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Author(s)	John Chee Keng Wang, Woon Chia Liu, Koon Teck Koh and Coral Boon San Lim
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新加坡小學、中學、與高中學生體育活動的參與比較

王志慶
新加坡國立教育學院體育教學及運動科學系教授
劉文佳
新加坡國立教育學院體育教學及運動科學系副教授
許坤德　林文珊
新加坡國立教育學院體育教學及運動科學系助理教授

本文的研究目的主要是描述與分析新加坡小學、中學、與高中學生體育活動的參與。體育活動是以計步器計算。本研究以 571 名新加坡小學、中學、與高中學生為調查對象。收集了五天正常上課日和一個週末日的計步。研究結果發現除了課外活動時間，三個年紀的男生都比女生活躍。除此，小學生也比中學和高中學生較為活躍。研究結果證實男生比女生活躍，但是，這個差距會隨著他們成長而降低，到了高中，男生和女生同樣不活躍參與體育活動。

關鍵詞：計步器、體育活動、計步、少年、兒童

Differences in Daily Step Counts among Primary, Secondary, and Junior College Students

John Chee Keng WANG
Professor, Physical Education and Sports Science, National Institute of Education, Singapore
Woon Chia LIU
Associate Professor, Physical Education and Sports Science, National Institute of Education, Singapore
Koon Teck KOH　Coral Boon San LIM
Assistant Professor, Physical Education and Sports Science, National Institute of Education, Singapore

The purpose of this study is to describe and analyse the physical activity patterns measured through pedometers among primary, secondary, and college students. A sample of 571 school children wore pedometers for 5 consecutive weekdays and one weekend day. Results showed that male students were more active than female students across all categories, except during co-curricular activity (CCAs). Primary school students were more active than secondary school and college students. Taken together, the findings of this study support the idea that, as children get older, the differences between boys and girls reduce drastically until the college level, at which point boys are equally as inactive as girls.

Keywords: pedometer, physical activity, step count, adolescents, children

Correspondence concerning this article should be addressed to John Chee Keng WANG, Blk 5 #03-28, Physical Education and Sports Science, National Institute of Education, 1 Nanyang Walk, Singapore 637616; email: john.wang@nie.edu.sg

Physical inactivity has become a serious problem among developed countries such as Mexico, the United States, Scotland, Spain, and Italy. In Mexico, 30% of the adult population is obese, and 70% is overweight. In America, 28% of the adult population is obese, and 68% is overweight (WHO, 2008). The proportion of obesity may have reached an epidemic level. In Singapore, the obesity rate has increased from 5.1% in 1992 to 10.8% in 2010 for Singaporeans aged 18 to 69 years old. This is only 1.2% lower than the global average obesity prevalence of 12%. Since the pattern of physical inactivity or "sedentism" begins early in life, many governments see encouraging regular physical activity in young people as a central goal (e.g., The Class Moves in Wale, Project ACES in USA, Healthy Lifestyle Campaign in Singapore).

A few common findings have emerged from the literature on physical activity among young people. We know that physical activity participation declines through adolescence (Myers et. al, 1996) and that the decline is greater in girls than in boys (Sallis et. al, 1997; Gorely et. al, 2007). One recent study from Singapore found that young people from different countries have significantly different patterns of physical activity and sedentary behavioural patterns (Wang et. al, 2006). Almost all of the previous studies are from Western countries; studies from Asia are scare. Many school-based intervention programmes from Western countries such as Project SPARK (Sports, Play, and Active Recreation for Kids) and CATCH in the United States (Child and Adolescent Trial for Cardiovascular Health, by McKenzie, Sallis, and colleagues) have reported success in increasing physical activity participation among school children (Sallis et. al, 1997; Wang et. al, 2006). Since school-based interventions targeted at increasing physical activity can be beneficial, it is important to know more about the breakdowns of physical activity patterns in different phases of the day such as commuting to school, in school, during co-curricular activities (CCAs), after school, and weekends. This is currently lacking in the literature. The purpose of this study is to describe and analyse the differences in physical activity patterns as indicated by step counts of primary, secondary, and college students.

Method

Participants

A sample of 571 school children from 10 to 18 years old from 11 schools took part in the study. There were 190 primary school students, 176 secondary school students, and 205 junior college students. There were 237 boys and 332 girls. Among the total sample, 103 were school athletes, and 465 were non-athletes. The students were attending Primary Four level to junior college Year Two in the Singapore school system. The university Institutional Review Board granted approval for the study. Subsequently, school principals were approached with a formal letter requesting informed consent for the study. The heads of department for physical education were then contacted to arrange for the study. All participants were told that their participation in the study was voluntary, and they were free to withdraw at any time.

