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# ASSESSMENT OF PHYSICAL ACTIVITY BY PEDOMETER IN POLISH PRESCHOOL CHILDREN

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ABSTRACT
**Purpose.** The aim of the study was to evaluate and compare the physical activity patterns of preschoolers aged 6–7 years. **Methods.** A sample of 221 preschool children (116 boys and 105 girls) aged 6 (5.92 ± 0.30) and 7 (6.91 ± 0.25) years was recruited. Physical activity was assessed over 7 consecutive days by using pedometers to determine step counts (steps/day). Accrued anthropometric data included height, mass, and BMI. Data were compared with ANOVA to determine any significant differences between age and sex groups and the part of the week (weekday/weekend); intergroup differences were evaluated with Fisher's LSD test. A < 0.05 level of significance was adopted for all statistical tests. **Results.** No significant differences were found between the age groups (6- and 7-year olds). Physical activity over the 7-day period was significantly greater in the boys (13318 ± 2354 steps/day) than girls (12300 ± 2750 steps/day). Mean weekday step counts were greater among boys (13800 ± 2458 steps/day) than girls (12587 ± 2802 steps/day); this difference was statistically significant. Mean weekend steps were 12112 ± 3467 and 11579 ± 3930 steps/day for the boys and girls, respectively. Mean weekday steps were significantly greater ($p < 0.001$) than mean weekend steps in both groups. The recommendation of 12000 steps/day was met by 60.6% of the sample (69.0% boys, 51.4% girls). **Conclusions.** Sex differences in physical activity patterns were observed in the sample of preschool children. Boys, compared with girls, were characterized with a higher physical activity level on both weekdays and weekend days. Physical activity for both sexes was lower on weekend days than weekdays. The results indicate the need for improved health literacy among parents on current recommended physical activity guidelines and the suitability of a pedometer-based assessment method.

**Key words:** physical activity, pedometers, preschool children

## Introduction

Physical activity is essential to health and normal development. It is known to reduce the risk of cancer and cardiovascular disease by neutralizing the negative effects of contemporary life and associated lifestyle diseases [1, 2]. Physical activity is one of the most effective measures in the prevention and treatment of overweight and obesity in various age groups [3–5]. Due to the rapidly increasing number of individuals with excess body weight, there is a resurgence of interest by researchers on physical activity and associated issues.

Common methods of measuring physical activity are questionnaires or participant observation, although both are limited to a comparatively subjective assessment of the relevant behavior. More reliable and accurate measurements can be gained through the use of various monitoring devices. These include pedometers (step counters) and accelerometers, the latter of which can provide additional data on daily activity [6, 7]. A result of improved accessibility and cost, the use of pedometers and accelerometers in clinical research has significantly increased over the past decade [8–13]. According to Gabel et al. [14], thse types of devices that can count daily steps can serve as a broad monitoring tool of physical activity in different populations. A similar view was also expressed by Tudor-Locke et al. [13] in reviewing data accrued by previous studies so as to determine recommended levels of physical activity in children and adolescents.

Current physical activity guidelines for developing youth recommend at least 60 min of moderate-to-vigorous physical activity per day [15, 16]. Research on using pedometers in the assessment of physical activity has translated this recommendation into a suggested minimum number of steps per day. Colley et al. [17] compared physical activity levels with step counts of three youth age groups (6–10, 11–14, 15–19 years) and recommended a target of 12000 steps/day for both sexes. Vincent and Pangrazi [18] determined a standard of 11000 steps/day for female and 13000 steps/day for male children order to meet physical activity guidelines. In turn, Tudor-Locke et al. [19] considered the dramatic rise of overweight and obesity among children and adolescents to recommend minimum step counts of 12000 steps/day for girls and 15000 steps/day for boys. For younger children aged 3–5 years, Gabel et al. [14] adopted a recommended physical activity level of at least 6000 steps/day.

Surprisingly, despite the worldwide interest in physical activity levels and minimum quantitatively-based cut points in a wide range of populations and age groups, there is a lack of research in Poland on this issue. In par-

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ticular, there is no data of this nature of the preschool-age population. Therefore, the aim of the present study was to evaluate and compare the physical activity patterns of Polish preschoolers aged 6–7 years.

## Material and methods

Data was collected from a sample of 221 healthy children (116 boys and 105 girls) aged 6 (5.92 ± 0.30) and 7 (6.91 ± 0.25) years attending local preschools from the city of Wrocław, Poland. Physical activity was measured using a HJ-113 pedometer (Omron, Japan) positioned at the waist. Measurements were recorded over 7 consecutive days during a normal week in June 2010. The pedometer was attached to the waist immediately after waking and removed before lying down to sleep.

