA™ mechanical stadiometer without shoes, with minimum clothes, and recorded to the nearest 0.1 cm. In addition, percentage body fat was measured by a Bio-electric Impedance Analyzer (BIA-TANITA™-BF-350, America) device to complement BMI-for-age data because BMI alone cannot separate lean mass, bone mass and fat mass. On the other hand, BIA assumes constant hydration of the body which may result in under or overestimation of body fat (Kyle *et al.*, 2015). However, validation with other methods may help overcome this limitation. In studies with school children by Marques-Vidal *et al.* (2008) and Kabiri *et al.* (2015), BIA had shown the same reliability and strong correlation with dual-energy X-ray absorption and high specificity for overfat and obese classification. In a study with European children BIA was validated against the deuterium dilution method and small differences were detected, thus the study supported the application of BIA for epidemiological studies in children (Kourkoumelis *et al.*, 2021). The cut-off value of 25% and 30% for boys and girls, respectively, has been used to define obesity in children (Marques-Vidal *et al.*, 2008). BMI for each child was converted into age- and sex-specific Z-score using WHO's AnthroPlus software. Demographic information such as gender, age, type of school and grade of children were also collected.

Physical activity questionnaire

A previously standardized validated and used physical activity questionnaire for older children and adolescents (physical activity questionnaire [PAQ-C]) was adapted from Kowalski *et al.* (2004), modified and used for this study. Other studies by Bailey *et al.* (1999) and Carter *et al.* (2001) used PAQ-C successfully with school children. The PAC-Q was selected because of its low cost and frequently use in epidemiological studies. It is an alternative to more expensive electronic devices such as accelerometers, pedometers and doubly labeled water techniques (Diouf *et al.*, 2016) and can apply to large groups of participants (Muntaner-Mas *et al.*, 2017). In addition, children ages ten years and above can give valid answers to PAQ-C (Muntaner-Mas *et al.*, 2017). The PAQ-C contains nine items. The PAQ-C was modified as necessary by adding and omitting some games to ensure relevance in our context. Games such as netball, rope skipping, household chores, walking to and from school were added because these are commonly done in Tanzania, and uncommon games in our setting such as ice-skating and ice hockey were omitted. The first item of the questionnaire was on physical and sedentary activities. It included type of activity, place of the activity (home or school), frequency and duration of each physical and sedentary activity in the last seven days before the survey. Physical activity included games like football, netball, dancing and rope skipping.

Sedentary activities involved watching television, listening to music, artwork, doing homework, computer games and telling stories. Patterns of physical and sedentary activities were assessed in frequency (number of times) per week and minutes spent on each day of the week. A child was asked to recall in the past seven days, the type of physical and sedentary activities, place of activity, frequency and duration of each activity. Each physical and sedentary activity was expressed as continuous (min/week) then categorized later further

for analysis. The mean hours of physical and sedentary activities were obtained from the summation of time spent in various activities then divided by days of the week. Items 2 through 8 of the PAQ-C considered what they did most and the frequency of participating in activities done on different occasions in a typical week (during recess, lunch, right after school, evenings and during weekends). Scores 1–5 were assigned for each item, 1 being less active and 5 being most active. A higher score indicates an increased frequency of being active on a particular occasion. Item 9 was the mean of all days of the week. The mean activity score of each item was computed and compared between the case and control groups.

Statistical analysis

All statistical analyses were performed by Statistical Package and Service Solution (SPSS)^{TM} Version 20. Descriptive statistics were used to classify the sample. The differences in socio-demographic and anthropometric data between cases and controls were tested using the independent sample *t*-test for normally distributed data and Mann-Whitney U-test for skewed data. The independent sample *t*-test was also used to compare the mean activity score between the two groups. To predict the association between physical activity patterns, sedentary behaviors and overweight/obesity, multivariable binary logistic regression models were used to estimate the odds ratios (ORs) at 95% CI. Overweight/obesity was considered as a dependent variable, whereas physical activities and sedentary behaviors were considered as independent variables. Univariate analysis was performed to assess the association between each of the independent variables and being overweight/obese. Independent variables that showed a probability value of <0.30 in the univariate analysis were entered into a regression model. Three tertiles were made for physical activities and sedentary behaviors; 0 = none, 1 = <2 h per week, 2 = >2 h per week. Total physical activity had two tertiles; 0 = <1 h per day, 1 = >1 h per day. Total sedentary had 0 = <4 h per day and 1 = >4 h per day. Furthermore, in each regression model, the first tertile of physical activity and sedentary behavior was considered as a reference category. The significance level was considered at $p < 0.05$.

