RESEARCH ARTICLE

REVISED Description and comparison of physical activity from self-reports and accelerometry among primary school children in Kilimanjaro, Tanzania: a pilot study [version 4; peer review: 2 approved]

Previously titled: Validation of self-reported physical activity by accelerometry among primary school children in Kilimanjaro, Tanzania: a pilot study

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Abstract

Background: Self-reports are commonly used to assess physical activity in children. Existing self-reports for physical activity have not been validated for primary school children in Tanzania. To understand if primary school children can accurately report their physical activity, we examined the validity of self-reported physical activity against accelerometer measured physical activity.

Methods: A community-based cross-sectional study was conducted from May to July 2018. We conveniently selected four primary schools in Moshi municipal and Moshi rural districts in Kilimanjaro, Tanzania. From these districts, 51 children aged 9 – 11 years were randomly selected. A self-reported questionnaire was used to collect physical activity-related variables. Children wore accelerometers for seven consecutive days to capture physical activity movements. Spearman's rank test and Bland Altman plots were used for assessing validity and agreement between self-reports and accelerometer moderate to vigorous physical activity (MVPA).

Results: The study participants' mean age was 10 (SD=0.8) years, and 32 (63%) were girls. A significant positive correlation was found between self-reports and accelerometer MVPA (rho=0.36, p=0.009).

Open Peer Review

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The mean total of weekday minutes in MVPA from accelerometers was higher than from self-reports, 408 (SD = 66) versus 261 (SD = 179). **Conclusions**: This study found a significant positive correlation between self-reports and accelerometers. Self-reports are prone to errors due to recall bias, which interferes with their validity. More research is needed to develop better self-reported measures with specific activities that children can easily remember. Also, researchers should carefully consider the inherent limitations in the validity of self-reports.

Keywords
Children, self-reports, accelerometer, physical activity, validation, Tanzania

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Any reports and responses or comments on the article can be found at the end of the article.

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REVISED **Amendments from Version 3**

There are slight additions in Figure 1 and Figure 4. For both figures, legends have been added/ updated. Information on sedentary time has been removed in the table and text to focus only on physical activities as the main study content.

Any further responses from the reviewers can be found at the end of the article

Introduction

Physical activity in children is the key to better health. Active children gain health benefits, including cardiorespiratory, muscular fitness and bone health. Physical activity plays a vital role in preventing non-communicable diseases (NCDs) and avoiding weight gain[1]. The World Health Organization (WHO) recommends an average of at least 60 minutes per day of moderate to vigorous activities (MVPA) for 5–17-year-olds to benefit their later life[2–4]. Studies in low- and middle-income countries (LMICs) reported low physical activity levels and high sedentary behaviours in children[5,6]. In Tanzania, 82.1% of school-going children are not meeting the recommended physical activity levels, according to self-reports[7].

Physical activity is a complex behaviour that includes day-to-day variations of activities, and these activities may not be easily remembered by children[8]. Tools for measuring physical activity include subjective measures such as self-reports, proxy reports by parents and teachers, activity diaries and recall. Self-reports are prone to errors due to significant day-to-day variations and inaccurate estimation of physical activity levels[9,10]. The selection of a suitable assessment questionnaire for physical activity and instruments is based on the target population under study, respondent burden, cost-effectiveness and type of information to be collected.

Over the years, accelerometers have been increasingly used in high-income countries to assess physical activity in children[11,12]. However, in LMICs, few studies have used objective measures to assess physical activity. Objective measures include motion sensors such as heart rate monitors, accelerometers and pedometers. Heart rate monitors are cheap to use, but they have shown a weak relationship with energy expenditure. Pedometers only capture steps taken to provide estimates of activity levels. Accelerometers are more valid than self-reports in estimating physical activity[8,9]. Finally, the doubly labelled water method is a gold standard to measure energy expenditure but is expensive and requires specialist techniques[13].

The validity of self-reports for assessing physical activity in primary school children has not been fully explored in Tanzania. It is unclear if children from Tanzania can accurately report their physical activity or estimate minutes spent in physical activity. Therefore, this study aimed to describe the physical activity, then compare and determine the validity of a self-reported questionnaire to measure physical activity in Tanzanian primary school children, using an accelerometer as the reference method.

Methods

Study design and setting

A community-based cross-sectional study was conducted in two purposely selected Kilimanjaro region districts in the Northern part of Tanzania, Moshi municipal and Moshi rural district. We conveniently selected two primary schools (one private and one government-funded) from each section.

Study participants

School children were recruited through a simple random technique between May to July 2018. A sample of 80 children (20 from each school) aged 9–11 years was randomly selected from the school attendance registers. The children's parents were contacted and provided a detailed explanation of the study aims and procedures. After that, the research team sent the children home with the information sheet and consent form for parents to sign, thereby acknowledging their child permission to participate in the study. Only children who were day-students (not boarding) were eligible for the study.

Study variables

Our primary study variable was minutes per day spent in MVPA, obtained from self-reports and accelerometry.

Data collection methods and tools

For this study, a questionnaire from the International Study on Childhood Obesity, Lifestyle and Environment (ISCOLE) was adapted and modified[14]. We reviewed the ISCOLE physical activity questions to check for appropriateness in this cultural context and its applicability amongst primary school children in Tanzania. This questionnaire was used in several high-income countries and one African country (Kenya). The focus during modification was to retain those questions that were descriptive enough for children to understand and related to durations and participation in different activities. We made changes to account for relevant and regular exercise types and the structure of questions. These modifications involved rewording some questions, and removing questions that were not appropriate, e.g., one question asked, "How much time did you spend outside before school or before bedtime?" This question was removed because it did not necessarily imply physical activity. We also removed questions that were not directly related to the study aim, e.g., "I can ask my parent or other adults to do physically active things with me", "I find exercise a pleasure activity".

A draft modified questionnaire, available as *Extended data*[15], was shared with the Regional school health coordinator for review and advice and then piloted with 15 school children to check for comprehension and relevance. Children were asked to indicate activities during typical days in their lives, stratified by the school and non-school days. Inputs from the students helped modify the flow and how some questions were asked. The tool was then returned to the 15 students, and after adjustment, the pilot's final questionnaire was developed.

Physical activity measurements

Self-reports

The final questionnaire was designed to collect information on multiple physical activities, including types, frequency and duration. The last sets of questions in the modified questionnaire focused on activities in a typical week (weekdays/ school days and weekends). The questions were as follows: "how many days did you participate in physical education classes (PE)," how long did it take to walk to school?", "participation in after school activities (e.g. house chores)", "when you are at school, during break time do you participate in any type of physical exercise such as playing netball, football, skipping etc. or any other activity?", and "how many days were you physically active for 60 minutes a day?", "how many days did you watch television?", "for how long did you watch television?" "how many days did you play video games?", "for how long did you play video games or use a computer for non-school activities?"

Accelerometry

Children were instructed how to wear the triaxial accelerometers (ActiGraph, wGT3X-BT Pensacola, FL). An accelerometer is a device used to measure physical activity movement. Researchers gave teachers and parents instructions (verbal and written) to assist their children with the accelerometer attachment. Further, researchers contacted parents/teachers every morning to ensure they reminded their child to wear the accelerometers. Children attached the accelerometers with an elastic band on their right hip. Children were instructed to remove the accelerometers when bathing or engaging in any water activity such as swimming. Accelerometers were set to collect data from 06:00 AM to 09:00 PM (bedtime) except for the initiation day when accelerometers commenced collecting data from 09:00 AM. Children wore accelerometers for seven consecutive days. When returned, data from each accelerometer were uploaded to the computer using Actigraph software, ActiLife version 6.13.4.

Statistical analysis

Self-reported activity data were entered into Excel, and accelerometer data were exported to Excel; both were then imported into STATA IC version 15.1 (StataCorp, College Station, TX, USA) for analysis.

Descriptive statistics were used to summarize the demographics and physical activity data from self-reports and accelerometers. The distribution of data was checked using the Shapiro Wilk test. It showed that daily average MVPA data from the accelerometer were normally distributed ($p = 0.34$). In contrast, for self-reports MVPA data were positively skewed, indicating high activity levels in some children ($p < 0.05$). Mean (standard deviation), and median (interquartile ranges) were used as appropriate. Different frequencies and proportions were used for categorical variables.

Estimating physical activity MVPA

Self-reports MVPA

Total time spent in different activities was calculated from the questionnaire responses. Total weekday MVPA was defined as the sum of minutes for walking to school for five school days (Monday – Friday) and reports of being physically active for at least 60 minutes each day of the week. The number of minutes used to walk to school was summarized from the categorical responses, and the midpoint was calculated. For example, a response of 15–30 minutes of walking to school was considered as 22.5 minutes. Being physically active for at least 60 minutes for each school (weekday) was calculated by multiplying the number of days and minutes. For example: if the child reported being active for three days, we multiplied this by 60 minutes to get 180 active minutes. The average minutes of MVPA were estimated by dividing the total time of MVPA by the five days of the week.