Participation in the study was voluntary; parents or guardians provided their informed consent and received detailed instructions on how to assess their child's physical activity throughout the day as well as a special form to detail daily physical activity besides continuous monitoring by the pedometer over the 7 day period. Physical activity was assessed for the entire week and separately for weekdays (Monday to Friday) and weekend days (Saturday and Sunday). This was done to take into account the influence of different environmental factors in which participants spent the majority of their time in preschool (weekdays) or under the care of their immediate family (weekend). A cut point of 12000 steps/day was adopted for both sexes to determine if recommended levels of daily physical activity were adhered [17].

Body height and mass were measured and used to calculate body mass index (BMI). These measurements were taken in the morning wearing lightweight clothing without footwear. Body height was measured with a stadiometer (GPM, Switzerland) accurate to 0.1 cm. Body mass was assessed using a MC-180 MA body composition analyzer (Tanita, Japan) accurate to 0.1 kg.

All statistical analyses were performed with Statistica 9.0 software (Statsoft, Poland). Basic descriptive statistics were calculated for all variables and included the mean, median, standard deviation, and minimum and maximum values. Data were compared with analysis of variance (ANOVA) to test for significant differences between the age and sex groups for physical activity level (step counts) and day of the week (weekday/weekend day); intergroup differences were evaluated post hoc with Fisher's Least Significant Difference (LSD). Significance was set at $p < 0.05$ level for all tests.

Financial support was provided by the Polish Ministry of Science and Higher Education Senate Ethics and ethics approval obtained from the Ethics Committee for Scientific Research of the University of Physical Education in Wrocław, Poland.

## Results

Descriptive characteristics of the study population are presented in Table 1. As no significant differences between the step counts of the 6-year-olds and 7-year-olds were found, the sample was treated as homogeneous and analyzed only by sex. Further analysis revealed no statistically significant differences between the boys and girls for height, weight, and BMI.

The effect of sex on step count was analyzed for the entire interval under study (7 consecutive days) and also for weekdays, weekend, and the individual days of the week. MANOVA indicated statistically significant differences between these time periods ($F = 35.150$, $p < 0.001$).

Significant differences ($p = 0.012$) were observed between the girls ($\bar{x} = 12299$ steps/day) and boys ($\bar{x} = 13318$ steps/day) for step counts over the entire 7-day period (Figure 1). Greater significant between-sex differences ($p = 0.029$) were found in weekday than weekend step counts. For mean weekday steps, the girls averaged 12587 ± 2802 steps/day whereas the boys achieved 13800 ± 2458 steps/day (Figure 2). In turn, the difference between the girls ($\bar{x} = 11579$ steps/day) and boys ($\bar{x} = 12112$ steps/day) for mean weekend steps were not significant ($p = 0.188$) (Figure 3). Mean weekday step counts were significantly greater ($p < 0.001$) than mean weekend steps for both girls and boys.

The mean number of steps for each day of the week is presented in Figure 4. Daily step count peaked in the middle of the workweek in both the boys and girls, whereas on weekend days the mean number of steps dropped to some of the lowest recorded values. When comparing day-to-day step counts, significant differences

Table 1. Descriptive characteristics of the sample

| | 6-year-olds (5.92 ± 0.30 years) | | 7-year-olds (6.91 ± 0.25 years) | |
|---|---|---|---|---|
| | Girls ($n = 72$) $\bar{x} \pm SD$ | Boys ($n = 67$) $\bar{x} \pm SD$ | Girls ($n = 33$) $\bar{x} \pm SD$ | Boys ($n = 49$) $\bar{x} \pm SD$ |
| Body height (cm) | 116.8 ± 5.30 | 115.6 ± 4.93 | 124.2 ± 4.82 | 124.4 ± 5.94 |
| Body mass (kg) | 20.8 ± 2.96 | 20.7 ± 2.76 | 25.1 ± 4.02 | 24.6 ± 3.66 |
| BMI (kg/m²) | 15.2 ± 1.35 | 15.5 ± 1.29 | 16.2 ± 1.66 | 15.8 ± 1.58 |
| Daily step count (steps/day) | 12160 ± 2844 | 13175 ± 2219 | 12602 ± 2550 | 13513 ± 2538 |

