



# Determining Differences among Genders and Days of the Week in Adolescent Physical Activity Levels Using Pedometers in Northwestern Bohemia

Ladislav Blaha<sup>ABDE</sup> , David Cihlar<sup>C</sup>

Department of Physical Education and Sport, Faculty of Education, Jan Evangelista Purkyně University in Ústí nad Labem, Czech Republic

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## Abstract

**Introduction:** Tracking motion activities through pedometer applications is one of the methods often mentioned for getting information about motion programs and for promoting a healthy lifestyle among adolescents. Similar problems are also addressed in the region of Northwestern Bohemia which is affected by certain structural characteristics. **Aim of Study:** This study strives to establish indicators of participation in physical activities among students in the second level of primary school (junior high school) and to evaluate them based on recommended criteria as well as from the point of view of the conclusions reached by other studies. **Material and Methods:** Physical activity was monitored concurrently and objectively by the Yamax SW-700 pedometer for seven consecutive days. Pedometers have proven themselves in a number of studies and are particularly suitable for assessing locomotive movement activities. Identification and recording sheets were used for the registration of the 358 boys and 330 girls from the second level of primary school (junior high school) in the Ústí nad Labem region who went through our survey. Pedometers were used during a period of favorable weather conditions and in the course of normal school attendance. **Results:** Groups of boys report different values throughout the second level of primary school (junior high school), where the average values of steps during weekdays is higher than 10,000 steps ( $M_{\min}=10,111$ ;  $M_{\max}=10,961$ ), which is the recommended number of steps, while the weekends record a decrease of values of steps to a number which is less than average ( $M_{\min}=8,547$ ;  $M_{\max}=9,761$ ). In regard to the results of the girls, the number of daily steps is lower than in the boys' groups ( $M_{\min}=9,247$ ;  $M_{\max}=10,598$ ). Girls results show the lowest values of steps during the weekend. **Conclusion:** Boys achieve higher daily values than girls in all tracked pointers. The values of steps that are typical for weekdays are significantly higher than those typical for weekend days. The lowest levels are the median values characterizing the steps taken during the weekend days for boys and girls.

**Keywords:** education, healthy lifestyle, monitoring, pedometer, physical activity, steps

**Address for correspondence:** Ladislav Bláha - Department of Physical Education and Sport, Faculty of Education, Jan Evangelista Purkyně University in Ústí nad Labem, Czech Republic, email: ladislav.blaha@ujep.cz

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## INTRODUCTION

Physical activity (PA) is associated with the cultivation of healthy lifestyles. We consider that lifestyle choices made during the period of adolescence contribute to the shaping and maintaining of our quality of life in adulthood.

The importance of sufficient exercise involving movement activities lies in their preventive effect in forestalling the rise and increase of disease due to the fact that they help to balance the ratio of energy intake and outflow. Unfortunately, the energy intake of a large number of adolescents is not adequately compensated, and monitoring the effectiveness of physical activities is becoming an ever-increasing trend. Although it is generally accepted that any movement is better than none [1], it is desirable to increase the volumes, frequencies, and quality of physical activities to a level that is beneficial to health and to one which can provide the desired benefits to the human organism. Many adolescents rely on an increase in their abilities at a greater level of physical development and they thus have the ability to benefit from ontogenetic developments. However, this potential is soon exhausted if it is not supported by sufficient exercise. Within the recommended criteria for physical activity, it is currently possible to acknowledge those characteristics of physical activity that can be considered to be minimally effective for maintaining health [2-5]. These characteristics can be found in a determination of the time and intensity of the load when exercising, the repetition frequency, the energy output from the conversion of other indicators (energy expenditure – kcal, HR and counts), and so on. At present, adolescent health-related recommendations are:

- Daily exercise of at least moderate intensity for 60 minutes a day, or PA of moderate intensity, or walking for at least 30 minutes at least 5 times a week.
- High intensity exercise activities that promote the development and maintenance of cardiorespiratory fitness, at least 20 minutes at a frequency of at least 3 times a week.
- A combination of previous recommendations for high or medium intensity PAs with the ability to increase the time in which activities are conducted to 10-minute and longer sections throughout.