Accelerometry MVPA

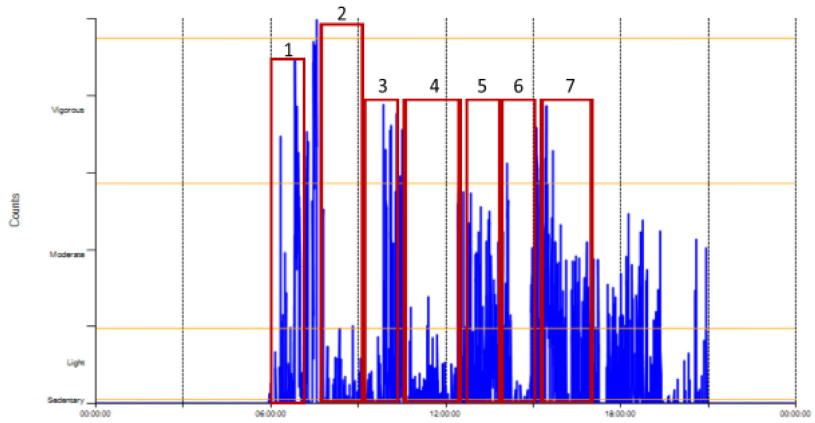
Data reduction and scoring

The raw activity data were reduced into 15-s epochs data for analysis, then converted to ".agd" files and imported into "CSV" and Excel sheets using Actigraph software, ActiLife version 6.13.4. Evenson's cut points for children used to categorize activities in counts per minute (CPM); 0–100 (Sedentary), 101–2295 (Light), 2296–4011 (Moderate) and >4012 (vigorous)[16–18]. After that, total time spent in moderate and vigorous physical activity (Total MVPA) was estimated. Spike tolerance was set to zero, and a minimum length of the non-wear period was set to 60 minutes of consecutive zeros to allow for interruptions. The minimum wear time was set to 10 hours, and children were included in the analysis if they had sufficient and valid accelerometer data with a minimum of three weekdays and at least one weekend day. For weekends children were included in the analysis if they had adequate accelerometer data with at least one weekend day. Children who did not meet these criteria were excluded from the analysis.

Using an Actigraph software and considering the Tanzanian primary school daily timetable, we applied filters to define time blocks of activities from the accelerometer output. The blocks were matched the self-reports questions to countercheck if reported activities were confirmed by accelerometer MVPA, e.g., walking to school.

Figure 1 presents an example of how the accelerometer captured activities and how this varied by time blocks. The graph was constructed using data from one child for one day of the week. The period with no bars means the child was not active or the child did not wear the device. The horizontal axis shows the time in 24 hours, and the vertical axis shows the levels of activities achieved.

Correlation between self-reports and accelerometer MVPA. To examine validity, we included only school days (weekdays), based on the assumption that children spend most of their time in schools and routinely participate in physical education classes. During weekend days, children are engaged in unstructured activities, which might be difficult for them to recall. We used scatter plots and Spearman's rank test to check for the correlation between overall weekday physical activities (MVPA) from self-reports and those measured by the accelerometer. The strength of correlations were ranked as small > 0.1, moderate > 0.3 and strong > 0.5[19]. Also, Bland–Altman plots



Blocks were defined based on the l normal school day routine (Monday – Friday) as follows:- 1. Morning walk to school (0600 – 0730 hours), 2. Morning sitting for classroom sessions (0800 – 1000 hours), 3. Tea / porridge breaktime (1002 – 1032 hours), 4. After break sitting for classrooms sessions (1100 – 1220 hours), 5. Lunch break (1232 – 1332hours), 6. After lunch sitting for classroom sessions (1400 – 1500 hours), 7. After school activities (1502 – 1730 hours)

Figure 1. Illustrates the accelerometer output for a single child in one weekday (school day), with defined blocks of activities.

were used to assess the agreement between average weekday self-reported MVPA and accelerometer measured MVPA.

Variability between self-reports and accelerometer blocks. Box-and-whisker plots were constructed to show the variability between self-reported responses (walking to school, exercise during tea break, exercise during lunch and after school activities) with the matching time block of activities from the accelerometer MVPA across the days of the week. Mann Whitney U test was applied to assess the significance of the difference in the median between children who reported participating in activities versus not participating.

Mean weekday MVPA. The mean weekday MVPA (minutes per week) for both self-report and accelerometer data were calculated. Student's T-test (for two groups) and ANOVA (for age only; > 2 groups) were used to compare the mean weekday MVPA from self-reports and accelerometers by sex, age, school location, school type, walking to school, exercise during breaks, after school activities and participation in physical education sessions. We accounted for the clustering effect of children within schools. We also performed post hoc pairwise comparison using the Bonferroni test for comparing the differences in mean total MVPA by age categories. There were no significant differences in means across age categories.

Sub-group analysis

Associations between child-level variables and accelerometer MVPA

We performed further analysis to explore the associations between weekday accelerometer MVPA and different child-level variables (sex, age, school type, school location and walking to school). Univariable and multivariable linear regression models were performed. We accounted for the repeated accelerometer measures for the same child on different days of the week. A child was regarded as a cluster since the repeated accelerometer measurement were nested within a single child. Regression coefficients from the linear regression, 95% confidence intervals (95% CI) and intra-class correlations were presented.

Ethics approval and consent to participate

All ethical procedures concerning human participants were followed. Ethics approval was obtained from the National Institute for Medical Research (NIMR), Tanzania certificate number: IX/2735 on 27/03/2018 and the Kilimanjaro Christian Medical University College Ethics Committee (KCMUCO) certificate number: 2225 on 21/09/2017. School permission was obtained from the regional medical officer, district education officers and school authorities. All parents of participating children signed written informed consent for their children to participate. Children were asked to sign a brief written assent to participate in the study.

Results

Demographics and child characteristics

A total of 51 primary school children were enrolled in the study, interviewed and wore accelerometers. Of the 80 parents contacted for consenting their children's participation in the study, 51 (65%) accepted. Of these 51 primary school children, 32 (63%) were girls. The daily average minutes of MVPA per day from the accelerometer was 96 (SD 35) and from

self-reports was 60 (IQR: 26, 65). Other characteristics of the study participants are shown in Table 1. All raw accelerometer and self-reporting data are available as *Underlying data*[15].

Correlation between self-reports and accelerometer MVPA

The correlation between self-reports and accelerometry is presented in Figure 2. Overall, a significant positive correlation was found between accelerometer measured MVPA and self-reported MVPA (rho = 0.36, p=0.009).

The Bland–Altman plot of a difference between self-report and accelerometer MVPA versus a mean of these two methods shows the mean difference of 29.9 minutes of MVPA per day, with the agreement limits ranges from -44 to 104 minutes per day (Figure 3).

Variability between self-reports and accelerometer blocks

Figure 4 presents the box-and-whisker plots on the comparison of MVPA from time blocks of activities for children who reported participating in activities versus not participating in activities across weekdays (from Monday to Friday). We found a significant difference in median MVPA for children who reported walking to school versus not walking to school block for both days ($p < 0.05$) except for Tuesdays ($p = 0.8$). There was no evidence of a difference in median MVPA for other activity blocks across days of the week.

Mean weekday MVPA

The mean MVPA for the 5 weekdays, Monday – Friday, considered together from self-reports and accelerometer were 261 (SD=179) and 408 (SD=66), respectively (Table 2). There is evidence of a consistently higher mean MVPA over the 5 weekdays for both accelerometer and self-reports for children who reported walking to school, 480 and 302 ($p <0.001$) compared to those who don't walk to school (Table 2). Similarly, for weekend (Saturday – Sunday) data, the mean accelerometer MVPA was higher than that of self-reported weekend activities (Table 3).

Subgroup analysis for associations between child-level variables and total weekday accelerometer MVPA

Table 4 presents the subgroup analysis of the associations between child-level variables and the accelerometer MVPA. In the crude analysis, we found that attending government school (33.6, 95% CI 18.9–48.4) and walking to school (33.4, 95% CI 18.5–48.3) were strongly associated with the total weekday accelerometer-measured MVPA. After accounting for the effect of child-level factors in the multivariable model, only school type remained significantly associated with the total weekday accelerometer-measured MVPA (23.4, 95% CI 4.0–42.8). In contrast, for walking to school, the association was lost. We noted that 32% (ICC) of the variations in accelerometer MVPA were explained by the differences in accelerometer MVPA measurements between one child to another. These differences present a higher variation of MVPA measurements within the same child than the variation between different children.

Table 1. Characteristics and physical activity data for primary school children (N=51).

Characteristic	n (%)
Socio demographics Age (years)	
Mean, SD	(10, 0.8)
9	11 (22)
10	17 (33)
11	23 (45)
Female	32 (63)
School type	
Government	27 (53)
Private	24 (47)
School location	
Moshi urban	33 (65)
Moshi rural	18 (35)
Accelerometry data Number of days during entire period for which accelerometer data were available	
3 days	1 (2)
4 days	1 (2)
6 days	1 (2)
7 days	48 (94)
Number of weekdays for which accelerometer data were available	
3 days	2 (4)
4 days	1 (2)
5 days	48 (94)
Number of weekend days for which accelerometer data were available (n = 49)[§]	
1 day	3 (6)
2 days	46 (94)
Daily average MVPA (minutes)	96 (35)*
Self-reported physical activity data	
Number (%) of children reporting:	
Walking to school	29 (57)
Screen time (electronic games, television)	48 (94)
Exercise during school breaks	41 (80)
After school exercises (house chores, games)	44 (86)
Attend physical education sessions (n=47)	36 (77)
Daily average MVPA (minutes)	60 (26, 65)**

MVPA moderate to vigorous physical activity. [§]Two children were missing valid data for weekend days. * Data are mean (SD). **Data are median (interquartile range), IQR: 25%;75%.