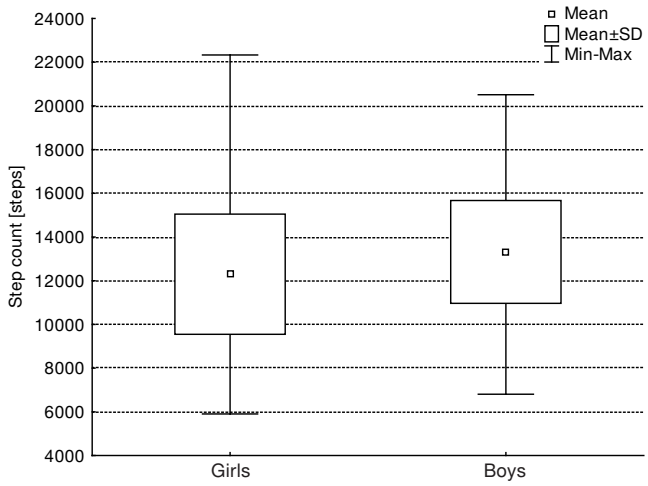


Figure 1. Mean week step counts (7-day week); difference between boys and girls significant at $p < 0.05$

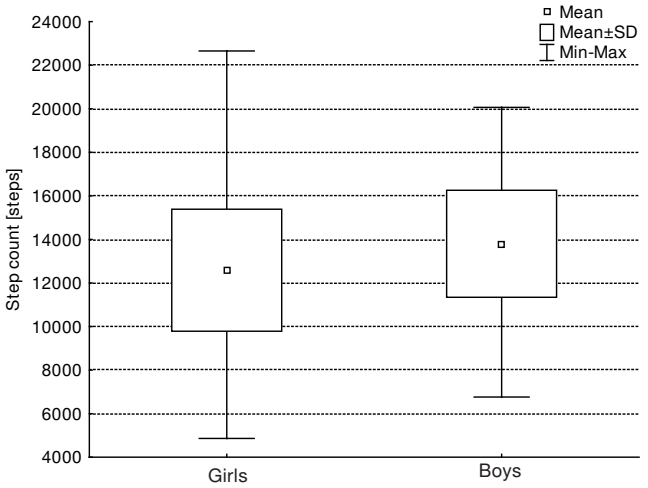


Figure 2. Mean weekday step counts (Monday–Friday); difference between boys and girls significant at $p < 0.05$

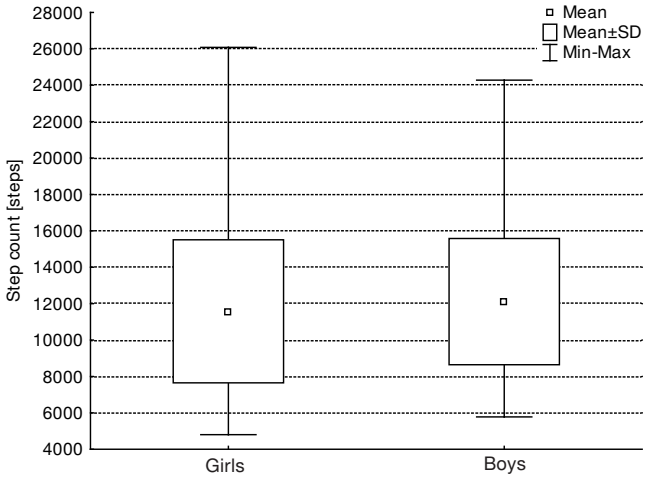


Figure 3. Mean weekend step counts (Saturday–Sunday); difference between boys and girls not significant at $p > 0.05$

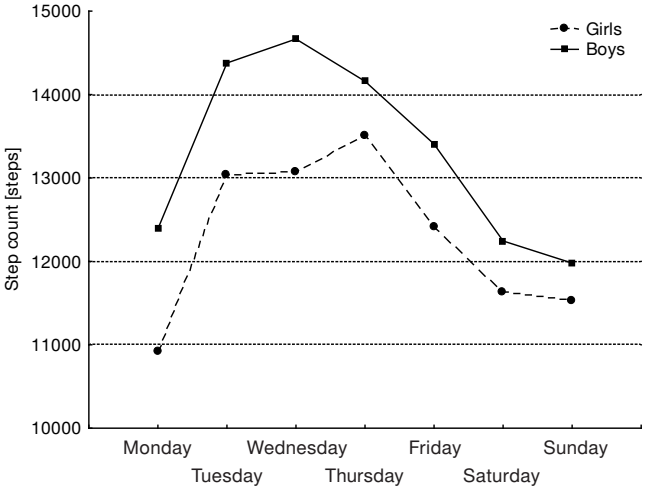


Figure 4. Daily step counts (day of the week)

between the sexes were observed in the first three days of the week (Monday–Wednesday) in favor of the boys.

Adherence to the recommended level of physical activity for this age group, identified as 12000 steps/day [17], was achieved by 60.6% of the sample (69.0% boys, 51.4% girls) when step count was averaged over the 7-day week.

