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RESEARCH

Physical activity of children from a small rural town, South Africa

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Introduction: Physical activity plays an integral role in the normal physical, mental, social and cognitive development of children. One of the main reasons for overweight children in low- and middle-income countries like South Africa is inactivity. This study's aim was to describe the physical activity measured in boys and girls from section 21, quintile 5 pre-primary and primary schools in a small rural South African town and to compare it with recommended international physical activity levels.
Method: Seventy-eight rural children, representing Caucasian and black African children, divided into three age groups, were issued a piezoelectric pedometer for seven complete days. Pedometer data obtained were total steps, aerobic steps, aerobic walking time, calories and distance. Steps per day were compared with international levels. Correlation statistics examined the association between physical activity and adiposity.
Results: Boys in the age groups 9–11 and 12–14 years are statistically more active than girls of the same age ($p = 0.005$ and 0.045 respectively). Although girls' physical activity levels tend to decrease with age, their aerobic activity levels increase with age. This group of rural children's physical activity levels are far lower than the recommended international normative levels. No correlation was found between physical activity and adiposity.
Conclusion: The pedometer data indicated that gender and age influence the activity of children. This group of rural children's physical activity is far less than international normative levels. Nine to 11-year-old boys are the most active boys, and girls of 12–14 years old are the most aerobic active girls in this study, therefore the authors concluded that, to increase physical activity, the age group 9–11 may be the ideal age to focus on for gender-specific intervention programmes.

Keywords: children, descriptive study, pedometer, physical activity, steps per day, South Africa

Introduction

Physical activity plays an integral role in all aspects of the development of a healthy child. Physical activity is not only important for the physical development of children,[1] but is also important to establish social structures, enhance sensory and emotional intelligence, and stimulate cognitive development.[2]

According to the World Health Organization (WHO), low- and middle-income countries are witnessing the fastest rise in overweight children.[3] This was confirmed by a review of South African literature, indicating high levels of overweight and obesity in children and adolescents; inactivity was identified as one of the major causes.[4]

Information available on activity levels in low- and middle-income countries indicated high volume at low-intensity activity.[5] However, little is known about the influence of age and gender on physical activity in the children from these countries.

For this study, pedometers were chosen to quantify physical activity. The rationale for their use is the increase in their popularity due to the fact that they are relatively inexpensive devices and produce good, reliable measurements of physical activity levels.[6]

The aim of this study was to determine and describe the physical activity in boys and girls from different age groups living in a small rural town in South Africa, and to compare it with recommended international standards. A secondary objective of this study was to determine the association between adiposity of the school children (body mass index) and their physical activity (total steps taken per day).

Study setting

The study town, primarily supported by agriculture and local industries, has a population of 3 792 people and is classified by the South African Treasury as a small rural town (B3).[7] This town has only three schools from which to choose children for this study: a pre-primary, primary and secondary school.

Methodology

Permission for the study was obtained from the primary and pre-primary school principals from the local Department of Education, the appropriate MMed Committee and the Ethics Committee of the Faculty of Health Sciences, University of Pretoria (Number 182/2012). The trial was registered on the South African National Health Research Ethics Council (NHREC) website (Application ID 3189).

The children asked to participate in the study were from the local primary and pre-primary schools (both section 21, quintile 5 schools) respectively. Three age groups of children were invited to participate in the study: children between the ages 12–14 years (group A), between 9 and 11 years (Group B) and between 5 and 6 years (Group C).

Thirty children per age group were chosen as a sample of convenience. Children identified as per the protocol were randomly selected from the alphabetical class lists by choosing every third child till the required number of children was reached.

For the age group 5–6 years, all the children enrolled at the school were chosen (i.e. 17 children). There was no racial preference in the selection process. A total of 78 healthy participants were randomly recruited for the study. These chosen children were informed of the study's aim, objectives and procedures during an informal meeting. The children were then given a detailed information letter directed to their parents/legal guardian. The information letter detailed the aims, objectives, procedure, possible risks and benefits, investigator's contact details, a copy of the Declaration of Helsinki and explanation of the way information and results would be handled to ensure confidentiality. Before a child was enrolled in the study, a signed Informed Consent Form from the parents and Assent Form from the children were obtained. All the children identified and asked to participate in the study gave their assent and their parents' consent.