One of the possible means used in assessing physical activity levels is by tracking locomotion – specifically the number of steps taken. Criteria recommended when assessing the number of steps taken during time units are reported by many of the authors on health [6-9]. For adolescents, meeting the recommended criteria would amount to 11,000 steps for girls and 13,000 steps for boys during the course of the majority of days of the week [10].

The utilization of pedometers in surveys has been found in a number of studies for a long period of time, and these studies are aimed at determining the level of locomotive activities with reference to possible relevant indicators. The use of pedometers has proven itself in numerous comparative and correlation analyses and also in intervention programs [11-15]. These also show a connection to the evaluation of the level of pedestrian activity and BMI [15,16]. Pedometer utilization has also proved to be a motivational factor. The monitoring programs and assessments of locomotion volume have led to a statistically significant increase in PA in the subjects studied, a decrease in BMI values, and a decrease in blood pressure of the probands [17]. Many of these pedometer-based programs confirm the occurrence of an increase in walking activities in a favorable environment and thus contribute to maintaining health [18,19]. It is clear that the results of such monitoring are not only aimed at public health but also directly affect the areas of communal policy, security and urbanism. In general, however, the use of pedometers is accompanied by PA support programs, also in connection with the application of the IPAQ questionnaire (e.g. [20,21]. It is also interesting to speculate on the advantages of the use of pedometers among the elderly and among people who themselves want to observe, evaluate, and determine loads in the interest of cultivating their health [22,23]. Studies have also been conducted to establish a link between favorable PA values determined by the pedometer and cardiorespiratory fitness values [24].

A number of studies have targeted the use of pedometers in adolescents. The values obtained can be generally related to recommended values for adults (10,000 steps/day). However, it is assumed that adolescents should achieve higher values. For children aged 6–12, attainment levels of 12,000 steps for girls and 15,000 steps for boys are preferred within the framework of an active lifestyle [25]. According to Frömel et al., is essential for pupils at the second level of primary school (junior high

school) to attain 11,000 steps for girls and 13,000 steps for boys [3]. In his survey, the girls' daily average was 11,666 steps, and the boy's daily average was 13,786 steps. The study by Vašíčková et al. [26] indicates average girls' scores at 12,356 steps during school days and 12,567 steps / day during weekend days. For boys, these values are 12,006 steps during school days and 11,014 steps during weekend days). The studies in visually impaired children showed large differences in individual graduation rates (girls 3,885 to 13,874 steps – an average of 9,686 steps/day, boys with an extreme value of 3,437 to 16,166 steps – an average of 9,770 steps/day) depending on the environment in which their movement takes place [27]. It is clear that the volume of locomotive activities is determined by a number of variables, the most important of which are lifestyle, housing and schools, transport, and many other factors.

The region of Northwestern Bohemia is one which has been affected by specific structural characteristics. The main problems of the region are the considerable extent of its industrial production, its persistent ecological burden, and the increased migration of its population, many of whom, to a large extent, do not reach levels of education and qualification which are the norms in the Czech Republic. These circumstances also contribute to many of the social problems in the area and are reflected in the sphere of education and in the participation of adolescents in physical activities. In our study, we wanted to find whether the indicators of locomotor activities in children at the second level of primary school (junior high school) in Northwestern Bohemia meet the health criteria. The question was also how different are the indicators we have identified from the conclusions of other studies?

The aim of the study was therefore to determine selected indicators of completed physical activities among pupils in the second level of primary school (junior high school) in the region through a week-long pedometer application and then to evaluate these indicators from the point of view of the recommended health-oriented criteria.

