

MEASURING PHYSICAL ACTIVITY IN SOUTH AFRICAN GRADE 2 AND 3 LEARNERS: A SELF-REPORT QUESTIONNAIRE VERSUS PEDOMETER TESTING

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ABSTRACT

The prevalence of childhood obesity is increasing in South Africa and can be linked to decreased physical activity (PA). It is important to be able to accurately measure children's PA levels as part of a holistic strategy for maintaining healthy body weight. The primary aim of this study was to determine whether children in grades two and three can self-report PA by means of a questionnaire. Fifty-eight participants (girls=28; boys=30) from a primary school in Gauteng were recruited for the study. The participants had to wear a pedometer (Omron HJ-720) for seven days after which they completed the Physical Activity Questionnaire for older Children (PAQ-C). The average steps per day were 9289, with weekday steps (10,219) being more than weekend steps (6,795). The mean score for the PAQ-C was 3.14 ± 0.47 . There was a significant moderate correlation ($r=0.49$; $p<0.01$) between the overall PAQ-C score and average steps per day. The PAQ-C can be an effective way to gain insight into the PA levels in children but should not replace objective measures of PA. The participants in this study appear to be accumulating insufficient PA over the course of the week.

Keywords: Physical activity; Pedometer; PAQ-C; Questionnaire; Children.

INTRODUCTION

In the "Health of the Nation Study" (Armstrong *et al.*, 2006), it was found that South African children, between the ages of 6 and 13 years, are showing trends in overweight and obesity that are comparable with those of developed nations ten years ago. Rossouw *et al.* (2012) performed a review of overweight- and obesity research in the South African context. Their results supported findings of the World Health Organisation (WHO), identifying Africa as having the fastest growing rates of overweight and obesity worldwide. In South African children (4-8 years), 16.4% of boys were found to be overweight and 3.0% obese, and for girls the figures are 12.2% and 3.1% respectively. In the 11-12 years age group 9.9% of boys are overweight and 6.0% obese with a prevalence for girls of 14.7% and 6.4%, respectively (Lundeen *et al.*, 2016). Reasons postulated for the rise in overweight and obesity include that there is an increase in high energy dense- foods in the diet (Steinberger & Daniels, 2003, Rossouw *et al.*, 2012, WHO, 2012) and decreases in daily physical activity (PA) (Mciza *et al.*, 2007; McVeigh & Norris, 2012). Sufficient PA levels in South African primary school aged children are only being met by approximately one third of children (McVeigh & Norris, 2012) and there is a direct relationship between low levels of physical fitness and activity, and obesity (Truter *et al.*, 2010).

As one strives to increase PA levels, a need arises to measure current levels of activity (Biddle *et al.*, 2011). This need is partially to know which children perform a sufficient quantity of PA, but also to gauge the success of programmes of intervention intended to affect PA levels (Biddle *et al.*, 2011; McVeigh & Norris, 2012). Measuring PA levels poses unique challenges due to the nature of the activity behaviour of children, as well as their level of cognitive development (Welk *et al.*, 2000). An additional difficulty in measuring PA is the absence of a 'gold standard' with which to determine PA (Kowalski *et al.*, 2004). Welk *et al.* (2000) described children's activity as tending to have an intermittent pattern, where short bouts of frequent activity occur, having a greater total volume of exercise than adults, but lacking tolerance for high intensity activity and less interest in continuous activity than adults.

Self-report questionnaires, such as the Physical Activity Questionnaire for older Children (PAQ-C), possibly provide a cost effective large scale solution to measuring PA levels in children, having been validated in developed nations. The PAQ-C is a self-report, seven-day recall questionnaire to determine general levels of PA for children eight to 14 years of age (Wareham, 2001; McVeigh & Norris, 2012). Certain strengths to its design including its measure of general PA levels, its use of memory cues, and being cost and time efficient (Kowalski *et al.*, 2004).