To obtain the anthropometric measurements, the same calibrated weight scale was used for obtaining the weight (nearest 1 kg) and a standardised measuring tape was used to obtain the height (nearest 1 cm) of the children. Ten steps were measured on three separate occasions to calculate the average step length for each child. The investigator captured the measurements, and then entered it into the pedometer settings.

Each child's body mass index (BMI) was calculated by using the standardised equation (weight in kilogram/[height in metres]^2). The BMI was used to classify each child according to the International Obesity Task Force's (IOTF) international body mass index cut-offs for thinness and obesity in children (reported in Table 2).[8]

After anthropometric measurements were obtained and entered, each child was fitted with a belt-fitted piezoelectric pedometer. The 30 Omron Multiply HJ-720ITC piezoelectric pedometers (Omron Healthcare Europe B.V., Hoofddorp, The Netherlands) with a 41-day memory function used in this study demonstrated validity and reliability at various mounting positions under prescribed and self-paced walking conditions with both healthy and overweight adults. The pedometer is accurate in the measurement of step-count, but demonstrates limited accuracy in the assessment of travelled distance and energy expenditure in a speed-dependent manner in children. De Craemer et al. concluded that the Omron pedometer-based step counts are valid estimates of preschoolers' physical activity levels during free-living activities based on group estimates.[6]

Each child received verbal instructions regarding the use of the pedometer. An information sheet was also provided to each child to take home, explaining how and when to use the pedometer. Contact details of the investigator were also provided on the information sheet. Each morning, an SMS was sent to the parents and/or children to remind them to use the pedometer. Group A were issued with their pedometers on Monday, Group B on Wednesday and Group C on Friday (separate weeks). A complete seven days' data were captured. The children wore the pedometers on the waist from the time they woke till bedtime, for seven complete and consecutive days. The pedometers could be removed for sleeping, bathing and swimming purposes. After the complete seven days, the data were captured on the investigator's personal computer, using the software program provided by the pedometer manufacturer.

The first and last days' (i.e. day 0 and day 8) pedometer data were not used in the analysis.

The IBM SPSS™ Statistics 20 package (IBM Corp, Armonk, NY, USA) was used to do the statistical analysis of the data obtained in this research project. Nonparametric techniques were implemented due to the small sample size. Means, standard deviations and median were used for descriptive purposes. Minimum and maximum values, medians, means and interquartile ranges were used to describe the pedometer data (total steps, aerobic steps, aerobic walking time, calories and distance). Aerobic steps are calculated when walking or jogging is for more than 60 steps per minute or is more than 10 min continuously. Calories consumed are calculated from the length, weight, stride distance, number of steps and walking speed. The Mann–Whitney two-tailed test was used to assess differences between boys and girls in the different groups. Statistical significance was defined as $p \leq 0.05$.

To examine the correlation between physical activity and BMI, Spearman correlation statistics were applied.

The research was done in accordance with the World Medical Association Declaration of Helsinki.

Results

Seventy-eight children provided a complete data-set for anthropometric and pedometer data. Each group's data-set was analysed separately, and compared. Descriptive statistics for the group characteristics and IOTF classification[8] are reported in Table 1.

The majority of children in this study are classified in the normal range of the IOTF, but 29% of children in group A are overweight or obese (55% girls), 16% in group B (60% girls) and 11% in group

Table 1: Group characteristics and IOTF classification[8]

Descriptive variables	Group A: 12–14 years		Group B: 9–11 years		Group C: 5–6 years	
	Boys	Girls	Boys	Girls	Boys	Girls
Gender (n =)	13	18	12	18	8	9
Mean age in months (SD)	153.3 (6.1)	149.6 (6.7)	125.2 (8.9)	123.2 (9.9)	66.5 (5.4)	65.8 (3.7)
Mean BMI (SD)	19.4 (4.5)	20 (3.3)	17.1 (4.5)	16.7 (3.0)	16 (0.7)	15.9 (2.1)
Underweight (< 18.5)	8%	6%	16.5%	28%	0%	11%
Normal range (18.5–24.9)	61%	67%	67%	56%	100%	67%
Overweight (25–29.9)	23%	27%	0%	11%	0%	11%
Obesity (30–34.9)	8%	0%	16.5%	5%	0%	11%
Morbid obesity (≥ 35)	0%	0%	0%	0%	0%	0%