## MATERIAL AND METHODS

The total number of the second level of primary school (junior high school) pupils was 688 ( $n_{\text{boys}}=358$ ;  $n_{\text{girls}}=330$ ) in the years 2010 to 2015. In some cases, the monitoring of physical activity through pedometer application was parallel to the questionnaire "Determinants of Participation in Exercise". However, we do not refer to interconnections for a low number of probands, to different conditions, and to the consistency of the guarantors of the survey in each primary school (basic schools in towns and cities: Podbořany, Markvartice, Ústí nad Labem, Děčín, Litoměřice, Teplice, Chabařovice). After clearing up all data, a total of 639 participants were evaluated ( $n_{\text{boys}} = 347$ ;  $n_{\text{girls}} = 292$ ). Investigation files for boys and girls showed no peculiarities. For probands, there was a clear balance of data in height and no great difference in the weight of boys and girls in the sixth year of elementary school. Beginning with the seventh grade, weight and height acceleration occurs in boys, who then begin to surpass the girls in these values and the differences between boys and girls gradually increase. For boys in the ninth year, we recorded a higher BMI than in girls.

Within the conditions of the Northwestern Bohemia region, our study supported, besides the basic framework of the survey (see acknowledgments), completed projects supported by internal grants from the Faculty of Education at the University of Jan Evangelista Purkyně (PF UJEP), as well as the openness of the second level of primary schools (junior high schools) in the region to cooperate. The present study contains selected data obtained during the implementation of a series of observations. The data were collected by UJEP students and by primary school teachers. In the course of the usually complex observation, we tried to obtain data on the lifestyles and the physical activity, or the physical fitness, of pupils in primary schools (2010–2015), to supplement the data with information related to the school environment and pupils' places of residence, and to apply a pedometer for a predetermined period to determine the volume of activity registered by this measuring technique.

The survey was carried out in schools which were chosen by a process of group selection, and always in a period of acceptable weather conditions which provided for a stable movement routine among pupils. This usually took place from the second half of September to the first half of November, and in the spring months from the second half of March to the first half of June. The wearing of

pedometers was conducted according to type of survey for several weeks, and for our needs we recorded data from 8 days (two weekends and 5–6 working days). The values obtained were registered on record sheets or in the INDARES database ([indares.com/public](http://indares.com/public)). The research was mostly presented to the pupils by their physical education teachers who were trained to use pedometers and record sheets and trained in the INDARES system. In a few cases, the author of the work or members of the research team from the CKV Institute of Active Lifestyle FTK UP Olomouc were present when the data were collected. The investigation was conducted after discussion with the school management, and according to its requirements parental approval was necessary. The basic research intention was approved by the ethics committee of FTK UP Olomouc, and since our investigation did not lead to interventions, we did not request the comments of the ethics committee of PF UJEP Ústí nad Labem.

For research purposes we used the pedometers Yamax Digiwalker SW-200 and SW-Yamax Digiwalker 700, as well as the computer equipment of schools with access to the system INDARES (Database for International Research and Education Support) and recording sheets for recording the applied physical activities. Yamax Digiwalker SW-700 and SW-200 pedometers are small and lightweight (20g) electronic pedometers that measure vertical oscillations. The data are a record of the total number of steps taken by pupils and the calculated distance and energy output (the value of the average step length and weight is preloaded) which can be read from the display when the protective lid is lifted.

YAMAX pedometers use the principle of switching on and off the electric circuit using a spring-loaded pendulum that moves during vertical oscillations. Vertical oscillation exceeding the sensitivity threshold is recorded as a step [28]. The number of steps – more accurately, vertical oscillations – is the most accurately measured value. For the distance traveled and the energy output, the error rate increases and the interpretation of the results has to be taken into account. The YAMAX pedometers demonstrate in practice considerable measurement accuracy [29].

The monitored variables were the values of the completed steps reported during a certain period. The statistical treatment was performed using STATISTICA 12 software. We worked with parametric data primarily by common statistical procedures, because of the assumed uneven representation of data in the case of the evaluation of few files, we also present medians and results for evaluation of nonparametric data (Mann Whitney tests).