Results

Social demographic and anthropometric data of cases and control children are presented in Table 1. Out of the 207 children, 126 (60.9%) were girls and from the total sample, 108

Characteristics	All median	Cases median	Controls median	*p*-value
n	207	69	138	
[1]Sex, girls %	60.9	60.9	60.9	0.48
[2]Age in years, mean ± SD	11.4 ± 0.8	11.3 ± 0.9	11.4 ± 0.8	0.25
[3]Weight (kg)	38.2	49.5	34.6	<0.001*
[2]Height (cm), mean ± SD	143 ± 7.7	146 ± 7.7	142 ± 7.4	<0.001*
[3]BMI kg/m^2	18.2	23.0	16.9	<0.001*
[3]BMI Z-scores	0.26	1.76	−0.35	<0.001*
[3]Body fat (%)	18.4	30.5	14.7	<0.001*
[2]Sleeping hours/day, mean ± SD	8. 4 ± 1.1	8.3 ± 1.0	8.4 ± 1.1	0.52
[3]Sedentary hours/day	3.7	3.7	3.6	0.99
[3]Physical activity hours/day	2.4	2.5	2.4	0.86

Notes: *p*-value derived from chi-square test[1], *p*-values are from independent sample *t*-test[2], *p*-value derived from Mann-Whitney U-test[3] indicates significant, *$p < 0.001$, mean ± standard deviation, BMI = body mass index

Table 1. Background characteristics of school children $n = 207$

(52.2%) children were children from private schools. The mean age of children was 11.4 years (SD: 0.8). The mean sleeping hours per day was 8.4 h (SD: 1.1). Cases had higher weight, height and percentage body fat than controls ($p < 0.001$). There was no statistically significant difference in age, number of sleeping hours per day and average time spent in sedentary and physical activities per day between cases and controls.

The mean score for being active on different occasions is presented in Table 2. Besides lunch (over the lunch break) normal weight children (controls) had a higher mean score of being active ($p = 0.012$) than overweight and obese children (cases). Mean scores for being active during break times/recess, right after school, during weekends and evenings were not significantly different between overweight/obese and normal weight children ($p > 0.05$). Although not statistically significant, overall mean scores of being active were slightly higher in normal weight than in the overweight/obese children.

Results for univariate analysis (Table 3) showed that rope skipping for >2 h per week was associated with overweight and obesity (OR 0.2, 95% CI 0.05–0.9). Other sports activities were not associated with overweight/obesity. However, ORs showed that those who were running, swimming for <2 h/week and/or riding a bike for >2 h/week were less likely to be overweight and obese (OR > 1). On the other hand, those who were dancing, walking for exercise and doing household tasks were more likely to be overweight and obese than those who did not participate in these activities (OR > 1). Although not significant, more percentage of normal weight children met the WHO recommendation for physical activity than overweight/obese children.

Univariate analysis (Table 4) showed that listening to music and/or radio for >2 h/week was significantly associated with overweight/obesity (OR 2.7, 95% CI 1.2–6.1). Other sedentary behaviors were not significantly associated with overweight and obesity ($p > 0.05$). However, those who watched television/video, travel to and from school by bus/car and talk on a telephone phone for >2 h/week were more likely to be overweight and obese than those who were not involved in those activities (OR > 1). In addition, those who were doing artwork and homework <2 h/week had OR >1 which indicates they are more likely to be overweight/obese.

In the multiple logistic regression analysis (Table 5), rope skipping for >2 h/week (AOR 0.14, CI 95% 0.03–0.7) was significantly associated with overweight and obesity, indicating that it was protective against overweight/obesity. Walking for exercise <2 h/week (AOR 2.1, 95% CI 1.1–4.1) and listening to music and/or radio (AOR 2.7, 95% CI 1.2–6.1) for >2 h/week significantly predicted overweight and obesity among school children.