Table 2: Pedometer descriptive statistics

Descriptive variables	Group A: 12–14 years			Group B: 9–11 years			Group C: 5–6 years		
	Boys	Girls	Mann-Whitney p-value	Boys	Girls	Mann-Whitney p-value	Boys	Girls	Mann-Whitney p-value
Mean total steps per day			0.045*			0.005*			0.441
Minimum value	4,385	1,982		8,829	4,340		611	1,843	
Maximum value	13,734	11,939		17,362	14,398		12,275	11,735	
Median	8,892	6,450		13,081	9,457		7,123	5,793	
Mean	8,524	6,967		12,808	9,367		7,198	6,376	
Interquartile range	6 919–9 394	5 968–7 575		10 414–14 742	7 878–11 419		6 141–9 085	4 405–7 908	
Mean aerobic steps per day			0.903			0.072			0.957
Minimum value	0	0		0	0		0	0	
Maximum value	4,298	3,967		3,715	1,235		775	353	
Median	300	230		414	230		0	0	
Mean	661	553		977	316		162	112	
Interquartile range	113–522	124–714		252–1 262	0–454		0–259	0–169	
Mean aerobic walking time (min) per day			0.793			0.075			0.872
Minimum value	0	0		0	0		0	0	
Maximum value	41.71	39.29		41.29	12.14		8	3.29	
Median	3.14	2.36		4.36	2.5		0	0	
Mean	6.67	5.46		10.12	3.17		1.73	1.06	
Interquartile range	1.43–5.58	1.43–7.00		2.57–12.43	0–4.71		0–2.93	0–1.86	
Mean calories (Kcal) per day			0.101			0.005*			0.336
Minimum value	72	47		163	71		7	21	
Maximum value	469	257		378	306		151	151	
Median	251	152		216	155		89	71	
Mean	221	159		234	173		91	77	
Interquartile range	138–287	120–212		184–267	142–206		77–117	50–94	
Mean distance (m) per day			0.034*			0.005*			0.441
Minimum value	2,799	1,393		6,013	2,817		181	55	
Maximum value	10,974	8,010		13,019	8,700		3,679	3,516	
Median	5,953	4,461		7,996	6,286		2,133	1,733	
Mean	6,223	4,829		8,416	6,102		2,156	1,908	
Interquartile range	4 687–7 460	4 094–5 619		6 690–9 716	5 203–6 923		1 837–2 722	1 314–2 367	

*: $p < 0.05$

C (100% girls). In total, 20% of all the children are overweight or obese of which 62.5% represent girls.

Minimum and maximum values, medians, means and interquartile ranges were used to describe the pedometer data (total steps, aerobic steps, aerobic walking time, calories and distance) for each age group (Table 2).

Boys of all three age groups took more steps per day than girls of the same age. Boys age 12–14 years took 27 5% more steps than girls age 12–14 ($p = 0.045$), boys of 9–11 years of age took 27.7% more steps than girls of the same age ($p = 0.005$), and 5–6-year-old boys (although not statistically significant; $p = 0.441$), took 18.7% more steps per day than girls of the same age. The distance covered (m) by boys in Group A ($p = 0.034$) and Group B ($p = 0.005$) was also significantly larger than the distance covered by the girls. Significant gender differences are also found in Group B for calories ($p = 0.005$). Figure 1 is a graphical representation of the mean steps per day for each age group (gender divided) as per day of the week.

The school-going age groups (Group A and B) showed fewer steps per day during the weekends. Data indicated that pre-school children are more active on Saturdays than on any other day of the week (Figure 1).