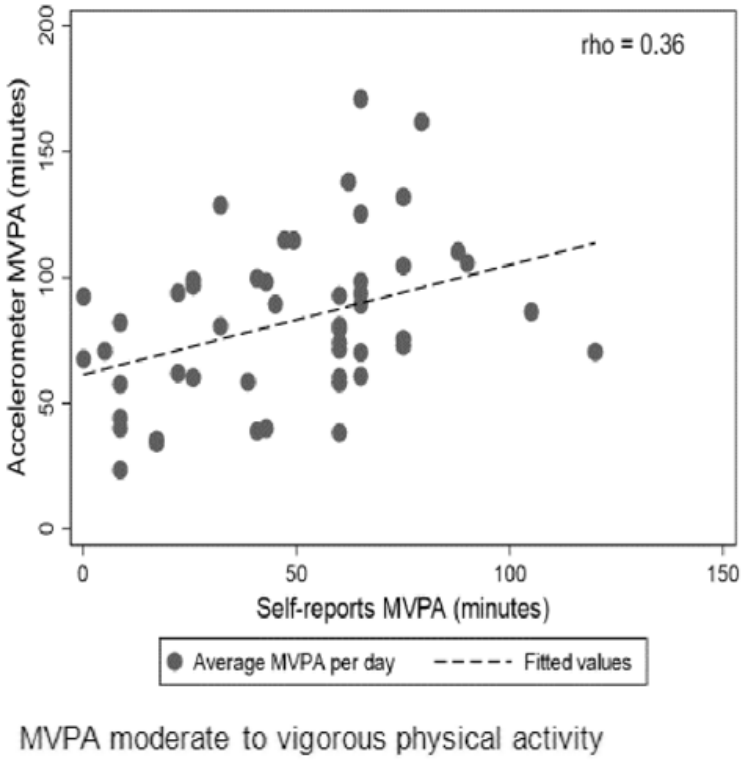


Figure 2. **Scatter plot for correlation between average MVPA per day from self-reports and accelerometer MVPA per day, showing a Spearman rho = 0.36.**

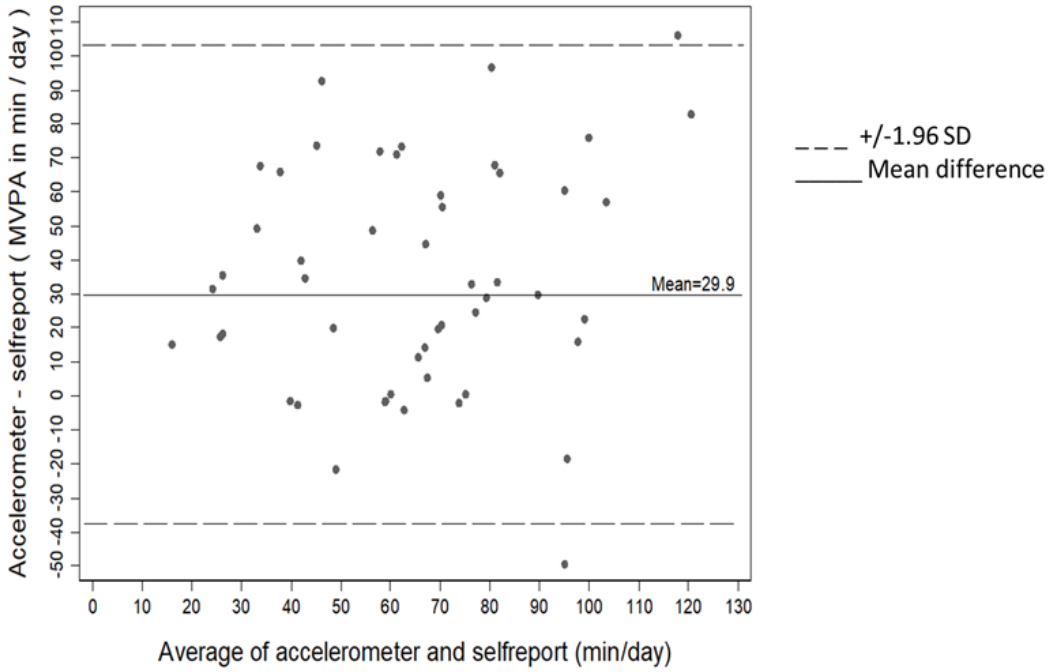


Figure 3. **Bland Altman plot of accelerometer and self-reports MVPA, indicating agreements between the two measurements.**

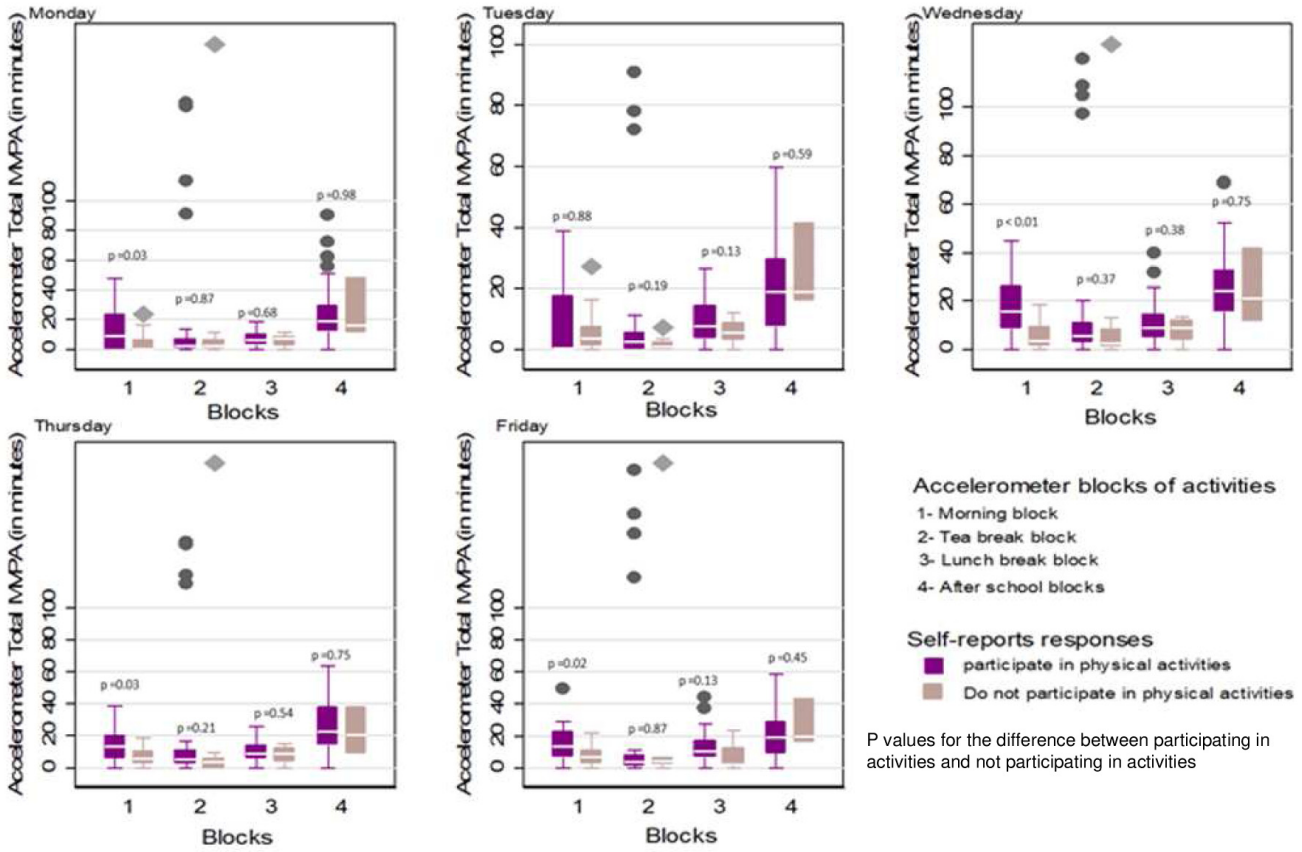


Figure 4. Box and whisker plot presenting accelerometer total MVPA from blocks of activities and self-reports responses across weekdays (school days).

Discussion

This study provides evidence regarding self-reports validity to measure physical activity in primary school children in Tanzania. We found a significant positive correlation between self-reports and accelerometry MVPA. Walking to school time block from self-reports corresponded with accelerometer measured activities from this same block.

The significant but moderate positive correlation we observed between self-reports and the accelerometer data can be explained by the inconsistencies of children reporting their actual minutes of MVPA. The level of agreement between these two measurements indicates that the accelerometer measured what self-reports were capturing. The error observed may be due to over-and under-reporting of the actual MVPA. Other validation studies reported similar findings, reflecting the limitations of children's accuracy to report their actual minutes of MVPA[8,20,21].

Our findings are consistent with other studies validating physical activity instruments in children. The few studies that evaluated objective measures against children's self-reported accounts of physical activity in different parts of the world found low to moderate correlations. For instance, a study for tracking physical activity trends in youth aged 10–18 years reported a correlation of 0.27 and 0.34 for boys and girls[22]. Similarly, other validation studies using accelerometers as a criterion method reported low correlations and documented that most physical activity questionnaires have low to moderate validity[21–26]. Together, these data highlight that researchers should interpret self-reported physical activity data with caution due to the limited physical activity assessment validity. However, self-reports are cheaper and easy to capture than objective measurements, and thus researchers can still use them to estimate physical activity levels.

The majority of children reported less time in total MVPA than confirmed by the accelerometer. The most plausible explanation can be due to recall bias. Children are unlikely to remember every minute they participated in physical activity. The accelerometer also captures every physical movement while self-reports followed only a series of questions included in the questionnaire. Differences in activity levels between the self-reports and the accelerometer correspond to what is found in the literature,

Table 2. Mean moderate to vigorous physical activity (MVPA) over weekdays, Monday – Friday, considered together for self-reports and accelerometer (N=51).