Table 2.
Comparison of mean activity scores among cases and controls

Activity level in different occasions	Cases $n = 69$ Mean	SD	Controls $n = 138$ Mean	SD	p-value
Participating in physical education	2.7	1.9	2.7	1.2	0.97
During recess/break times	1.9	0.9	1.9	1.0	0.96
Beside lunch	1.9	0.8	2.3	0.9	0.012*
Right after school	2.0	1.0	2.1	0.98	0.62
During evenings	2.3	1.1	2.5	1.1	0.31
During weekends	2.2	0.9	2.4	1.0	0.29
Being active in the past 7 days	2.0	0.9	2.2	0.98	0.28
Overall mean activity score	2.2	0.5	2.3	0.6	0.12

Notes: p-value is from independent sample t-test, indicate significant, *$p < 0.05$, scores are numbers 1–5, 1 = Less active, 5 = Most active, SD = Standard deviation

Physical activity	Cases $N = 69$	Controls $N = 138$	Crude OR (95% CI)	p-value
Dancing				
None	35 (50.7)	79 (57.2)	1	
<2 h/week	27 (39.1)	47 (34.1)	1.3 (0.7–2.4)	0.41
>2 h/week	7 (10.1)	12 (8.7)	1.3 (0.5–3.6)	0.60
Running/jogging				
None	29 (42.0)	41 (29.7)	1	
<2 h/week	29 (42.0)	76 (55.1)	0.5 (0.3–1.0)	0.05
>2 h/week	11 (15.9)	21 (15.2)	0.7 (0.3–1.8)	0.50
Swimming				
None	54 (78.3)	120 (87.0)	1	
<2 h/week	9 (13.0)	12 (8.7)	0.5 (0.1–1.5)	0.18
>2 h/week	6 (8.7)	6 (4.3)	0.8 (0.2–3.1)	0.69
Bike riding				
None	42 (60.9)	77 (55.8)	1	
<2 h/week	20 (29.0)	37 (26.8)	0.9 (0.5–1.9)	0.97
>2 h/week	7 (10.1)	24 (17.4)	0.5 (0.2–1.3)	0.18
Doing household chores				
None	23 (33.3)	45 (32.6)	1	
<2 h/week	24 (34.8)	50 (36.2)	0.9 (0.5–1.9)	0.86
>2 h/week	22 (31.9)	43 (31.2)	1.0 (0.5–2.1)	0.99
Play on the ground				
None	41 (59.4)	74 (53.6)	1	
<2 h/week	12 (17.4)	31 (22.5)	0.7 (0.3–1.5)	0.36
>2 h/week	16 (23.2)	33 (23.9)	0.9 (0.4–1.8)	0.71
Skipping rope				
None	36 (52.2)	68 (49.3)	1	
<2 h/week	31 (44.9)	52 (37.7)	1.1 (0.6–2.1)	0.70
>2 h/week	2 (2.9)	18 (13.0)	0.2 (0.05–0.9)	0.044*
Walking as part of exercise				
None	37 (63.6)	93 (67.4)	1	
<2 h/week	23 (33.6)	30 (21.7)	1.9 (0.9–3.7)	0.05
>2 h/week	9 (13.0)	15 (10.9)	1.5 (0.6–3.7)	0.37
Total physical activity				
<1 h/day	16 (23.2)	26 (18.8)	1	
>1 h/day	53 (76.8)	112 (81.2)	1.3 (0.6–2.6)	0.46

Notes: OR: odds ratios, CI: confidence interval, indicates significant; *$p < 0.05$, p-value is from univariate analysis, crude odds ratios also included playing football, netball, walking on foot to and from school with no significant association with overweight/obesity

Table 3.
Association of physical activity with and overweight/obesity among school children

Regarding places of physical activities (data not shown in the table), most children engaged more in physical activities in their home environments compared to school. The most common games played at home included dancing (39%), running (46.4%), bike riding (40.1%) and rope skipping (32.3%). At school, less than 10% of children reported playing these games. Most of the sedentary activities also took place at home except reading (57.5%) and telling stories (43%) which took place in both home and school environments. There were no reported popular games for school and home differently. There was no significant difference in places of physical activities and sedentary behaviors (home or school) between cases and controls. Frequencies of performing