Pedometers or 'step-counters' are an alternative method of assessing PA levels. They make use of motion sensors, which when worn, will record the movement that accompanies locomotion (Chen *et al.*, 2008). With walking and running being primary forms of PA, and pedometers being reasonably low cost devices that are easy to use, pedometers may also be a logical step to ensure validity in determining PA (Ryan *et al.*, 2006; McNamara *et al.*, 2010). Mciza *et al.* (2007) stated that in order to understand the value of PA questionnaires they must be compared with objective measures (pedometers or accelerometers). With continual reduction in cost and improvement of technological freedom, measuring PA levels may soon be measured completely with objective means. Until such time, self-report questionnaires remain the only way to gather data from large sample groups (Biddle *et al.*, 2011). A need exists to increase PA and exercise compliance in children, and as a result negate the devastating consequences of inactivity and overweight on their health.

PURPOSE OF RESEARCH

It is imperative to measure PA levels and patterns effectively in children. This study's primary aims were to determine whether primary school children (South African, Gauteng) could accurately self-report PA using the PAQ-C and to establish PA levels and patterns in this group of children. To achieve the aims of this study the results of PA reported via the PAQ-C were correlated with PA measured using a pedometer.

METHODOLOGY

Participants

The study used a non-random sample of volunteers from a Quintile 5 primary school in Pretoria East (Gauteng). All children in grades 2 and 3 were asked to volunteer for the study. Permission was acquired from the Gauteng Department of Education and school governing body to conduct

the study at the school. Ethical clearance was obtained from the Postgraduate Committee of the Faculty of Humanities, University of Pretoria. In addition, parents or legal guardians of the children signed an informed consent, while the participants had to complete an assent form to participate in the study.

Measurements

Body mass of the participants was measured using a Tanita scale - model BF-350 (Tanita Corporation, Tokyo, Japan), which was required for the pedometer set-up. Two measurements were taken and where a difference was found the average was recorded to the nearest 0.1kg. Participants were weighed without footwear and in minimal school wear.

Stride length was measured using a flexible tape measure to mark off one meter intervals on a tile floor. Each participant was given three attempts to walk ten consecutive steps, each attempt was recorded, and in the event of a participant not following one of the instructions, the attempt was not counted and the participant was asked to perform another attempt (Beets *et al.*, 2005). An average stride length was then calculated.

The pedometer (Omron HJ-720 – Omron Corporation, Osaka, Japan) was set up using the body mass and stride length of each participant, and then labelled with a number allocated to each participant. The use of pedometers was explained and demonstrated to the participants with an opportunity for them to demonstrate that they understood the instructions. The pedometer was to be worn clipped onto the waist band of the boys' clothing at the midline of the thigh (Omron Healthcare, 2007; De Cocker *et al.*, 2012). The girls they had the option of wearing it in the front shirt pocket or to wear the pedometer around the neck attached to a lanyard as described by De Cocker *et al.* (2012) and as described in the Omron HJ-720 user guide manual (Omron Healthcare, 2007). The girl's uniform did not allow for wearing the pedometer on the waist. The pedometers were not sealed thus participants could see on the screen how many steps they were taking. Pedometers were worn for a total of seven days, after which the pedometer data was downloaded by the researcher via mini-USB cable using Omron's Health Management Software Version 1.3, and exported into spread sheet format in Microsoft Excel 2010. For every day the pedometer was worn, a bundled short message service (SMS) was sent to the participants to remind them to wear the pedometer. At the end of the trial the SMS system was also used to make sure all pedometers were returned.