## RESULTS

The monitored variables were the values of the steps taken during a certain period of time. For the basics, we consider the daily values specifically for boys and girls in the week. Conscious of the day-to-day routine being different from weekdays, we also present the daily values of STP<sub>works</sub> and STP<sub>week</sub> in particular. Presented daily values in week, working days and weekends for boys and girls are presented in Table 1.

Table 1. Daily values of locomotive motion in the week or in segments of the week for the second level of primary school (junior high school) boys and girls

File	Part of the week	M	Mdn	SD
Boys 6 - 9th grade (n=347)	STP1	10,549.23	9,705.71	4,526.72
	STP <sub>work</sub>	11,152.78	10,268.00	4,853.83
	STP <sub>week</sub>	9,040.33	7,786.00	5,552.05
Girls 6 - 9th grade (n=292)	STP1	9,972.01	9,229.07	3,962.31
	STP <sub>work</sub>	10,431.38	9,605.40	4,114.68
	STP <sub>week</sub>	8,823.59	7,857.75	5,090.76

M – mean, Mdn – median, SD – standard deviation; STP1 – Daily number of steps in a single day; STP<sub>work</sub> – Daily number of steps on a single school day; STP<sub>week</sub> – Daily number of steps on a single weekend day

**Table 2.** Daily reported number of steps in boys' and girls' files according to grade at the second level of primary school (junior high school).

File	Part of the week	M	Mdn	SD
Boys 6th grade (n=121)	STP1	10,544.04	9,343.00	6,286.76
	STP <sub>work</sub>	10,856.96	9,830.00	6,007.45
	STP <sub>week</sub>	9,761.75	7,612.00	6,873.98
Boys 7th grade (n=96)	STP1	10,555.18	8,899.00	6,407.98
	STP <sub>work</sub>	11,299.90	9,720.50	6,384.06
	STP <sub>week</sub>	8,693.37	6,481.50	6,080.66
Boys 8th grade (n=67)	STP1	10,961.91	9,982.00	8,792.91
	STP <sub>work</sub>	11,927.49	11,040.00	9,615.15
	STP <sub>week</sub>	8,547.97	7,574.00	5,596.24
Boys 9th grade (n=63)	STP1	10,111.22	9,124.00	6,912.96
	STP <sub>work</sub>	10,672.88	9,904.00	5,655.62
	STP <sub>week</sub>	8,707.09	6,199.00	9,194.35
Girls 6th grade (n=96)	STP1	10,205.05	9,310.50	6,430.25
	STP <sub>work</sub>	10,382.73	9,799.00	6,195.72
	STP <sub>week</sub>	9,760.85	8,400.50	6,962.38
Girls 7th grade (n=55)	STP1	10,598.19	9,422.00	6,026.15
	STP <sub>work</sub>	10,939.09	9,645.00	6,179.76
	STP <sub>week</sub>	9,745.95	9,042.50	5,532.68
Girls 8th grade (n=90)	STP1	9,751.31	9,165.00	5,627.43
	STP <sub>work</sub>	10,380.53	9,708.50	4,742.45
	STP <sub>week</sub>	8,178.27	7,521.50	5,277.57
Girls 9th grade (n = 51)	STP1	9,247.54	8,875.00	4,804.77
	STP <sub>work</sub>	10,065.18	9,241.00	4,498.68
	STP <sub>week</sub>	7,203.46	5,997.00	4,935.11

M – mean, Mdn – median, SD – standard deviation; STP1 – Daily number of steps in a single day; STP<sub>work</sub> – Daily number of steps on a single school day; STP<sub>week</sub> – Daily number of steps on a single weekend day

Boys achieve higher daily values than girls in all tracked pointers. At daytime average values, some girls surpass 577 steps, but average 476 steps. However, this difference is not statistically significant ( $p = 0.194353$ ) and the value of factual significance is also low ( $d = 0.102$ ). The values of typical steps that are usual for weekdays are significantly higher than those usual for weekend days. On weekdays, however, boys surpass girls in their daily locomotive values with a larger difference than during the weekend. However, during weekdays ( $p = 0.101320$ ;  $d = 0.129$ ), these are not statistically or materially significant differences, especially for daily values of weekend days ( $p = 0.902766$ ;  $d = 0.009$ ). When comparing the values on individual days of the week, we recorded a statistically significant difference between a group of boys and girls only one day per week (Monday –  $p=0.016183$ ;  $d=0.191$ ). Attention is drawn to the relatively large values of standard deviations that illustrate the characteristics of the files.