Factors	Cases $N = 69$	Controls $N = 138$	OR (95% CI)	p-value
Listening to music				
None	15 (21.7)	52 (37.7)	1	
<2 h/week	32 (46.4)	58 (42.0)	1.9 (0.9–3.9)	0.07
>2 h/week	22 (31.9)	28 (20.3)	2.7 (1.2–6.1)	0.014*
Watching TV/video				
None	11 (15.9)	29 (21.0)	1	
<2 h/week	13 (18.8)	36 (26.1)	0.9 (0.4–2.4)	0.92
>2 h/week	45 (65.2)	73 (52.9)	1.6 (0.7–3.6)	0.23
Arts work				
None	36 (52.2)	79 (57.2)	1	
<2 h/week	29 (42.0)	45 (32.6)	1.4 (0.7–2.6)	0.27
> 2 h/week	4 (5.8)	14 (10.1)	0.6 (0.2–2.0)	0.44
Doing homework				
None	12 (17.4)	24 (17.4)	1	
<2 h/week	29 (42.0)	55 (39.9)	1.1 (0.5–2.4)	0.90
>2 h/week	28 (40.6)	59 (42.8)	0.9 (0.4–2.2)	0.90
Playing computer games				
None	51 (73.9)	97 (70.3)	1	
<2 h/week	9 (13.0)	23 (16.7)	0.7 (0.3–1.7)	0.49
>2 h/week	9 (13.0)	18 (13.0)	0.9 (0.9–2.3)	0.91
Reading				
None	3 (4.3)	5 (3.6)	1	
<2 h/week	24 (34.8)	43 (31.2)	0.9 (0.2–4.2)	0.93
>2 h/week	42 (60.9)	90 (65.2)	0.8 (0.2–3.4)	0.74
Travel by bus to and from school				
None	33 (47.8)	74 (53.6)	1	
<2 h/week	9 (13.0)	18 (13.0)	1.1 (0.5–2.8)	0.80
>2 h/week	27 (39.1)	46 (33.0)	1.3 (0.7–2.5)	0.39
Talk on phone				
None	36 (52.2)	74 (53.6)	1	
<2 h/week	32 (46.4)	62 (44.9)	1.1 (0.6–1.9)	0.84
>2 h/week	1 (1.4)	2 (1.4)	1.0 (0.1–11.7)	0.98
Total sedentary				
<4 h/day	41 (59.4)	75 (54.3)	1	
>4 h/day	28 (40.6)	63 (45.7)	0.8 (0.5–1.4)	0.49

Table 4.
Association of sedentary activities and overweight/obesity among school children

Notes: OR: odds ratios, CI: confidence interval, indicates significant; *$p < 0.05$, p-value is from univariate analysis, crude odd ratios also included telling stories with no significant association with overweight/obesity

Factor	β	SE (β)	Adjusted OR	95% CI for OR	p-value
Skipping rope >2 h/week	−2.0	0.8	0.14	0.03–0.7	0.014*
Walk as part of exercise <2 h/week	0.7	0.4	2.1	1.1–4.1	0.034*
Listening to music/radio >2 h/week	0.9	0.7	2.7	1.2–6.1	0.014*

Table 5.
Logistic regression analysis of selected physical activity and sedentary behaviors and overweight and obesity among school children

Notes: β: Regression coefficient; SE (β): standard error of β; CI: confidence interval; OR: adjusted odds ratio, indicates significant *p-value is from multivariate analysis, $p < 0.05$, odds ratios are adjusted for playing netball, running/jogging, bike riding, rope skipping, walking as part of exercise, listening to music/radio, watching television/video and arts work

physical and sedentary activities in the two groups were not statistically significant ($p > 0.05$).

Discussion

The current study characterized physical activity and sedentary behaviors of school children and their association with overweight/obesity. Data revealed that listening to music and/or radio for >2 h per week and walking for <2 h per week were significantly associated with overweight/obesity. This indicates that more overweight/obese children had access to music devices and walked less frequently. Rope skipping for >2 h/week was protective against overweight/obesity. This is a strenuous physical activity that involves vigorous jumping and resultantly uses more energy. Alternatively, obese children may feel too heavy to participate in rope skipping. Our findings suggest that children who spend >2 h/week in television viewing were 1.6 times more at risk of being obese/overweight than children who did not watch television, However, the finding was not significant which in contrast with the study by Bhuiyan *et al.* (2013) who found that watching television for >4 h/day was significant risk factors for overweight and obesity.