Upon returning the pedometer each participant received a copy of the PAQ-C questionnaire for completion at home. The questionnaire had been used earlier the same year by the participants therefore they were familiar with it. The questionnaire allows a mark out of five to be allocated to each of the nine items, with a mean collected from the nine items to give each participant a mark out of five to indicate level of PA (1="low"; 5="high"). The questionnaire received by the participants was altered from the original in two ways: Firstly, it was translated from English into Afrikaans; secondly, the first question features a list of activities common to North American youths, which was altered to reflect local sporting activities. Football, street hockey, ringette and cross-country skiing were removed and rugby, field hockey, netball, tennis, and cricket were added. The data collection was performed during November 2012 (13th-19th) after the school sports had ended to prevent sporting activities influencing the results.

Statistical analysis

The statistical analysis of the data was conducted by an independent statistician using the Statistical Package for Social Sciences (SPSS Statistics 20). The Spearman's ranked correlation and the Mann-Whitney U-test were used to determine whether or not there was a statistically significant correlation or difference ($p < 0.05$), respectively, between the PAQ-C and pedometer results. Pedometer data was time stamped and separated into the following categories: Total steps taken for seven days, steps taken before school (12am–7am), steps taken during school time (8am–1pm) and steps taken after school (1pm–12am), as well as separating weekday and weekend periods. Note that the hour between 7am–8am could not be allocated to either before or during school as it falls half way into both, it was used however in calculating the totals for the days. The PAQ-C score out of five was used to quantify the children's reported activity level and compared to the pedometer results. In addition, the items within the questionnaire were also compared to pedometer measurements to investigate associations to specific questions. The classification of Landis and Koch (1977) was used to describe the strength of the correlations.

RESULTS

The participants ($N=58$) were children in Grade 2 (age 7-8 years; $n=29$) and Grade 3 (age 8-9 years; $n=29$), of which 28 were girls and 30 were boys. Body mass was 29.4 ± 6.7 kg for Grade 2 and 34.1 ± 6.9 for Grade 3. Table 1 presents the pedometer results (collected over seven days) for the total group and differentiating between grades and gender. The average steps per day were 9289 ± 2573 , with the total weekday steps ($10,219 \pm 2761$) being more than the total weekend steps (6795 ± 3289). The steps taken during school hours (3726 ± 1048) were only slightly less than those taken after school hours (4813 ± 1796).

The mean (\pm SD) score for the PAQ-C was 3.14 ± 0.47 . The most commonly selected activities (PAQ-C) were jog/run (3.72), swimming (3.5), walking for exercise (2.76), game of 'tag'/chasing (2.69), and cycling (1.91) indicated as a mean of the selection options out of a maximum of five.

Table 2 shows the strongest correlations found between various pedometer steps measured and the PAQ-C score of the participants. There was a moderate correlation ($r=0.49$; $p < 0.01$) between the overall PAQ-C score and average steps per day, with a slightly stronger correlation when comparing the score only to weekdays ($r=0.53$; $p < 0.01$).

When comparing the reported PA, as well as the measured PA of Grade 2 participants versus Grade 3 participants, there was only one significant difference ($p < 0.05$) between the two groups for "steps measured after school" (Figure 1). Participants in Grade 2 had an average of 5296 steps after school with participants from Grade 3 having an average of 4330 steps. Pedometer steps and PAQ-C scores held no correlation with body mass in the present study (Figure 2). Body mass ranges and means are shown in Figure 3.

Table 1. Pedometer data collected over seven days

Pedometer measurement	Girls (n=28) M±SD	Boys (n=30) M±SD	Grade Two (n=29) M±SD	Grade Three (n=29) M±SD	Total (n=58) M±SD
Ave. number of steps	7988±2136	10503±2368	9681±2490	8896±14745	9289±2573
Total steps weekday	44697±12750	57068±12111	52412±12917	49780±2949	51096±13803
Ave. steps per day for weekday	8939±2550	11413±2422	10482±2583	9956±6527	10219±2761
Total steps weekend	11220±5361	15804±6914	14679±6559	12503±6527	13591±6578
Ave. steps per day on the weekend	5610±2681	7902±3457	7339±3280	6251±3264	6795±3289
Ave. steps during school hours (8am-1pm)	3296±914	4129±1018	3585±985	3868±1108	3726±1048
Ave. steps after school hours (1pm-12am)	4041±1391	5533±1851	5296±1859	4329±1620	4813±1796
Ave. steps before & after school hours (12-7am; 1pm-12am)	4666±1751	6133±1837	5845±1895	5004±1900	5425±1928
Total no. of steps for 7 days	55917±14952	73526±16573	67773±17429	62278±18466	65025±18012