Instruments

The Yamax DIGI Walker SW-200 pedometer was used to assess physical activity for this study. This pedometer is considered to be a reliable and valid instrument for assessing children's physical activity levels. Pedometers exhibiting +/- 5% error on a walking test and pedometers within +/- 1% error during a shake test were included in the study. All pedometers met these criteria.

Procedures

Two research assistants were present at the school throughout the duration of the study. The participants were taught the correct way to wear the pedometers and were allowed to practice and become familiar with the pedometers during physical education lessons prior to the study. Each participant completed three 20-count step tests to check the accuracy and position of the pedometers. Afterwards, the participants wore the pedometers for two consecutive school days for practice to reduce potential effects of novelty and reactivity before the actual study.

During the actual study, participants were told to wear the pedometers for a week (7 days) at all times except while sleeping, showering, or doing water activities. Participants were given a log card to record the step counts at four time points during weekdays: when they arrive in class in the morning, at the end of the last period in school, just before they leave school, and at the end of the day before sleep. For the weekends, they simply recorded the step counts at the end of the day.

Research assistants were present at the start of the school day and just before the last period to remind the participants to record their step counts. Participants who were absent from school or fell ill for any of the days were not included in the study because this would affect their step counts. Data were also deleted if participants indicated to the research assistant that they failed to wear the pedometer for the entire day.

Data Treatment and Analysis

In the initial treatment of the data, the data was scanned for extremely high or low values and missing cases. Cases with extremely high step counts per day (> 40,000 steps) were deleted (n = 33). The five weekdays and the two weekend scores were averaged for each category. Descriptive statistics were computed for the overall sample. A one-way multivariate analysis of variance (MANOVA) was conducted with gender, athletic status, and grade level as the independent variables and step counts as the dependent variables (steps to school, steps in school, steps in CCAs, steps after school, and steps in weekend).

Results

Table 1 shows the means and standard deviations of the step counts in the five categories of overall sample, as well as the breakdown by gender and athletic status. The Cronbach's alpha score for all the weekdays was .78, indicating that the step counts were reliable. The correlations between the weekday and weekend means were much lower (r = .40 to .51).

Table 1: Mean Steps / Day of the Overall Sample by Gender and Athletic Status (SD in parentheses)

Category	Overall	Male	Female	Athletes	Non-Athletes
To-School	1191.07 (959.88)	1243.98 (1105.38)	1156.56 (870.23)	1362.22 (1317.39)	1155.13 (877.88)
In-School	2346.00 (1439.65)	2632.96 (1731.88)	2048.24 (912.69)	2207.65 (1529.66)	2306.85 (1298.87)
In CCA	2194.24 (1560.93)	2233.09 (1563.77)	2072.98 (1487.75)	2368.42 (1899.57)	2087.82 (1421.10)
After School	4760.22 (2680.39)	5216.42 (3108.16)	4446.29 (2292.65)	5425.52 (2943.24)	4612.20 (2602.67)
Weekend	9610.54 (4771.16)	10614.72 (5407.14)	8911.68 (4147.98)	10351.81 (5121.90)	9455.05 (4683.99)

In general, the descriptive statistics show that boys accumulated more steps in all categories and athletes recorded more steps to school, in CCAs, after school, and during weekends. Among the three educational levels, primary school children accumulated more steps to school, in school, and during weekends (Table 2). Secondary school students were more active after school. College students had the lowest step counts in most of the categories (to school, in school, after school, on the weekend).

The results of the one-way MANOVA showed main effects of gender Wilks' Λ = .931, $F(5, 521) = 7.77$, $p < .001$, $\eta^2 = .07$, athletic status Wilks' Λ = .956, $F(5, 521) = 4.85$, $p < .001$, $\eta^2 = .04$, and grade level Wilks' Λ = .805, $F(10, 1042) = 11.97$, $p < .001$, $\eta^2 = .10$. There was interaction between gender and grade level Wilks' Λ = .939, $F(10, 1042) = 3.33$, $p < .001$, $\eta^2 = .03$. No other interaction effects were found.

Follow-up ANOVAs for gender showed that male students were more active than female students across all categories (all *p*s < .05), except during CCAs, where there was no difference. In terms of athletic status, school athletes were more active than non-athletes after school. There were no significant differences between athletes and non-athletes in walking to school, in school, in CCAs, or the weekend.