Step counts from the boys and girls were compared with normative (i.e. expected values) activity data obtained from

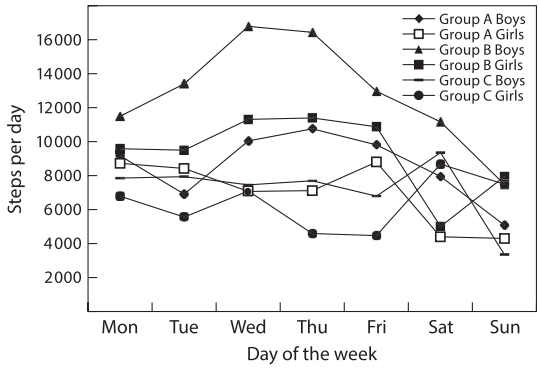

Figure 1: Mean steps per day for each gender age group as per weekday.

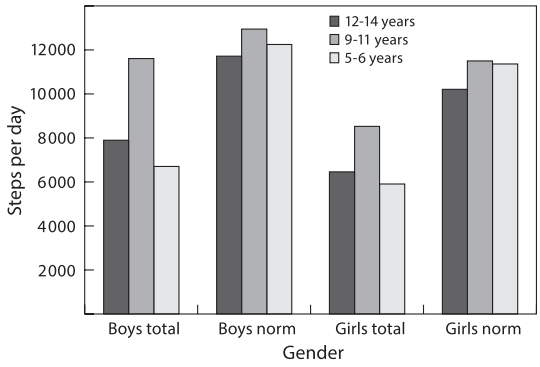

Figure 2: A comparison of this study population's mean step counts (boys' total and girls' total) with the CANPLAY data norms (boys' norm and girls' norm) for different age groups.[9]

Spearman correlation statistics were applied to examine the association between physical activity and BMI. Table 3 summarises the Spearman correlation coefficient and probability of a correlation between physical activity (as measured by total steps) and BMI. This was done for the whole group and by gender.

Only weak with no statistically significant associations were found. This is, however, a small study population; to draw conclusive results about the correlation between physical activity and BMI a bigger sample size is needed.

Discussion

This study described the physical activity of boys and girls, from three different age groups, living in a small rural South African town.

Results from the current study indicated an increase in activity for both boys and girls from group C to Group B followed by a decrease in the physical activity of Group A, although group A's girls tend to be more aerobically active than the younger girls. The trend that boys are more active than girls ($p = 0.045$ and $p = 0.005$ respectively for groups A and B) is also supported by a South African study done with similar age groups; 11–12 and 14–15 years of age respectively.[10]

There are also large differences between the three age groups' pedometer step count, not reflected in the CANPLAY normative data.[9] Vincent and Pangrazi, also using pedometers, reported significant differences between boys and girls (12 300 to 13 989 steps per day for boys versus 10 479 to 11 274 steps per day for girls).[11]

Table 3: Spearman correlation coefficient (r_s) and the statistical significance of the coefficient

Group	Boys	Girls
Group A (*p*-value)	0.486 (0.094)	–0.249 (0.320)
Group B (*p*-value)	–0.189 (0.557)	–0.049 (0.849)
Group C (*p*-value)	0.262 (0.531)	–0.333 (0.381)
Total (*p*-value)	–0.142 (0.430)	–0.195 (0.198)

Canadian children in the same age groups (CANPLAY) (Figure 2).[9] This study, the largest and most comprehensive set of sex- and age-specific normative reference data for children's and adolescents' pedometer-determined physical activity to date, was done between 2005 and 2011 on 21 271 children (5–12 years) and 12 956 adolescents (13–19 years) and correlates with other international reference literature on the normative values for physical activity. A pedometer, equivalent to the pedometer used in this study, was used in the CANPLAY study. Figure 2 shows that this rural study population's step counts were far lower than the CANPLAY data norms.

The 9- to 11-year-old boys, who were the most active group of this study, gave an average of 11 601 steps per day, compared with the 9–11-year-old CANPLAY boys who took an average of 12 940 steps. Children in the 5–6-year-old age group lack the most physical activity compared with their Canadian counterparts (i.e. 6 704 steps per day for the boys and 5 906 steps per day for the girls compared with 12 242 steps and 11 361 steps per day for the CANPLAY children).