M=Mean

SD=Standard Deviation

Ave=Average

Table 2. CORRELATIONS BETWEEN VARIOUS REPORTED AND MEASURED ACTIVITIES

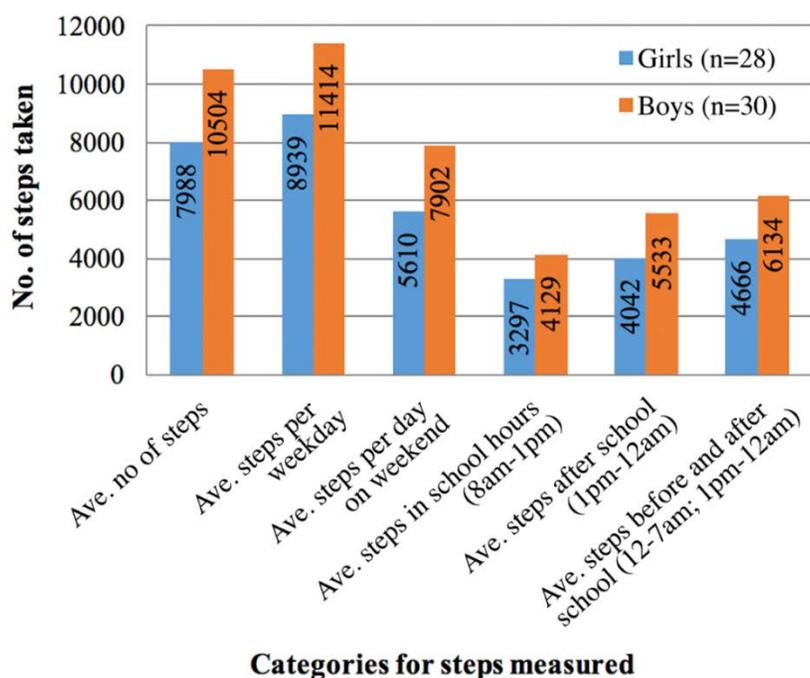
Measure	Item	Assessment	r	p
PAQ-C score	Average steps per day	Moderate	0.49	<0.01
	Tot. no. of steps for weekdays	Moderate	0.53	<0.01
	Tot. & ave. frequency of activity for Q1	Almost perfect	0.81	<0.01
	Ave. activity reported for 7 days in Q9	Almost perfect	0.82	<0.01
Ave. steps per day	Tot. & ave. frequency of activity for Q1	Moderate	0.39	<0.01
	Ave. activity reported for 7 days in Q9	Fair	0.28	<0.05