Characteristic	n	Accelerometer		Self-report	
		Mean MVPA[a] (95% CI)	p-value	Mean MVPA[a] (95% CI)	p-value
Overall[b]		408 (361- 455)		261 (199 - 323)	
Sex					
Male	19	441 (361-522)	0.3	294 (225 - 362)	0.2
Female	32	388 (328 - 448)		231 (185 - 278)	
Age (years)					
9	11	307 (92 - 523)		248 (164 - 332)	
10	17	457 (296 - 617)	0.06	266 (200 - 331)	0.9
11	23	420 (247 - 592)		242 (184 - 301)	
School type					
Government	27	490 (434 - 547)	<0.001	279 (222 - 335)	0.1
Private	24	315 (255 - 374)		221 (170 - 272)	
School location					
Moshi urban	33	389 (331 - 448)	0.3	253 (199 - 308)	0.9
Moshi rural	18	441 (357 - 526)		248 (202 - 295)	
Walking to school					
Yes	29	480 (419 - 541)	<0.001	302 (254 - 350)	0.002
No	22	313 (258 - 367)		185 (134 - 237)	
Screen time (games, television)					
Yes	47	395 (347 - 444)	0.1	243 (204 - 284)	0.2
No	4	555 (372 -738)		344 (263 - 424)	
Exercise during school breaks					
Yes	41	402 (352 - 453)	0.6	238 (202 - 275)	0.2
No	10	430 (288 - 572)		307 (168 - 445)	
After school exercises					
Yes	44	407 (358 - 456)	0.9	256 (215 - 296)	0.1
No	7	412 (214 - 611)		284 (131 - 438)	
Attend physical education sessions (n=47)					
Yes	36	380 (332 - 428)	0.2	248 (212 - 285)	0.3
No	11	456 (300 - 611)		202 (91 – 313)	

Data are shown in mean MVPA over weekdays (Monday – Friday). [a] Mean adjusted for schools as clusters. [b]Overall mean MVPA for 5 weekdays. CI, confidence interval.

Table 3. Mean weekend (Saturday – Sunday) moderate to vigorous physical activity (MVPA) of self-reports and accelerometer (N=49).

Characteristic	n	Accelerometer		n	Self-report	
		Mean MVPA[a] (95% CI)	p-value		Mean MVPA[a] (95% CI)	p-value
Overall[b]	49	186 (155 - 218)		24	113 (104 - 121)	
Sex						
Male	17	235 (161 - 309)	0.02	10	108 (90 - 126)	0.37
Female	32	160 (134 -187)		14	116 (107 - 125)	
Age (years)						
9	10	169 (94 - 244)		6	100 (74 -126)	
10	16	226 (164 - 287)	0.21	9	120	0.17
11	23	166 (128 - 204)		9	113 (100 -127)	
School type						
Government	27	231 (190 - 272)	<0.001	13	115 (105 - 125)	0.46
Private	22	131 (93 - 170)		11	109 (93 -125)	
School location						
Moshi urban	32	186 (143 - 228)	0.95	14	107 (92 -122)	0.13
Moshi rural	17	188 (139 - 236)		10	120	
Screen time (electronic games, television)						
Yes	41	183 (149 - 218)	0.66	19	114 (105 - 123)	0.59
No	8	202 (106 - 298)		5	108 (75 - 141)	

MVPA moderate to vigorous physical activity, CI confidence interval. Data are shown in minutes per weekend days (Saturday – Sunday). [a]Mean adjusted for schools as clusters. [b]Overall mean MVPA for 5 weekdays. Notes: Two children were missing the weekend's valid data

illustrating the difficulties for children to quantify bouts of activities performed[7,23,27]. Recently, researchers in the Active Healthy Kids Global Alliance, which aims to promote physical activity in children and youth worldwide, pointed out that estimating physical activity prevalence is a worldwide concern. Thus, there is a need for standardized physical assessment surveillance systems in each country[18].

A child's daily routine of walking to school every day, especially for children in government schools, could explain the higher MVPA captured by self-reports and accelerometers. It is possible that this regular activity is easily recalled by school children and well captured by an accelerometer. Furthermore, several activities occur after school daily routine: "after school activities". For example, running to catch a school bus, playing while waiting for the school bus/ private cars, some children playing on their way home, or participating in several unstructured activities; others participate in household chores. These activities can explain the higher MVPA observed for after school activities. Studies presented in the Global matrix report highlighted that walking to school was a reliable indicator for assessing children's physical activity and youth[28].

In the present study, we found that 68% of the daily variation of MVPA was due to day-to-day variability within children, and the effect of a cluster explained 32%. These variations can be explained by the differences in daily activities whereby children may not follow the same activity routine every day. Most government schools' children walk to school every day while most private schools use private cars / buses to reach school. However, other activities may contribute to the variation in MVPA from day to day, e.g., different activity levels between formal lessons, with some children being active and running around and others just staying in class and being more sedentary. Some studies reported that children's activities depend on their habitual behaviours. Thus, children differ in activity types and levels depending on the time and opportunities to be involved in activities, and supportive environment[27,29]. The inclusion

Table 4. Associations between child-level variables and total weekday accelerometer moderate to vigorous physical activity (MVPA) for primary school children (N = 249).

Characteristic	Crude Coefficient (95% CI)	p-value	Adjusted Coefficient (95% CI)	p-value	ICC
Sex					
Female	1		1		0.32
Male	12.5 (-5.2-30.1)	0.17	13.2 (-1.0-27.3)	0.07	
Age (years)	7.9 (-2.9-18.8)	0.15	5.4 (-4.0-14.8)	0.26	
School type					
Private	1		1		
Government	33.6 (18.9-48.4)	<.001	23.4 (4.0-42.8)	0.02	
School location					
Moshi urban	1		1		
Moshi rural	11.5 (-6.4-29.3)	0.21	7.7 (-8.8-24.2)	0.36	
Walking to school					
No	1		1		
Yes	33.4 (18.5-48.3)	<0.001	13.7 (-6.8-34.3)	0.19	

47 children had a total of 5 days, 4 had either 3 or 4 days) which made a total number of 249 observations (5 days x 47, 3 days x 2, 4 days x 2). ICC, intraclass correlation coefficient; CI, confidence interval.

of the cluster analysis of the association between child characteristics and accelerometer MVPA could have led to an overestimation of the effect of the child characteristics on MVPA. Further, these variations might contribute to the observed correlations.

This study's strengths include using an objective method, "accelerometers" to validate physical activity questionnaire "self-reports". To our understanding, this is one of the few studies conducted in resource-restricted countries that aimed to validate the self-reported physical activity questionnaire by applying an objective measurement method. We achieved high compliance with wearing accelerometers; most enrolled children wore them for seven days as instructed. Also, this study explored the effect of the cluster in explaining the variations between individual children's activities.

In contrast, the limitations of this study need to be acknowledged. There was a high refusal rate from parents with 36% of parents prohibiting their child from participating. The main reason for refusal was fear to use the accelerometers. The denial could have introduced a selection bias to our study as the children who were unable to participate may have been systematically different from those who participated. Further, there are no standard protocols for processing accelerometer data, making interpretation of physical activity data complex.

Conclusions

This study found a significant positive correlation between self-reports and accelerometers. Self-reports are prone to errors due to recall and social desirability bias which might compromise their validity. Despite these flaws, assessing physical activity using devices is often impossible, especially in low- and middle-income countries due to cost. More research is recommended to develop better self-reported measures with specific physical activities that children can easily recall.

Data availability

Underlying data

Figshare: Validation of self-reported physical activity by accelerometry among primary school children in Kilimanjaro, Tanzania: a pilot study. https://doi.org/10.6084/m9.figshare.12763946.v2[15].

This project contains the following underlying data:

- Accelerometry with all days.xlsx. (Raw accelerometry data for each participant.)

- All data_accelerometry_self reports.csv. (Self-reported data for each participant.)

Extended data

Figshare: Validation of self-reported physical activity by accelerometry among primary school children in Kilimanjaro, Tanzania: a pilot study. https://doi.org/10.6084/m9.figshare.12763946.v2[15].

This project contains the following extended data:

- Bland Altman data.csv. (Data used to generate Bland Altman plots.)
- Box plots data.csv. (Data used to generate box plots.)
- Additional file 1_Self reports questionnaire.docx. (Questionnaire used for self-reporting of activity.)
- Accelerometer time blocks.docx (Description of the different time blocks given for accelerometer data.)

Acknowledgements

We thank the school authorities, parents and children for their participation in this study. We would like to acknowledge Glory Salla and Victor Mosha's contribution for data collection and follow-up visits. Special thanks to Frederick L Mashili for accelerometry training and Mwita Wambura for statistical advice.

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Open Peer Review

Current Peer Review Status: ✔ ✔

Version 4

Reviewer Report 18 May 2021

https://doi.org/10.21956/aasopenres.14352.r28602

✔ **Ing-Mari Dohrn**
Department of Neurobiology, Care Sciences and Society (NVS), Karolinska Institutet, Stockholm, Sweden

I thank the authors for their responses and the changes made. I have no further comments.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 3

Reviewer Report 05 May 2021

https://doi.org/10.21956/aasopenres.14335.r28558

? **Ing-Mari Dohrn**
Department of Neurobiology, Care Sciences and Society (NVS), Karolinska Institutet, Stockholm, Sweden

Please see my comments in the 2 documents linked below:

1. Full comments
2. Annotated copy of the article

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 10 May 2021

Mary Mosha, Kilimanjaro Christian Medical University College, Moshi/ Kilimanjaro, Tanzania

Dear Ing-Mari Dohrn,
Thanks for reviewing this manuscript, as suggested please see below responses.

Comment;
Table 1 is still confusing: What is the difference between * and **? Which data is mean and sd? It looks like you are only presenting median and IQR.

Response:
This has been corrected.

"For accelerometry, sedentary analysis is telling us about the bouts of low activity which gives detailed information about sedentary behavior without considering non-wear time as sedentary time. Total sedentary time includes all times when the device is not worn, sleeping time etc. which might create more confusion. We acknowledge your concern on sedentary analysis, and we hope it is now clear."

Comment:
I am afraid this is still unclear: What exactly do you mean by: “the daily average of sedentary bouts was 74 (IQR: 48, 118)”?