Some contextual South African environmental circumstances influencing the time children spent being physically active, which were verbally and informally collected, were provided by the children's parents. These reasons are supported by Kruger et al. and include urbanisation of the population resulting in smaller houses with limited outdoor space, safety concerns for children in an urbanised environment, and the costs of daily living, which result in both parents working and spending minimal time with their children.[12]

When comparing the activity measured in this rural group of Southern African children with that of normative international reference data,[9] it is clear that the children in this study lag far behind, with the children in group C lagging the most. A comparison between these rural 9–11-year-old South African children (predominantly Caucasian children) and 9–12-year-old children from rural Kenya (only black African children), also indicated that the rural Kenyan children are more active than this study group (14 700 +/– 521 versus 11 601 +/– 2 454).[13] This trend is supported by Craig et al.; they reported high activity volume

but low-intensity physical activity levels in rural South African children (black African children) with the results also not meeting international physical activity recommendations.[5]

Anthropometric variables used to classify the study population according to the IOTF cut-offs for thinness and obesity in children indicated that, in the three age groups, girls tend to be 1.2 times more likely to be classified as obese than boys, but no statistical correlation could be established between physical activity and adiposity.

This study's investigators recommend that the relatively high activity of the age group 9 to 11 may be the ideal platform to focus gender-specific intervention programmes to increase physical activity in South African children. The fact that such a great gap exists between activity displayed by Group A and Group B girls may point to the ideal age to start organised intervention programmes to counteract the obesity prevalence of 30% in South African women older than 15 years.[14] The fact that the girls' aerobic time increased through the different age groups and the fact that girls tend to be more aerobically active the older they get may indicate the potential for further increases when encouraged and motivated by intervention programmes.

Limitations and comments

Because no single measure is able to accurately assess all types of physical activity, the use of a pedometer, a practical, relatively inexpensive tool, is a suitable alternative to objectively assess physical activity in children (> 5 years). However, its level of accuracy is dependent on the walking pace and the relative intensity of the activities. Pedometers may undercount steps, especially at slower walking speeds.[6] These facts may influence the results in this study, especially those obtained for smaller children (Group C).

As this study's aim was to describe the physical activity measured in boys and girls from section 21, quintile 5 pre-primary and primary schools in a small rural South African town, no preference as to race was used in the selection process for the sample group and therefore there is an unequal distribution in the sample groups. The sample groups are a true representation of the racial makeup of the school and the town where the study was conducted.

Because of logistics (i.e. limited number of children available) and limited resources (i.e. pedometers), a sample of convenience was chosen. This resulted in age groups of 30 children, a relative small sample size compared with other studies. The data captured by the pedometers reflected that the children wore the pedometers for the recommended time each day. The period of seven days during which the children wore the pedometers was chosen to fall in the middle of a school semester, i.e. during normal semester sport and recreational activities.

The children were provided with unsealed pedometers (i.e. no restriction on participants viewing their step count), and therefore reactivity (i.e. activity changes as a result of wearing the pedometer) could influence the validity of the study results. To improve the chances of valid results, a seven-day study design was used as no reactivity was reported in a meta-analysis by Clemes et al.[15] No reactivity was observed in the statistical analysis.

No major problems were reported by the children or their parents/legal guardians. Breakage of the clamp of the pedometer and pedometers getting detached from the clothes (especially in the lower age group) were the only minor problems reported.

Conclusions

Gender and age influence the activity of this group of South African children. Boys in the age group 9–11 years tend to be more physically and aerobically active than older boys (12–14 age group) and younger boys (5–6 years), but girls tend to be more aerobically active the older they get, although their daily activity level declines with age. Results indicated that this group of rural children's physical activity levels are far lower than the recommended international levels. The analyses of the pedometer data indicate that there is no correlation between physical activity and adiposity.

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Conflict of interest – The authors declare that they have no financial or personal relationship(s) which may have inappropriately influenced them in writing this paper.

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