Ave=Average

Tot=Total

Q=Question

no=number

**Figure 1. GENDER DIFFERENCES REGARDING AVERAGE NUMBER OF STEPS TAKEN**

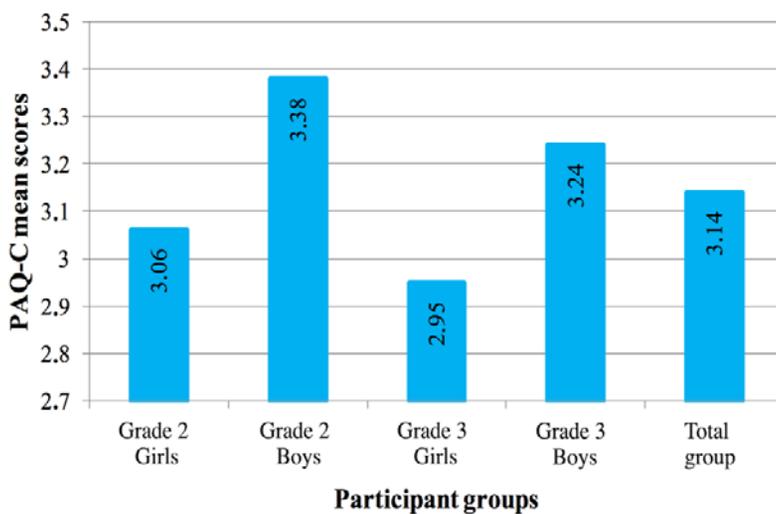


Figure 2. PAQ-C SCORES

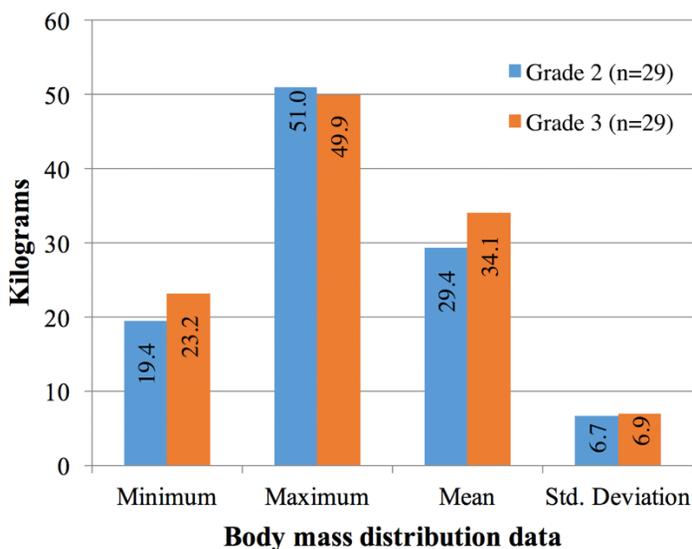


Figure 3. BODY MASS DISTRIBUTION DATA OF PARTICIPANTS

DISCUSSION

The primary aim of this study was to determine whether the PAQ-C is an accurate reflection of actual activity in a group of Grade 2 and Grade 3 primary school children (Gauteng). The overall score for the PAQ-C showed a significant moderate correlation ($r=0.49$; $p=0.00$) with the average number of steps taken per day, as well as for the total activity the pedometer measured over the week, and a significant slightly stronger correlation ($r=0.53$; $p=0.00$) when only taking weekdays into account. The questionnaire can thus be said to moderately correlate with the participants steps as measured by the Omron HJ-720 pedometer. There was not a statistically significant relationship between the steps measured over the weekend and the reported activity from the questionnaire when examined in isolation. A probable reason for this result is that the questionnaire is based more around the memory cues of the week, with only one multiple choice question aimed at the weekend, thus underestimation or overestimation error in reporting may become exaggerated. Furthermore, activity cues for the weekend are absent in the questionnaire, hampering accurate recall and making comparisons with weekday activity difficult. It is also possible that due to the low overall activity measured for the weekend, continuous steady state exercise was decreased. Pedometers are most inaccurate with intermittent activity as opposed to continuous activity.

From the results of this study it would appear that the PAQ-C could be used, with a similar group of children, to determine what the impact is of an exercise intervention on activity levels or to categorise children into lowest versus highest PA levels groups, however, not to the extent that it could be a replacement for objective measurement for research. These results agree with those of Beets *et al.* (2005) that objective measurement remains superior to self-report in age groups from five to 12 years, despite cost implications. In addition, the questionnaire, remains more appropriate to just separate the children with the highest activity levels from those with the lowest activity levels (Kowalski *et al.*, 2004).