In terms of grade level, ANOVA results showed significant differences among the primary, secondary, and college students in all five categories of steps (Table 2). Primary school students were more active than secondary school and college students while walking to school, in school, and during weekends. Primary school students were as active as college students during CCAs, compared to the secondary students. The differences between college students and primary/secondary student were the largest after school and during weekends.

Table 2: Mean Steps / Day by Educational Level (SD in parentheses)

Category	Primary	Secondary	College	*F* (2, 525)	η^2
To-School	1414.40_a (1408.11)	1109.77_b (679.02)	1065.21_b (624.34)	12.15**	.04
In-School	2953.47_a (1465.77)	2089.76_b (1195.21)	1873.16_b (1106.51)	33.07**	.11
In CCA	2306.67_a (1543.70)	1700.92_b (1291.17)	2352.94_a (1605.77)	8.03**	.03
After School	5001.45_a (2851.77)	5345.91_a (2947.99)	4054.24_b (2076.68)	11.76**	.04
Weekend	11135.34_a (4841.52)	9538.37_b (4603.94)	8331.42_c (4474.34)	12.79**	.05

Note: Means in the same row with different subscripts differ significantly at $p<0.05$ in the Tukey HSD comparison.
** $p < .05$.

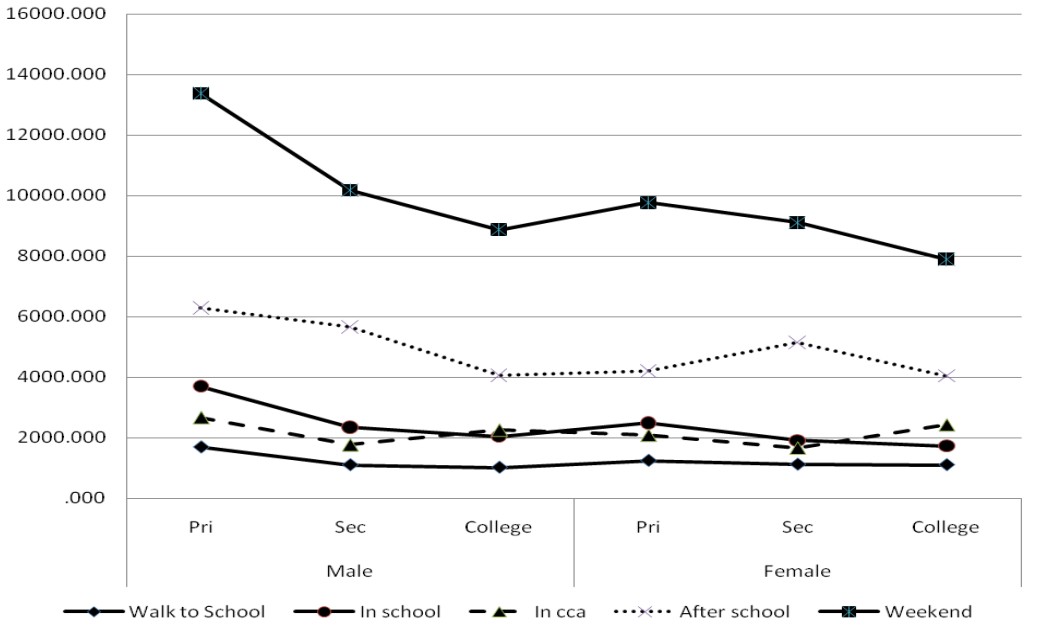
We more closely examined the interaction effects of gender by grade level in step counts and found a consistent pattern: Female primary school students took significantly fewer steps than their male counterparts in all five categories. The gender differences were much smaller among the secondary school students. At the college level, female students were more active than male students while walking to school and during CCAs (Figure 1).

Discussion

The main purpose of this study was to compare the physical activity patterns of children in primary school, secondary school, and junior college. There are several interesting findings from this study in light of previous studies (McKenzie et. al, 1997; Flohr, 2006). Among primary school students, Singaporean school students were more active than their American counterparts living in the inner-city (Flohr, 2006). The average daily recorded steps in the current study were 14,359 ± 4,385 for primary school boys and 10,036 ± 2,955 for primary school girls, compared to Johnson and colleagues' US findings of 12,589 ± 3,921 for boys and 9,539 ± 3,135 for girls. There were no corresponding data for older children.

The findings are consistent with the literature in that both boys and girls across all age groups have different patterns of physical activity (Wang et. al, 2006; Johnson et. al, 2010). This study found that, in general, boys are more active than girls, and younger children are more active than older children. School athletes tended to be more active than non-athletes, particularly after school. The findings of this

Figure 1: Step counts of students by gender and level



study are generally consistent with previous studies (McKenzie et. al, 1997; Wang & Liu, 2007; Gorely et. al, 2009).