## Discussion

Several differences were found in the activity levels of the Polish boys and girls which indicated that preschool males are more active. Over the week under study, mean daily step counts were 12299 for girls and 13318 for boys. Both this difference and the one noted for mean weekday steps were statistically significant. While a trend was observed towards larger mean weekend step counts among boys, the difference was not significant when compared with the mean weekend steps of girls. Nonetheless, it can be inferred that weekday step count is a better measure of physical activity and indicator for between-sex comparisons due to the uniform conditions provided by children attending preschool.

Colley et al. [17] also found differences in the mean daily step counts of boys and girls in a sample of Canadian children aged 6–10 years. Furthermore, Canadian girls showed slightly lower (11728 steps/day) and Canadian boys similar (13274 steps/day) physical activity levels compared with the present sample of Polish children.

Greater physical activity was observed among boys than girls by Telford et al. [20] in Australian children aged 8 years (12014 vs. 10552 steps/day, respectively). Similar to the present findings, Telford et al. found weekly patterns in physical activity over the 5-year period of study, in which less daily physical activity was performed on weekend days than weekdays. This research group and others concluded that monitoring daily step counts may

be useful in creating more specific strategies to increase the physical activity of children in various age groups [20, 21]. Younger children, in particular, achieve lower step counts. In a population of Belgian 4–5 year olds, Cardon and Bourdeaudhuij [22] recorded a daily mean step count of 9980 with minimal sex differences (girls 9867 vs. boys 10121 steps/day). Gabel et al. [14] presented a similar daily step count (9886) in a sample of 5-year-old preschoolers.

Due to the significant differences in the physical activity patterns of children aged up to 5 years of age and those 6 years and older, we feel it is appropriate to define age-appropriate guidelines and support the recommendations of Gabel et al. [14] of 6000 steps/day for children ages 3–5 and Colley et al. [17] of a cut point of 12000 steps/day for those 6–10 years (as adopted in the present study).

While compliance with the recommended amount of physical activity was achieved by 60.6% of our sample of Polish 6- and 7-year-olds (51.4% girls, 69.0% boys), the analysis of Canadian children by Colley et al. [17] indicated that only 45.6% of girls and 54.4% of boys aged 6–10 years adhered or exceeded the 12000 steps/day target and led them to recommend a more targeted health-promotion policy to increase the physical activity levels of children and youth.

## Conclusions

1. Differences between the sexes are observed in the physical activity of preschool children. Boys, compared with girls, were characterized with a higher physical activity level on both weekdays and weekend days.

2. Physical activity (step counts) on weekend days was lower than on weekdays in both sexes. The results may indicate the need for improved health literacy among parents recommended physical activity guidelines and suitable measurement methods.

3. The recommendation of 12000 steps/day was achieved by 60.6% of the sample (69.0% boys, 51.4% girls) when step counts were averaged over the 7-day week. Based on the present data, intervention efforts should be introduced already at the preschool age to promote physical activity and introduce age-appropriate health literacy on the benefits on regular exercise.