Overall, the average activity measured was found to be well below what is considered the minimum necessary for health, based on the recommendations that Epstein *et al.* (2001) indicated is 15,000 steps/day. This group of participants are not getting adequate PA with an average of 10,219 steps/day for the weekdays and 6796 steps/day over the weekend (average of 9289 steps/day for the week) as measured using the pedometer. The decrease in PA over the weekend is a finding supported by other studies investigating Canadian children aged 10 to 15 years (Comte *et al.*, 2013) and British and Spanish children aged 10 to 14 years (Ramirez-Rico *et al.*, 2014). Thus, it is possible that this group of participants is at risk of developing diseases of lifestyle (hypokinetic disease), in particular those traits that are shown to track into adulthood, such as atherosclerosis, hypertension, overweight/obesity and smoking (Monyeki & Kemper, 2008; Rayner, 2012; Plowman & Smith, 2013).

The PAQ-C results showed that the participants rated themselves in the middle options (two, three, or four out of five) with none scoring the highest or lowest options. The original validation studies on American youth, ages 8–13 years, had mean scores of 3.23 and 3.35 respectively in comparison to the participants in this study who had a mean score of 3.14 (Kowalski *et al.*, 1997). Thus, this group of children appear to be slightly less active than those of the original validation study. The pedometer measurements for the group showed average

activity (measured in steps per day) as being below optimal, thus an average rating for this group of 3.14 as determined by the PAQ-C, also suggests sub-optimal PA levels.

Though there should be more free time for play over the weekend and thus more activity recorded – free time appears to be spent more sedentary when the structure of school and after school sports are removed. The largest block was the steps taken after school hours at an average of 4813 steps, compared to during school hours which were an average of 3726 steps (the time since waking up until the start of school accounted for 612 steps on average). The results are comparable to that of Walter (2011) showing that a large part of daily PA for South African children (aged 8 to 12) occur during school hours (58% study). Apart from recess and a Physical Education class twice per week, school hours are spent largely sedentary, yet the afternoons accounted for only 25% more activity than the mornings of school days. No inventory was taken on how the weekend was spent in terms of activities. This could be the focus of future research.

With little activity reported, it would be reasonable to assume that the preferred free time activities are largely sedentary, such as computer-, handheld- and console games, or television watching with little in the way of outside play and sports based activities. Daley (2009) showing that ‘active’ new-generation gaming is still lacking evidence regarding health benefits. As long as modern entertainment is sedentary, children will not self-select to do adequate PA, however, if schools can to a greater extent draw children into programmes based around PA (with encouragement from parents) this activity deficit can decrease. Parental lifestyle has been shown to affect the PA habits of their children as well (Morgan *et al.*, 2011). Part of the solution is parents modelling the behaviour that they wish their children to follow.

In all pedometer variables and the total PA reported for PAQ-C, the boys were significantly more active than the girls for both Grade 2 and Grade 3 participants. The pattern of boys (aged 6 to 18) being more physically active than girls has been reported by various researchers (Trost *et al.*, 2002; Cardon & De Bourdeaudhuij, 2004; Bassett *et al.*, 2007).

When comparing the reported PA and the measured PA of Grade 2 participants versus Grade 3 participants, there was only one significant difference ($p < 0.05$) between the two groups for “steps measured after school”. Participants in Grade 2 had an average of 5296 steps after school with participants from Grade 3 having an average of 4330 steps. Although a decrease in PA was expected between grades since previous studies have found that there is a definite drop-off in PA levels with progressing age (Trost *et al.*, 2002; Nader *et al.*, 2008), the extent of the drop was surprising (from one grade to the following). It is currently not evident whether this drop could be assigned to gender differences and warrants further investigation.

Though there was not a direct correlation between PA and body mass, previous research conducted on adults in the United States of America has shown the connection between inactivity and increased body mass, as well as resulting increases in health risk factors (Sisson *et al.*, 2010).