One strong contribution of this study is its analysis of physical activity patterns in different time periods. This study provides data for step counts of young people walking to school, in school, in CCAs, after school, and during weekends. The three categories that had the lowest step counts were walking to school, in school, and in CCAs, in contrast to after school and during the weekend. Interventions trying to increase step counts while children walk to school and during CCAs are needed to increase the physical activity of young people. For example, programmes could focus on encouraging students to alight one bus stop early and walk the rest of the way to school. Programmes could also encourage parents to drop their children about half a kilometre away from school and let their children walk the rest of the way to school. When the children are in the school, increasing recess time and physical education periods may increase levels of physical activity.

Another contribution of this study to the literature is the finding of gender differences in physical activity across different age groups. At the primary school level, boys were more active than girls in walking to school, in CCAs, and after school. At the secondary level, the differences between the boys and girls reduced significantly, and there was no difference between the two genders in walking to school.

At the college level, boys were equally as inactive as the girls after school, and they were less active than the girls in CCAs and walking to school. It appears that the concern should be on the steep decrease in boys' step counts from primary school to secondary and college.

There are a few limitations of this study. First, the data for walking to school did not differentiate between walking to school or activities before school. A student may arrive to school early and play on the playground before class or walk to school from home. Second, the step count in school did not differentiate between step counts in physical education classes and normal lessons. Third, this was a cross-sectional study with a small sample size. Therefore, a multilevel analysis was not possible. Future studies should examine the hierarchical nature of the data in terms of class, level, and school effects.

Key Points

- Taken together, the findings of this study support the idea that boys are more active than girls, and younger children are more active than older children.
- School athletes tended to be more active than non-athletes after school. In the older children, the differences between the boys and girls were drastically reduced, and, at the college level, boys were equally as inactive as girls.
- It is important for practitioners to examine the reasons for the steep decrease in boys' step counts from primary school to secondary school and college while designing interventions to increase physical activity while walking to school, in school, and during CCAs.

Reference

WHO (2008). World Health Statistics 2008. In: *Organisation WH* (Ed). WHO Press.

Myers, L., Strikmiller P. K., Webber, L. S., & Berensen, G. S. (1996). Physical and sedentary activity in school grades 5-8: The Bogalusa Heart Study. *Medicine and Science in Sports and Exercise, 28*, 852-859.

Sallis, J. F., McKenzie, T. L., Alcaraz, J. E., Kolody, B., Faucette, N., & Hovell, M. F. (1997). The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. *American Journal of Public Health, 87*, 1328-1334.

Gorely, T., Marshall, S. J., Biddle, S. J. H., & Cameron, N. (2007). Patterns of sedentary behaviour and physical activity among adolescents In the United Kingdom: Project STIL. *Journal of Behavioral Medicine, 30*, 521-531.

Wang, C. K. J., Chia, M., Quek, J. J., & Liu, W. C. (2006). Patterns of physical activity, sedentary behaviours and psychological determinants among Singaporean school children. *International Journal of Sport & Exercise Psychology, 4*, 227-249.

McKenzie, T. L., Sallis, J. F., Kolody, B., & Faucette, F. N. (1997). Long-term effects of a physical education curriculum and staff development program: SPARK. *Research Quarterly for Exercise and Sport, 68*, 280-291.

Flohr, J. A., Todd, M. K., & Tudir-Locke, C. (2006). Pedometer-assessed physical activity in young adolescents. *Research Quarterly for Exercise and Sport, 77*, 309-315.

Johnson, T. G., Brusseau, T. A., Darst, P. W., Kulinna, P. H., & White-Taylor, J. (2010). Step counts of non-white minority children and youth by gender, grade level, race/ethnicity, and mode of school transportation. *Journal of Physical Activity and Health, 7*, 730-736.

Wang, C. K. J., & Liu, W. C. (2007). Promoting enjoyment in girls' physical education: The impact of goals, beliefs, and self-determination. *European Physical Education Review, 13*, 145-164.

Gorely, T., Biddle, S. J. H., Marshall, S. J., & Cameron N. (2009). The prevalence of leisure time sedentary behaviour and physical activity in adolescent boys: An ecological momentary assessment approach. *International Journal of Pediatric Obesity, 4*, 289-298.

Le Masurier, G. C., Beighle, A., Corbin, C. B., Darst, P. W., Morgan, C., & Pangrazi, R. P. (2005). Pedometer-determined physical activity levels of youth. *Journal of Physical Activity and Health, 2*, 159-168.