What is the average? Is it average number of sedentary bouts? Is it the average total time in sedentary bouts? Is it the average length of a sedentary bout?
Total sedentary time does not have to include non-weartime. If you cannot sort this out, I suggest that you leave out your sedentary data and only report MVPA.

Response:
Thanks for your concern, and advice on the sedentary data. We have removed the sedentary information to avoid confusion, as it is also not the main component

Competing Interests: NA

Reviewer Report 26 April 2021

https://doi.org/10.21956/aasopenres.14335.r28559

Edvard H. Sagelv
School of Sport Sciences, Faculty of Health Sciences, UiT the Arctic University of Norway, Tromsø, Norway

In Figure 4, please write in the figure legend what the p-values represent; i assume they test the difference between activities versus no activities?

I have no further comments.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Physical activity measurements, epidemiology, exercise physiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 10 May 2021

Mary Mosha, Kilimanjaro Christian Medical University College, Moshi/ Kilimanjaro, Tanzania

Dear Edvard H. Sagelv,
Thanks for reviewing this manuscript. We have included the information on p values for figure 4 as suggested.

Comment:
In Figure 4, please write in the figure legend what the p-values represent; i assume they test the difference between activities versus no activities?

Response:
P values representation added to figure 4.

Competing Interests: NA

Version 2

Reviewer Report 19 February 2021

https://doi.org/10.21956/aasopenres.14305.r28292

?

Ing-Mari Dohrn
Department of Neurobiology, Care Sciences and Society (NVS), Karolinska Institutet, Stockholm, Sweden

I thank the authors for their answers and the changes made, but there are still some issues that must be addressed.

Abstract:
This sentence has not been revised: *"Accelerometer had higher mean MVPA"...* It is not correct grammar to say that "accelerometer had". You also have to add which outcome it represents.
I suggest a change to: *The mean total weekday minutes in MVPA from accelerometers were higher than from self-reports, 408 (SD=66) vs 261 (SD=179).*

Below is my previous comment and the author response. This is still in the abstract, as far as I can see.

- *Maybe leave out since this is not really a validation result, but rather a description of PA level: "Children who reported walking to school had higher MVPA for both accelerometer and self-reports compared to children who use other means of transport to school, e.g. school buses ($p < 0.001$)."*
  Response:
  We have removed that section from the abstract as suggested.

- **Methods:**
  Figure 1 is now hard to read. Please only show the vertical axis as this is the cutpoints refer to, and clarify the blocks and numbers. In the figure legend, specify if it shows weekday data.
  Response:
  We have modified the figure to improve clarity, the figure legend has been improved as suggested. The figure shows one weekday / school day accelerometer output from a single child. More details of blocks descriptions is found in the supplementary file, please see lines 199 – 204.

  The figure is now clearer, but you still show data from all three axes. It would be better to show only data from axis 1, the vertical axis, as this is what the cut-points relate to, or at least state that the cut-points are for axis 1 in the figure legend.

- **Results:**
  Please clarify if your main outcome is mean or median minutes in MVPA per day or total MVPA per week? I do not understand how daily MVPA minutes from the accelerometers can be median 98 as stated in table 1 and in the results on p 5, when mean weekday MVPA minutes are 408 in table 2? It also seems highly unlikely that only 74 minutes per day (median) are spent sedentary during a 15 hour day. Are these data in table 1 correct?

Response:
The MVPA data from table 1 is the average MVPA per day, while for table 2, is the mean MVPA per week. The sedentary time from accelerometer is correct but is now clarified as a daily sedentary bouts of 10 minutes each, please see table 1.

In Table 1: I think you still show median and IQR for MVPA?
In Table 2: You still write mean "MVPA for weekdays" and not "mean MVPA per week".

Regarding sedentary data: Your write that the data show daily number of 10 min bouts, it that bouts of 10 min each or bouts of at least 10 min each? Median number of bouts is 74, (IQR 48,118) – if the bouts are 10 min each, would that mean that a median min spent sedentary per day is 740 min with IQR: 480-1180 minutes? That equals 12,3 h (IQR 8 h; 19,7 h). Is that realistic? And why do you think that number of bouts are interesting. I cannot see that you are discussing the pattern of sitting or comment on the outcome 10 min bouts. I strongly suggest that you present total number of sedentary minutes? Or at least bouts and total time.

Regarding figure 4 in the new manuscript. Like the other reviewer I suggest that you remove this figure. It confuses more than it adds, and your interpretation of these results is questionable.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 06 Apr 2021

Mary Mosha, Kilimanjaro Christian Medical University College, Moshi/ Kilimanjaro, Tanzania

Approved with reservations

- **Abstract:**
  This sentence has not been revised: *"Accelerometer had higher mean MVPA"...* It is not correct grammar to say that "accelerometer had". You also have to add which outcome it represents.
  I suggest a change to: *The mean total weekday minutes in MVPA from accelerometers were higher than from self-reports, 408 (SD=66) vs 261 (SD=179).*

Response:
This sentence has been changed as suggested.

- *Maybe leave out since this is not really a validation result, but rather a description of PA level: "Children who reported walking to school had higher MVPA for both accelerometer and self-reports compared to children who use other means of transport to school, e.g. school buses ($p < 0.001$)."*

Response:

We have removed that section from the abstract as suggested.

- **Methods:**
  Comment:

The figure is now clearer, but you still show data from all three axes. It would be better to show only data from axis 1, the vertical axis, as this is what the cut-points relate to, or at least state that the cut-points are for axis 1 in the figure legend.

Response:
We have modified the figure, and now it shows only one axis (axis 1) which represents physical activity. See lines 148 – 150.

- **Results:**
  Comment:

  In Table 1: I think you still show median and IQR for MVPA?
  In Table 2: You still write mean "MVPA for weekdays" and not "mean MVPA per week".

  Regarding sedentary data: Your write that the data show daily number of 10 min bouts, it that bouts of 10 min each or bouts of at least 10 min each? Median number of bouts is 74, (IQR 48,118) – if the bouts are 10 min each, would that mean that a median min spent sedentary per day is 740 min with IQR: 480-1180 minutes? That equals 12,3 h (IQR 8 h; 19,7 h). Is that realistic? And why do you think that number of bouts are interesting. I cannot see that you are discussing the pattern of sitting or comment on the outcome 10 min bouts. I strongly suggest that you present total number of sedentary minutes? Or at least bouts and total time.

Response 1:
Table 1 has been corrected.
For accelerometry, sedentary analysis is telling us about the bouts of low activity which gives detailed information about sedentary behaviour without considering non-wear time as sedentary time. Total sedentary time includes all times when the device is not worn, sleeping time etc. which might create more confusion. We acknowledge your concern on sedentary analysis, and we hope it is now clear.

Response 2:
Table 2 has been clarified. Results are presented per week. This is now clearly elaborated on the text and table. Therefore Table 2 presents MVPA per week (that is Monday to Friday), while Table 3 presents weekend data.

Comment:
Regarding figure 4 in the new manuscript. Like the other reviewer I suggest that you remove this figure. It confuses more than it adds, and your interpretation of these results is questionable.

Response:
As per another reviewer, we understand your concern. However, we think this figure is an important part of the paper. The figure reflects the variations of physical activity MVPA which might have contributed to the low to moderate correlations we are observing. To clarify further we used a statistical test to show clearly these differences. See lines 167 – 169, 259 – 261.

Competing Interests: NA

Reviewer Report 05 February 2021

https://doi.org/10.21956/aasopenres.14305.r28291

Edvard H. Sagelv
School of Sport Sciences, Faculty of Health Sciences, UiT the Arctic University of Norway, Tromsø, Norway

Thank you for the revised version of your manuscript. You have done a good job in revising important aspects of this paper.

I have some follow up concerns:

I raised this concern in my previous report:
"*In page 5 you have a statement in results: "The highest level of activity is seen after school hours and this is consistently captured by both self-reports and accelerometer." How can I see that from figure 3? The quartiles are all over each other?",* and your response was:
"**Response:**
From figure 3, vertical axis represents the total MVPA captured by accelometer while horizontal presents the blocks of activities. The bars and whisker present the responses from self-reported activities. Thus, from that we can link with the output from accelerometer on the vertical axis. More importantly, the whiskers present the variations of MVPA captured from different blocks of activities between children who participate and not participate in activities"

Although the median cut off is higher on the y-axis in Figure 4, the variability is high (Q1, Q3, max and min). In my eyes by reading your figure, I cannot say for certain that MVPA is higher after school. For example the IQR seems to be within the IQR of block 3, they may as well overlap to so much extent that they are not different? Thus, whether both accelerometry and self-reported MVPA is higher after school hours compared with in school hours blocks should be tested. I am no statistical expert, so you should consult one. My initial thoughts: An ANOVA might do the work, by setting the time blocks as exposure, however, as these different blocks are the same individuals, I

am not sure the ANOVA is correct? Paired t-tests (or the equivalent wilcoxon signed rank test for non-normally distributed data) will work, but here make sure to correct for multiple tests (i.e. per test should the alpha (significance level) be divided; two t-tests, p=0.025 for significant difference, three t-tests, p=0.0125 for significant, and so on.

My next comment was also on figure 3.
"In page 6, you have a statement in results: "Separately, the accelerometer measured total MVPA during the first block of the day (walking to school) was consistently higher for children who report walking to school compared to those who do not report walking to school or use other means of transport such as private cars or school buses (Figure 3)." Do you have any statistical analysis to back this up? But more importantly, what does this say? That those who produces much acc measured MVPA before school hours also reports higher MVPA in walking to school? Good, but that does not add anything to the validity of the PAQ, the validity of the PAQ is nicely presented in figure 2: correlations and B and A plot."
And your response:
"Response:
Thanks for the comment, we do not have any statistical test for this, rather the median and quartiles. This figure tries to confirm or compare if at all those children who reported yes/no, they participate in physical activity is well captured by accelerometer."