In the current study, mean score of being active over the lunch break was significantly higher in normal weight than in overweight/obese children. This may be attributable to the fact that obese children may be less active following a lunch session or they could be spending more time eating thus become less active. The overall mean activity score did not differ between cases and controls which was also revealed by a study of Thasanasuwan *et al.* (2016) in obese and non-obese children. In addition, participation in physical education classes was moderate in both groups and only 16.9% of children were active. This figure is lower than the study reported by Micklesfield *et al.* (2014) among South African school children. Evidence from the literature showed that physical education classes promote physical activity through access to knowledge and stimulation of physical activity practice (Ferrari *et al.*, 2020) and prepare young people to adopt a physically active future and a healthy lifestyle (Walter, 2011).

Results of the current study showed that overweight/obese children were significantly taller than normal weight children of the same age. Similar findings were found in Mexico City by Vilchis-Gil *et al.* (2015) who reported overweight and obese children to be taller compared to their counterparts, it was further said that their increase in height might have been accelerated by imbalances of growth hormones causing rapid bone maturation. Our results also found no difference in sleeping time between cases and controls which is different from findings revealed in Thailand (Amini *et al.*, 2009; Thasanasuwan *et al.*, 2016) which reported that obese children slept fewer hours than non-obese children. The reasons discussed by the authors included the fact that children with normal weight were more active than obese children, thus required more time to sleep. Low sleep quality results from being obese because of sleep apnea; and the fact that most obese children played more electronic games thus shorten their sleeping time.

In our study, over 70% of cases and over 80% of controls meet the WHO daily recommendation for physical activities in children indicating that many children from both groups participated in physical activities. This finding would explain the reason for few factors reported to be associated with overweight/obesity in our study. In addition, evidence from the literature showed that there is a possibility of overestimation of physical activity level through a self-report questionnaire (Mindell *et al.*, 2014). The levels reported in our study are higher than those found in Sao Paulo in Latin America by Ferrari *et al.* (2020).

Based on the finding that many children in both groups reported participating in physical activity, this could explain the reason for the current study not to associate between

overall physical activity and sedentary behaviors with overweight/obesity. This was also revealed in studies by Keane *et al.* (2017), Godakanda *et al.* (2018); and Wiersma *et al.* (2019) who found that total sedentary behaviors were not the risk factors for overweight/obesity. However, many studies revealed a significant relationship between sedentary behaviors or physical inactivity with overweight/obesity (Mushtaq *et al.*, 2011, Bhuiyan *et al.*, 2013; McVeigh and Meiring, 2014; Vilchis-Gil *et al.*, 2015; Muntaner-Mas *et al.*, 2017). There is a scarcity of data in Sub-Saharan Africa including Tanzania that link physical activity patterns and sedentary behaviors with weight status. One study from South Africa reported an association between BMI and physical activity in high schools (McVeigh and Meiring, 2014). However, other studies (Walter, 2011; Micklesfield *et al.*, 2014; Esht *et al.*, 2018; Ferrari *et al.*, 2020) have compared differences in physical activity among boys and girls and not weight status.

Our findings showed that most physical activities were conducted in the home environment which may indicate that adequate space is available. This was revealed through focus group discussion (unpublished results) with parents of school children of the current study. Most of them admitted that at home there is adequate space for informal and local games. This is contrary as it was expected that large cities are normally faced with reduced space for physical activity. In addition, games, such as dancing, running, rope skipping and walking, may not require a well-defined/structured space. Therefore, the promotion of participation in physical activity by school children at the family level would achieve greater levels of physical activities. Nevertheless, children spend an adequate amount of time in the school environment; therefore, schools should be accountable for at least half of the time to meet the daily recommendation for physical activities (Walter, 2011).

Limitation of the study

Physical and sedentary activities data were self-reports, based on recall, thus prone to bias. There might be some challenges in remembering accurately the time spent in physical and sedentary activities across the reference period. However, probing questions asking the daily schedule of each child helped to minimize these biases.

Conclusion

This study found that more time of listening to music and/or radio and less walking were significantly associated with overweight and obesity among children and rope skipping for >2 h/week was protective. Although the overall mean activity score was not significant the data showed that overweight/obese children were slightly less active than normal weight children. Other possible risk factors for overweight and obesity among school children such as dietary intake, food habits and parental/family factors need to be adequately studied in Tanzania. This will make it easy to design interventions for schools to prepare a healthy future generation.

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Further reading

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