## References

1. Williams M.A., Haskell W.L., Ades P.A., Amsterdam E.A., Bittner V., Franklin B.A. et al., Resistance exercise in individuals with and without cardiovascular disease: 2007 update: a scientific statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism. *Circulation*, 2007, 116 (5), 572–584, doi: 10.1161/CIRCULATIONAHA.107.185214.
2. Kushi L.H., Byers T., Doyle C., Bandera E.V., McCullough M., McTiernan A. et al., American Cancer Society Guidelines on Nutrition and Physical Activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin*, 2006, 56 (5), 254–281, doi: 10.3322/canjclin.56.5.254.
3. Drygas W., Jegier A., Bednarek-Gejo A., Kwaśniewska M., Dziankowska-Zaborszczyk E., Kostka T., Physical activity volume as a key factor influencing obesity and metabolic syndrome prevalence in middle-aged men. Long-term prospective study [in Polish]. *Przegląd Lekarski*, 2005, 62 (3), 8–13.
4. Ford E.S., Kohl H.W., Mokdad A.H., Ajani U.A., Sedentary behavior, physical activity, and the metabolic syndrome among U.S. adults. *Obesity Research*, 2005, 13 (3), 608–614, doi: 10.1038/oby.2005.65.
5. Carnethon M.R., Loria C.M., Hill J.O., Sidney S., Savage P.J., Liu K., Risk factors for the metabolic syndrome: The Coronary Artery Risk Development in Young Adults study (CARDIA) study, 1985–2001. *Diabetes Care*, 2004, 27 (11), 2707–2715, doi: 10.2337/diacare.27.11.2707.
6. Colley R.C., Garriguet D., Janssen I., Craig C.L., Clarke J., Tremblay M.S., Physical activity of Canadian children and youth: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep*, 2011, 22 (1), 15–23.
7. Riddoch C.J., Mattocks C., Deere K., Saunders J., Kirkby J., Tilling K. et al., Objective measurement of levels and patterns of physical activity. *Arch Dis Child*, 2007, 92 (11), 963–969, doi: 10.1136/adc.2006.112136.
8. Craig C.L., Cameron C., Tudor-Locke C., CANPLAY pedometer normative reference data for 21,271 children and 12,956 adolescents. *Med Sci Sports Exerc*, 2013, 45 (1), 123–129, doi: 10.1249/MSS.0b013e31826a0f3a.
9. Harmon J., Brusseau T. A., Collier D., Lenz E., Habitual physical activity patterns of inner-city children. *Hum Mov*, 2013, 14 (4), 305–309, doi: 10.2478/humo-2013-0036.
10. Vander Ploeg K.A., Kuhle S., Maximova K., McGavock J., Wu B., Veugelers P.J., The importance of parental beliefs and support for pedometer-measured physical activity on school days and weekend days among Canadian children. *BMC Public Health*, 2013, 13, 1132, doi: 10.1186/1471-2458-13-1132.
11. Beets M.W., Bornstein D., Beighle A., Cardinal B.J., Morgan C.F., Pedometer-measured physical activity patterns of youth: a 13-country review. *Am J Prev Med*, 2010, 38 (2), 208–216, doi: 10.1016/j.amepre.2009.09.045.
12. Laurson K.R., Eisenmann J.C., Welk G.J., Wickel E.E., Gentile D.A., Walsh D.A., Evaluation of youth pedometer-determined physical activity guidelines using receiver operator characteristic curves. *Prev Med*, 2008, 46 (5), 419–424, doi: 10.1016/j.ypmed.2007.12.017.
13. Tudor-Locke C., Pangrazi R.P., Corbin C.B., Rutherford W.J., Vincent S.D., Raustorp A. et al., BMI-referenced standards for recommended pedometer-determined steps/day in children. *Prev Med*, 2004, 38 (6), 857–864, doi:10.1016/j.ypmed.2003.12.018.
14. Gabel L., Proudfoot N.A., Obeid J., MacDonald M.J., Bray S.R., Cairney J. et al., Step count targets corresponding to new physical activity guidelines for the early years. *Med Sci Sports Exerc*, 2013, 45 (2), 314–318, doi: 10.1249/MSS.0b013e318271765a.
15. Tremblay M.S., Warburton D.E.R., Janssen I., Paterson D.H., Latimer A.E., Rhodes R.E. et al., New Canadian physical activity guidelines. *Appl Physiol Nutr Metab*, 2011, 36 (1), 36–46, doi: 10.1139/H11-009.
16. World Health Organization, Global Recommendations on Physical Activity for Health. WHO, Geneva (Switzer-

land) 2010. Available from: http://www.who.int/dietphysicalactivity/publications/9789241599979/en/ [Accessed: June 2014].
17. Colley R.C., Janssen I., Tremblay M.S., Daily step target to measure adherence to physical activity guidelines in children. *Med Sci Sports Exerc*, 2012, 44 (5), 977–982, doi: 10.1249/MSS.0b013e31823f23b1.
18. Vincent S.D., Pangrazi R.P., An examination of the activity patterns of elementary school children. *Pediatr Exerc Sci*, 2002, 14 (4), 432–441.
19. Tudor-Locke C., Craig C.L., Beets M.W., Belton S., Cardon G.M., Duncan S. et al., How many steps/day are enough? for children and adolescents. *Int J Behav Nutr Phys Act*, 2011, 8, 78, doi: 10.1186/1479-5868-8-78.
20. Telford R.M., Telford R.D., Cunningham R.B., Cochrane T., Davey R., Waddington G., Longitudinal patterns of physical activity in children aged 8 to 12 years: the LOOK study. *Int J Behav Nutr Phys Act*, 2013, 10, 81, doi: 10.1186/1479-5868-10-81.
21. Vale S., Silva P., Santos R., Soares-Miranda L., Mota J., Compliance with physical activity guidelines in preschool children. *J Sports Sci*, 2010, 28 (6), 603–608, doi: 10.1080/02640411003702694.
22. Cardon G., De Bourdeaudhuji I., Comparison of pedometer and accelerometer measures of physical activity in preschool children. *Pediatr Exerc Sci*, 2007, 19 (2), 205–214.

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