Okay, I accept your intent, however, your interpretation might be wrong, as you do not test this. I strongly urge to either 1) perform statistical analyses testing whether there are in reality differences among those who report yes and no, and between blocks. The median and IQR are in my view overlapping many places. Thus, your interpretation may be overrated by used looking at the figure. A second way of dealing with this is to just omit figure 3. Your paper is nice as it is without that figure. I would have done the last thing here, just omitting figure 3. A last option is to present it and not comment on it, i.e. whether one block is higher than the other in terms of MVPA (it is here I do not follow and I fear your interpretation by just looking at the figure might be mistaken).

My third comment here also is about the same theme:
"*Table 2: ok, good. Here comes the states about MVPA before school etc. then, I do not see what figure 3 and the box and whisker add, and the whole variability/bias in methods add.*
"Response:
Thanks for the suggestion, we included the box and whisker plots to understand if accelerometer time blocks output (MVPA) and self-reports responses are matching. E.g. We were expecting to see the higher MVPA from children who said yes, they walk to school than those who don't."

So whether acc and self-report matches is presented nicely in the bland and altman plot. Table 2 present the data and test for whether walking to school gives higher acc MVPA, and whether after school exercise gives more MVPA (which it did not). so, you do not need figure 3, i think many readers will face my problem in understanding what it is and what it represents.

Table 2: ok, good. Here comes the states about MVPA before school etc. then, I do not see what figure 3 and the box and whisker add, and the whole variability/bias in methods add.

Here is another response you had to my comment on low/moderate validity:
"Response:
We have included the word criterion as suggested. Low to moderate validity depends on the nature of the study, that is there is no specific cut off points. For most studies of these nature validity was described as the strength of the correlations and ranked as small (>0.1), moderate (>0.3) and strong (>0.5)"

Exactly: therefore, you should have presented the definition for low and moderate validity in parentheses. e.g. low validity (pearson´s r<0.01) in your text.

Finally, I still find some typos all over the text, however, these typos are not influencing the message of the sentences, thus, a reader will clearly understand what is meant. However, if possible, consider reading carefully through your text to remove typos.

All other comments are appropriately addressed and answered, and I have no further comments.

I would like to again congratulate the authors on a nice study, a good job and a good presentation your data from a part of the world where this is much needed. Well done.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Physical activity measurements, epidemiology, exercise physiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 06 Apr 2021

Mary Mosha, Kilimanjaro Christian Medical University College, Moshi/ Kilimanjaro, Tanzania

Approved
Thank you for the revised version of your manuscript. You have done a good job in revising important aspects of this paper.

I have some follow up concerns:

Although the median cut off is higher on the y-axis in Figure 4, the variability is high (Q1, Q3, max and min). In my eyes by reading your figure, I cannot say for certain that MVPA is higher after school. For example, the IQR seems to be within the IQR of block 3, they may as well overlap to so much extent that they are not different? Thus, whether both accelerometry and self-reported MVPA is higher after school hours compared with in school hours blocks should be tested. I am no statistical expert, so you should consult one. My initial thoughts: An ANOVA might do the work, by setting the time blocks as exposure, however, as these different blocks are the same individuals, I am not sure the ANOVA is correct? Paired t-tests (or the equivalent wilcoxon signed rank test for non-normally distributed data) will work, but here make sure to correct for multiple tests (i.e. per test should the alpha (significance level) be divided; two t-tests, p=0.025 for significant

difference, three t-tests, p=0.0125 for significant, and so on.

Response:
We used Mann Whitney U test to examine the differences between medians of activities measured by accelerometer versus those activities measured by self-reports. See lines 167 – 169, 259 – 261.

Comment:
Okay, I accept your intent, however, your interpretation might be wrong, as you do not test this. I strongly urge to either 1) perform statistical analyses testing whether there are in reality differences among those who report yes and no, and between blocks. The median and IQR are in my view overlapping many places. Thus, your interpretation may be overrated by used looking at the figure. A second way of dealing with this is to just omit figure 4. Your paper is nice as it is without that figure. I would have done the last thing here, just omitting figure 4. A last option is to present it and not comment on it, i.e. whether one block is higher than the other in terms of MVPA (it is here I do not follow and I fear your interpretation by just looking at the figure might be mistaken).

Response:
Thanks for your concern on figure 4 (The box and whisker plot). We would like to acknowledge your important comments on this figure. We still think this figure adds an important information on this paper, as what we are learning from this figure might have contributed to the low to moderate correlations found between self-reports and accelerometers. However, we have now performed a statistical test to clearly understand the differences in medians between different blocks of activities. See lines 167 – 169, 259 – 261.

Comment:
Exactly: therefore, you should have presented the definition for low and moderate validity in parentheses. e.g. low validity (Pearson's r<0.01) in your text.

Response:
This has been considered and mentioned in the text. See lines 160 – 161.

Comment
Finally, I still find some typos all over the text, however, these typos are not influencing the message of the sentences, thus, a reader will clearly understand what is meant. However, if possible, consider reading carefully through your text to remove typos.

Response:
We have corrected typos.

Competing Interests: NA

Version 1

Reviewer Report 26 November 2020

https://doi.org/10.21956/aasopenres.14218.r28147

?

Edvard H. Sagelv
School of Sport Sciences, Faculty of Health Sciences, UiT the Arctic University of Norway, Tromsø, Norway

General comment:
Thank you for the opportunity to review this paper. This paper assessed the criterion validity of self-report in children in Tanzania. The study is well conducted and the results support the conclusion. The language and structure of the manuscript is good, and the reading flows nicely. Overall, this manuscript holds high quality in all parts.

My major concern is Figure 3. I do not understand it, or the time blocks to assess for the bias. Could you please elaborate and/or at least make it easier to understand?

Below follow minor concerns. My biggest comment here is the long conclusion, that in my view could benefit from being shorter.

Abstract:

- Results: “Accelerometer had higher MVPA compared to self-reports.” Please report some statistical output here. A t-test results f.ex.

- “Conclusions: This study found the moderate positive correlation between self-reports and accelerometers.” – please replace “the moderate..” with “a moderate..”.

Intro:

- Statement: “Accelerometers provide valid estimates of activity levels by capturing movement in real time and having low technical error of measurement” – You need a reference for this. However, whether the estimates from accelerometry is valid can be debated. I suggest to state: *“more valid than self-report when evaluated against doubly labelled water estimated energy expenditure”* or something similar.

- Statement: “The validity of self-reports for assessing physical activity in primary school

children have not been fully explored in our setting. It is unclear if children from Tanzania can accurately report their physical activity, or estimate minutes spent in physical activity." – just omit the last sentence here and replace "our setting" with "Tanzania" in the first sentence.

Methods:

- Shapiro-wilk: so how did your normality distribution turn out? I assume acc MVPA are positively skewed due to the acc intensity cut-offs? Please report the results from your normality tests. F.ex. you use spearman as I assume MPVA is not normally distributed?#

- You mention moderate correlation in results, but I do not see any reference to strength of correlation cut-offs under statistical analysis?

- Sub-group analysis: in my view, this is far from your aim and adds little to any validity study? You may consider to place all these things in supplementary? Or further.

- Bias/time blocks/Figure 3: the box and whisker plots. I do not follow this figure, nor do I follow your chosen blocks. Those in purple reported in the PAQ to perform MVPA in that specific time period (morning, tea, lunch, after school), while those in pink reported not to? If so, you lined the median and quartiles, and you have no outliers? So, what is that used for? This figure shows accelerometry detected MVPA in those reporting no MVPA to, so I do not follow. Could you please make this easier for a reader to follow? So, on nr 4: after school, the no PA reporters are all over the acc measured MVPA?

Results:

- In page 5 you have a statement in results: *"The highest level of activity is seen after school hours and this is consistently captured by both self-reports and accelerometer."* How can I see that from figure 3? The quartiles are all over each other?

- In page 6, you have a statement in results: *"Separately, the accelerometer measured total MVPA during the first block of the day (walking to school) was consistently higher for children who report walking to school compared to those who do not report walking to school or use other means of transport such as private cars or school buses (Figure 3)."* Do you have any statistical analysis to back this up? But more importantly, what does this say? That those who produces much acc measured MVPA before school hours also reports higher MVPA in walking to school? Good, but that does not add anything to the validity of the PAQ, the validity of the PAQ is nicely presented in figure 2: correlations and B and A plot.

- Table 2: ok, good. Here comes the states about MVPA before school etc. then, I do not see what figure 3 and the box and whisker add, and the whole variability/bias in methods add.

Discussion

- Para 2: typo: "a moderate correlation observed", should be "a moderate correlation <u>was</u> observed."

- Para 3: typo: "a few studies", should be "few studies". This first sentence in this para needs rephrasing: my suggestion: *"Our findings are consistent with other studies validating self-reported physical activity instruments in children"* – you cite quite many studies further into

the para, so few studies is perhaps an overstatement?

- Para 3: *"Similarly, other validation studies using accelerometers as a reference method, reported low correlations and documented that most physical activity questionnaires have low to moderate validity19,21–27"* replace "acc as reference" to "acc as the criterion", as you and these studies report on the acc as the criterion method. Further, what is low to moderate validity?

- Para 3: "…and speak to the need for using both methods i.e objective measures and self-reports where possible."" Sure, but more importantly, as you mention in the intro, perhaps not all can afford ACCs, so in my view, the most important take home is: "…this highlight that researchers should interpret self-reported PA data with caution due to the imprecise assessment of PA." but still, they are not way off, indicating that it is better than no assessment.

- Para 4: first sentence, typo: "…confirmed by acc". Should be "… confirmed by the acc".

- Para 4: alternatively, the most plausible explanation is that recall bias influences this. How can a 10-year old precicely remember all MVPA minutes? I am not 10 years old, but still, I cannot recall every MVPA minute I did.