It is important to note the following factors which could have influenced the results of the study in terms of the amount of PA measured and the correlation between the two instruments. The

Omron HJ-720 pedometer has a random movement filter of four seconds, thus movement must be continuous for four seconds or more before it is recorded; Walking for three seconds and then stopping will cause no recording (Nakae *et al.*, 2008). The purpose of this form of recording is to prevent false positives being recorded, but leads to false negatives being recorded (Beets *et al.*, 2005). Beets *et al.* (2005) showed that the Sun TrekLINQ pedometer, using a five-step random movement filter showed a marked decrease in accuracy compared to other pedometers at low speeds and may be problematic due to the intermittent nature of children's PA, particularly when in an uncontrolled environment.

The time of year the data collection took place could have also influenced the results obtained. The testing was performed in the middle of November. During this period all sporting activity sponsored by the school had ended and only those participants that were in outside sporting clubs would still have continued training and competing. This would mean that the values measured for the participants would be some of the lowest of the school year for the group as a whole, and could rise greatly during most other months. This month was however chosen since it shows what the baseline activity of the participants is, as they would need to accumulate the minimum amount throughout the entire year regardless of sporting season.

Of the activities that were participated in the most (according to average selected frequency), the most common options, given as a rating out of five, were: Jog/run (3.72), swimming (3.5), walking for exercise (2.76), game of 'tag'/chasing (2.69), and cycling (1.91). Swimming and cycling, being the second and fifth most commonly selected activities respectively, are examples of activities which cannot be evaluated through the use of a pedometer and confirms that many daily activities will go unmeasured by traditional PA monitors and thus could have also contributed to the low levels of activity recorded in this study.

Adjustments to the PAQ-C are recommended to improve the accuracy of the results obtained from the questionnaire. Some activities listed in the questionnaire did not receive any answers and can therefore be removed from the list in future. Improvements of recalling activity levels over weekend should be investigated. Whilst the weekday portion is filled with clues surrounding the daily routine, which can jog memory and put the amount of activity in perspective, the weekend is less so. Using an online form of completion via the internet or smart device 'app' (software application) or even simply the routine of filling in sections to the questionnaire at specific time intervals over the weekend could shorten the duration between activity and writing down the activity. The current questionnaire's questions format would have to be altered as the questions are not phrased in such a way. A simple method that could enhance accuracy is merely to decrease the recall time from the current seven days, specifically the components of the questionnaire dealing with PA over the weekend. Regarding promoting PA to further health outcomes, it is suggested, based on the PA patterns observed in this study, that focus should be given to participation in structured school and after school physical activities and that regular Physical Education classes in school should be encouraged. A regular after school programme providing 30–60 minutes of PA, as was the case of Lennox and Pienaar (2013), can boost the total PA performed during the week so that the average daily requirement is still met over the course of seven days. After school activities can also be structured and controlled more rigidly to ensure that it is not only a perception of adequate PA that is occurring, but PA that is intense and great enough to meet the necessary requirements.

CONCLUSIONS

The participants in this study appear to be accumulating insufficient PA over the course of the week as per health recommendations, with particularly low levels of activity over the weekend. School activity appears to promote PA, and further increases are recommended to meet criteria for improving health. The PAQ-C showed a moderate correlation with the average and total number of steps taken per day as recorded by a pedometer, and a slightly stronger correlation when only taking weekdays into account. It would appear from the results that PAQ-C could be used with a similar group of children to determine what the impact is of an exercise intervention on activity levels or to categorise children into lowest versus highest PA levels groups. However, this kind of application could not be a replacement for objective measurement for research.

Important limitations of this study include; pedometers do not measure certain activities, such as swimming; the PAQ-C was not validated after being translated into Afrikaans prior to the study; and the questionnaire relies on seven-day recall therefore different results may have been obtained if it was administered daily due to memory recall. It is recommended that future research focuses on the differences in PA levels in South African children from rural and urban communities, seasonal influences on PA levels in children and the types of activities that are most effective in promoting PA in children.

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