- Para 4: here are recall. I simply suggest to restructure this para. Make recall come first.

- Para 5: I refer the authors to my statement in methods: this is outside the aims, consider supplementary or omit.

- Para 6: there is no gold standard for assessing PA (Hills AP, Mokhtar N, Byrne NM.. *Front Nutr*

- 2014;1:5; Westerterp KR. *Eur J Appl Physiol* 2009;105:823–8). This is no strength of the study. Please omit. The high compliance is a strength.

- Limitations: the refuse rate is a limitation. The nature of self-report PA, i.e. recall bias, is not a limitation OF this study. This study aimed to assess the validity of self-reported PA.

- A limitation can be the no standard of acc protocol for processing the data?

Conclusion:

- Quite long. I suggest to cut it after: *"This study found the moderate positive correlation between self-reports and accelerometers. Self-reports are prone to errors due to recall bias which might interfere their validity. Despite these flaws, assessing physical activity using devices is often not possible, especially in low- and middle-income countries due to cost."* The other things you mention: "Secondly…", that is suitable for the discussion.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Physical activity measurements, epidemiology, exercise physiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 05 Jan 2021

Mary Mosha, Kilimanjaro Christian Medical University College, Moshi/ KIlimanjaro, Tanzania

General comment:
Thank you for the opportunity to review this paper. This paper assessed the criterion validity of self-report in children in Tanzania. The study is well conducted and the results support the conclusion. The language and structure of the manuscript is good, and the reading flows nicely. Overall, this manuscript holds high quality in all parts.

My major concern is Figure 3. I do not understand it, or the time blocks to assess for the bias. Could you please elaborate and/or at least make it easier to understand?

Response:
Thanks for this concern, figure 3 is now elaborated to make it easier to understand

Below follow minor concerns. My biggest comment here is the long conclusion, that in my view could benefit from being shorter.

Abstract:

- *Results: "Accelerometer had higher MVPA compared to self-reports." Please report some statistical output here. A t-test results f.ex.*

Response
We have added the mean MVPA differences and standard deviation.

- *"Conclusions: This study found the moderate positive correlation between self-reports and*

accelerometers." – please replace "the moderate.." with "a moderate..".

Response:

We have corrected the sentence as suggested, "the moderate" is replaced with "a positive significant".

Intro:

- *Statement: "Accelerometers provide valid estimates of activity levels by capturing movement in real time and having low technical error of measurement" – You need a reference for this. However, whether the estimates from accelerometry is valid can be debated. I suggest to state: "more valid than self-report when evaluated against doubly labelled water estimated energy expenditure" or something similar.*

Response:

We have worked on the sentence, and it now reads as "Accelerometers are more valid than self-reports in estimating physical activity, however some studies suggest doubly labeled water method as a gold standard to measure energy expenditure related physical activity"

- *Statement: "The validity of self-reports for assessing physical activity in primary school children have not been fully explored in our setting. It is unclear if children from Tanzania can accurately report their physical activity, or estimate minutes spent in physical activity." – just omit the last sentence here and replace "our setting" with "Tanzania" in the first sentence.*

Response:

We have added the word Tanzania, and the last sentence is omitted it now reads "It is unclear if children from Tanzania can accurately report their physical activity, or estimate minutes spent in physical activity. Please see line 79.

Methods:

- *Shapiro-wilk: so how did your normality distribution turn out? I assume acc MVPA are positively skewed due to the acc intensity cut-offs? Please report the results from your normality tests. F.ex. you use spearman as I assume MPVA is not normally distributed?#*

Response:

We have presented the results from Shapiro Wilk test.

- *You mention moderate correlation in results, but I do not see any reference to strength of correlation cut-offs under statistical analysis?*

Response:

We would like to acknowledge your observation on the strength of correlation. The decision of the cutoffs was informed by the previous studies as indicated under discussion section references 19 - 25.

- *Sub-group analysis: in my view, this is far from your aim and adds little to any validity study? You may consider to place all these things in supplementary? Or further.*

Response:

Thank you for the important concern, we thought it is important to understand the effect of the cluster on MVPA. We therefore performed the subgroup analysis to explore the associations (sex, age, school type and school location), considering clustering effect (child) in order to understand the effect of cluster on MVPA, which could explain the amount of variability in child MVPA

Bias/time blocks/Figure 3: the box and whisker plots. I do not follow this figure, nor do I follow your chosen blocks. Those in purple reported in the PAQ to perform MVPA in that specific time period (morning, tea, lunch, after school), while those in pink reported not to? If so, you lined the median and quartiles, and you have no outliers? So, what is that used for? This figure shows accelerometry detected MVPA in those reporting no MVPA to, so I do not follow. Could you please make this easier for a reader to follow? So, on nr 4: after school, the no PA reporters are all over the acc measured MVPA?

Response:
This has been elaborated, and included the outliers as suggested.

Results:

- *In page 5 you have a statement in results: "The highest level of activity is seen after school hours and this is consistently captured by both self-reports and accelerometer." How can I see that from figure 3? The quartiles are all over each other?*

Response:
From figure 3, vertical axis represents the total MVPA captured by accelometer while horizontal presents the blocks of activities. The bars and whisker present the responses from self-reported activities. Thus, from that we can link with the output from accelerometer on the vertical axis. More importantly, the whiskers present the variations of MVPA captured from different blocks of activities between children who participate and not participate in activities

- *In page 6, you have a statement in results: "Separately, the accelerometer measured total MVPA during the first block of the day (walking to school) was consistently higher for children who report walking to school compared to those who do not report walking to school or use other means of transport such as private cars or school buses (Figure 3)." Do you have any statistical analysis to back this up? But more importantly, what does this say? That those who produces much acc measured MVPA before school hours also reports higher MVPA in walking to school? Good, but that does not add anything to the validity of the PAQ, the validity of the PAQ is nicely presented in figure 2: correlations and B and A plot.*

Responses:
Thanks for the comment, we do not have any statistical test for this, rather the median and quartiles. This figure tries to confirm or compare if at all those children who reported yes/no, they participate in physical activity is well captured by accelerometer.

Table 2: ok, good. Here comes the states about MVPA before school etc. then, I do not see what figure 3 and the box and whisker add, and the whole variability/bias in methods add.

Response:
Thanks for the suggestion, we included the box and whisker plots to understand if accelerometer time blocks output (MVPA) and self-reports responses are matching. Eg. We were expecting to see the higher MVPA from children who said yes, they walk to school than those who don't.

Discussion

- *Para 2: typo: "a moderate correlation observed", should be "a moderate correlation <u>was</u> observed."*

<u>Response:</u>
We have corrected the paragraph and the word "was" added.

- *Para 3: typo: "a few studies", should be "few studies". This first sentence in this para needs rephrasing: my suggestion: "Our findings are consistent with other studies validating self-reported physical activity instruments in children" – you cite quite many studies further into the para, so few studies is perhaps an overstatement?*

<u>Response:</u>
We have corrected the typo. We cited several studies to show the range of correlations from different studies of the same nature, and how were they reported.

- *Para 3: "Similarly, other validation studies using accelerometers as a reference method, reported low correlations and documented that most physical activity questionnaires have low to moderate validity19,21–27" replace "acc as reference" to "acc as the criterion", as you and these studies report on the acc as the criterion method. Further, what is low to moderate validity?*

<u>Response:</u>
We have included the word criterion as suggested. Low to moderate validity depends on the nature of the study, that is there is no specific cut off points. For most studies of these nature validity was described as the strength of the correlations and ranked as small (>0.1), moderate (>0.3) and strong (>0.5)

- *Para 3: "…and speak to the need for using both methods i.e objective measures and self-reports where possible."" Sure, but more importantly, as you mention in the intro, perhaps not all can afford ACCs, so in my view, the most important take home is: "…this highlight that researchers should interpret self-reported PA data with caution due to the imprecise assessment of PA." but still, they are not way off, indicating that it is better than no assessment.*

<u>Response:</u>
Thanks for this comment, we have added some more details as suggested and it now reads "these data highlight that researchers should interpret self-reported physical activity data with caution due to the limited validity in assessment of PA. However, self-reports are cheaper and easy to administer than objective measurements, and thus they can still be used to estimate physical activity levels".

- *Para 4: first sentence, typo: "…confirmed by acc". Should be "… confirmed by the acc".*

<u>Response:</u>
We have corrected they typo as suggested, please see line 335.

- *Para 4: alternatively, the most plausible explanation is that recall bias influences this. How can a 10-year old precicely remember all MVPA minutes? I am not 10 years old, but still, I cannot recall every MVPA minute I did.*

- *Para 4: here are recall. I simply suggest to restructure this para. Make recall come first.*

<u>Response:</u>

We have restructured paragraph 4 as suggested.

- *Para 5: I refer the authors to my statement in methods: this is outside the aims, consider supplementary or omit.*

Response:
Thanks for this concern, we have modified the title to include this information as it was important to understand the relevance of reporting physical activity from children as compared with accelerometry.

- *Para 6: there is no gold standard for assessing PA (Hills AP, Mokhtar N, Byrne NM.. Front Nutr*

- *2014;1:5; Westerterp KR. Eur J Appl Physiol 2009;105:823–8). This is no strength of the study. Please omit. The high compliance is a strength.*

Response:
We have reviewed this paper and changed the first part of the paragraph as suggested.

- *Limitations: the refuse rate is a limitation. The nature of self-report PA, i.e. recall bias, is not a limitation OF this study. This study aimed to assess the validity of self-reported PA.*

- *A limitation can be the no standard of acc protocol for processing the data?*

Response:
We have included more details on this section.

Conclusion:

- Quite long. I suggest to cut it after: *"This study found the moderate positive correlation between self-reports and accelerometers. Self-reports are prone to errors due to recall bias which might interfere their validity. Despite these flaws, assessing physical activity using devices is often not possible, especially in low- and middle-income countries due to cost."*
  The other things you mention: "Secondly…", that is suitable for the discussion.

Response:
We have reduced the conclusion as suggested.

Competing Interests: No competing interests were disclosed.

Reviewer Report 29 September 2020

https://doi.org/10.21956/aasopenres.14218.r27869

Ing-Mari Dohrn
Department of Neurobiology, Care Sciences and Society (NVS), Karolinska Institutet, Stockholm,

Sweden

The findings of the presented manuscript add value to the existing knowledge in this field of research. However, there are some minor and major aspects that need to be addressed by the authors before approval.

Title:

- The authors present quite a lot of data that is more of a description of PA level and pattern in the examined group in addition to the validation data, and may want to change the title to include that, or exclude some of the presented results.

Abstract:

- Please omit “using a simple random sampling technique” as this implies that is was not a convenience sample.

- Change to “A moderate, positive correlation was found between self-reports and accelerometer for weekday MVPA.. “ and “Accelerometer data showed more time in MVPA..”

- Maybe leave out since this is not really a validation result, but rather a description of PA level: “Children who reported walking to school had higher MVPA for both accelerometer and self-reports compared to children who use other means of transport to school, e.g. school buses ($p < 0.001$).”

Introduction:

- Please add: “In Tanzania, 82.1% of school-going children are not meeting the recommended physical activity levels according to self-reports.”

- The sentence: “Objective measures have been widely used in high-income… can be replaced by this sentence further down “Over the years, accelerometers have been used increasingly in high-income countries for assessment of physical activity in children[11,12]. Methods include…”

- Please change "self-reports" in the aim to a modified questionnaire.

Methods:

- I suggest the following changes:
"The World Health Organization (WHO) recommends an average of at least 60 minutes per day of moderate to vigorous physical activity (MVPA) for 5–17-year-olds…" and “Our main study variable was minutes per day spent in MVPA which was obtained from self-reports and accelerometry.” I guess it is not minutes per week?

- Please include the final set of questions that you used, in this section. The reader should be able to understand how the study was performed without having to go an appendix to get information.

- Did you ask the children to note any removals of the accelerometer during the day? How did you treat non-wear time during the day? Did you have a minimum hours of wear time for a valid day?

- Figure 1 is now hard to read. Please only show the vertical axis as this is the cutpoints refer to, and clarify the blocks and numbers. In the figure legend, specify if it shows weekday data.

Results:

- Please clarify if your main outcome is mean or median minutes in MVPA per day or total MVPA per week? I do not understand how daily MVPA minutes from the accelerometers can be median 98 as stated in table 1 and in the results on p 5, when mean weekday MVPA minutes are 408 in table 2? It also seems highly unlikely that only 74 minutes per day (median) are spent sedentary during a 15 hour day. Are these data in table 1 correct?

- Figure 2: A) should the value for r be 0.36? B) It is unclear if the outer dotted lines are ± 1.96 SD? It is not necessary to report CI for the mean difference (inner dotted lines), it only makes the graph hard to read.

- Figure 3: It is unclear how the pink and purple boxplots represent children participating in physical activity or not. What was this classification based on? This is not explained in the figure legend.

- The ICC calculations and the results presented in table 3 and 4 are only relevant if they are used for validation of the questions. For example, is the self-report questions more valid for boys or girls or children in one type of school. Please revise.

- In the discussion you state that “Walking to school and afterschool activity blocks from self-reports corresponds with accelerometer measured activities from these blocks.” Please present clearly these results and how this was analyzed.

- Please comment on why you did not use weekend data in the validation or data on sedentary time. I think this would strengthen the results.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: My areas of expertise are physical activity and sedentary behavior and associations with health, and objective assessment methods for physical activity and sedentary behavior, such as accelerometry.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 05 Jan 2021

Mary Mosha, Kilimanjaro Christian Medical University College, Moshi/ KIlimanjaro, Tanzania

The findings of the presented manuscript add value to the existing knowledge in this field of research. However, there are some minor and major aspects that need to be addressed by the authors before approval.

Title:

- *The authors present quite a lot of data that is more of a description of PA level and pattern in the examined group in addition to the validation data and may want to change the title to include that or exclude some of the presented results.*

Response:
We have altered the title to reflect reviewers' comments. Please see line 1

Abstract:

- *Please omit "using a simple random sampling technique" as this implies that is was not a convenience sample.*

Response:
We have revised this section and clarify, it is now written as "Four primary schools conveniently selected in Moshi municipal and Moshi rural districts, Kilimanjaro, Tanzania. A total of 51 primary school children aged 9 – 11 years were randomly selected from the 4 schools". Please see lines 22 - 24

- *Change to "A moderate, positive correlation was found between self-reports and accelerometer for weekday MVPA.. " and "Accelerometer data showed more time in MVPA.."*

Response:
We have changed the sentence as suggested, please see line 33

- *Maybe leave out since this is not really a validation result, but rather a description of PA level: "Children who reported walking to school had higher MVPA for both accelerometer and self-reports compared to children who use other means of transport to school, e.g. school buses ($p < 0.001$)."*

Response:

We have removed that section from the abstract as suggested.

Introduction:

- *Please add: "In Tanzania, 82.1% of school-going children are not meeting the recommended physical activity levels according to self-reports."*

Response:
We have added the sentence as suggested, please see line 55

- *The sentence: "Objective measures have been widely used in high-income… can be replaced by this sentence further down "Over the years, accelerometers have been used increasingly in high-income countries for assessment of physical activity in children[11,12]. Methods include…"*

Response:
We have replaced the sentences as suggested, see lines 66 - 76

- *Please change "self-reports" in the aim to a modified questionnaire.*

Response:
We have changed this sentence, please see line 80

Methods:

- *I suggest the following changes:*
  "The World Health Organization (WHO) recommends an average of at least 60 minutes per day of moderate to vigorous physical activity (MVPA) for 5–17-year-olds…" and "Our main study variable was minutes per day spent in MVPA which was obtained from self-reports and accelerometry." I guess it is not minutes per week?

Response:
We have made changes so that it is now clear, please see lines 98 – 99.

- *Please include the final set of questions that you used, in this section. The reader should be able to understand how the study was performed without having to go an appendix to get information.*

Response:
We have now included the final set of questions used as suggested, please see lines 129 - 139

- *Did you ask the children to note any removals of the accelerometer during the day? How did you treat non-wear time during the day? Did you have a minimum hours of wear time for a valid day?*

Response:
Thank you for this question. Children were told to note the time when they remove the accelerometers, but it didn't work out. However, with the Actigraph software you can determine the non-wear time, and we defined non wear time during analysis. This section is now elaborated, please see lines 193 - 196

- *Figure 1 is now hard to read. Please only show the vertical axis as this is the cutpoints refer to, and clarify the blocks and numbers. In the figure legend, specify if it shows weekday data.*

Response:
We have modified the figure to improve clarity, the figure legend has been improved as suggested. The figure shows one weekday / school day accelerometer output from a single child. More details of blocks descriptions is found in the supplementary file, please see lines 199 - 204

Results:

- *Please clarify if your main outcome is mean or median minutes in MVPA per day or total MVPA per week? I do not understand how daily MVPA minutes from the accelerometers can be median 98 as stated in table 1 and in the results on p 5, when mean weekday MVPA minutes are 408 in table 2? It also seems highly unlikely that only 74 minutes per day (median) are spent sedentary during a 15 hour day. Are these data in table 1 correct?*

Response:
The MVPA data from table 1 is the average MVPA per day, while for table 2, is the mean MVPA per week. The sedentary time from accelerometer is correct but is now clarified as a daily sedentary bouts of 10 minutes each, please see table 1

- *Figure 2: A) should the value for r be 0.36? B) It is unclear if the outer dotted lines are ± 1.96 SD? It is not necessary to report CI for the mean difference (inner dotted lines), it only makes the graph hard to read.*

Response:
We have corrected the figure, and CI removed from the figure, please see figure 2

- *Figure 3: It is unclear how the pink and purple boxplots represent children participating in physical activity or not. What was this classification based on? This is not explained in the figure legend.*

Response:
We have improved the figure legend, and elaborate more on the document that this figure compares the total MVPA from accelerometer output with children who either said yes they participate in physical activity or no they don't . Please see lines 219 – 222, and figure 3

- *The ICC calculations and the results presented in table 3 and 4 are only relevant if they are used for validation of the questions. For example, is the self-report questions more valid for boys or girls or children in one type of school. Please revise.*

Response:

We performed the analysis to explore the associations between weekdays accelerometer MVPA and different child level variables, since child was having repeated measurements from accelerometer i.e. Monday to Friday we regarded child as a cluster. This helped to understand the effect of a child as cluster on accelerometer MVPA. i.e understanding how much of the variations in MVPA is contributed by child.

- *In the discussion you state that "Walking to school and afterschool activity blocks from self-reports corresponds with accelerometer measured activities from these blocks." Please present clearly these results and how this was analyzed.*

Response:
Box and whisker plots were plotted to present these findings. The horizontal axis informs us about the total MVPA captured by accelerometry from the children who said they

participate in certain activities versus those who they don't participate (from self-reports). Therefore for walking to school and afterschool activity blocks, we see high levels of total MVPA which indicates that participation in these activities was well captured by accelerometer.

Please comment on why you did not use weekend data in the validation or data on sedentary time. I think this would strengthen the results.

Response:
Thanks for sharing this concern, we targeted school days as we expected that during school days children are participating in a set of activities which can easily be remembered than weekends in which there are several unstructured activities in which we could not capture by a questionnaire. However, some of the weekend data are presented in table 3. This is elaborated in lines 210 - 213

Competing Interests: No competing interests were disclosed.