Table 3. The daily number of reported steps in each day of the week regardless of gender and grade (n=639)

Day of the week	M	Mdn	SD
Monday	10,491.69	9,405.00	5,519.34
Tuesday	10,727.21	9,645.00	6,314.39
Wednesday	10,508.26	9,541.00	5,764.09
Thursday	10,792.11	10,022.00	7,569.85
Friday	11,596.37	10,338.00	6,178.92
Saturday	9,537.64	8,016.00	7,003.41
Sunday	8,344.95	7,081.00	5,954.72

M - mean, Mdn - median, SD - standard deviation

We have also attempted to monitor the differences and the development in higher education grades of primary school children. The reported weekly values of boys' and girls' steps by grade school year is presented in Table 2.

The recorded daily locomotor values for boys and girls does not vary much. A certain break and decrease in values can be seen in boys and girls in the ninth grade. The lowest levels are achieved in the median values of the steps taken during the weekend for boys and girls of the ninth year of primary school.

The obvious differences between the locomotive values at work/school days and weekend have led us to examine the differences between pupils in the second level of primary school (junior high school) in the reported activities in between days of the week. These characteristics are given in Table 3.

If we compare tracked days of the week (Wilcoxon test), we usually find statistically significant differences between working and weekend days. This is true for Monday - Saturday values ( $p=0.000002$ ); Monday - Sunday ( $p=0.000000$ ); Tuesday - Saturday; Tuesday - Sunday; Wednesday - Saturday; Wednesday - Sunday; Thursday - Saturday; Thursday - Sunday; Friday - Saturday; Friday - Sunday (always  $p=0.000000$ ). Expressed differences showing a decrease in values on the last day of the week also occur between Saturdays - Sundays ( $p=0.000223$ ). So, it is clear that Sunday is the least active day for the adolescents.

## DISCUSSION

The recorded data are based on a large number of large-scale sets of boys and girls - pupils of the secondary schools. The data were acquired in a very attentive way, they were properly treated and recorded, therefore they are a good basis for computations and preformation of appropriate comparisons. The usual debate on the decline of adolescent participation in physical activities was based not only on other studies related to this topic but also on daily contact with the teachers of P.E. (physical education) and other educators, and possibly parents. Our motive for this study was to find objective data on reported physical activities with a focus on this region and its specifics.

First, we were surprised by the lack of high average daily values found in boys (10,549 steps) and girls (9,972 steps). These average daily values oscillate around 10,000 steps a day, which would correspond to the recommended values for the adult population. However, the values given in tables 1 and 2 show us certain circumstances that need to be highlighted. The median values for all indicators are significantly lower than the average values and indicate that many members of individual sets reach significantly lower values, and are even below that recommended for the adult population. This information is also a warning due to the fact that the results for probands also include the locomotive activity attained in regular school physical education lessons. Boys and girls who have an active lifestyle, many of whom are also members of sport clubs and take part in various competitions and tournaments during weekends, are the reason for increased average values. This is also shown by the values of standard deviations across all years. It is clear that children in the sixth year of school attendance have great differences in participation in physical activities and the "scissors" between physically active individuals and inactive behavior among children spread with increasing age. In our study, this is confirmed by the daily average values in the ninth year for boys and girls, the median

values, and also in particular for boys, the standard deviation ( $SD=6,913$ ;  $SD_{work}=5,656$ ;  $SD_{week}=9,194$ ). Although there is no significant decrease in statistical values, the established trends are obvious and are likely to continue and further deepen in the high school period. If we go back to compare our findings with other studies, we can say that the groups of boys and girls we observed are not reaching the recommended number of steps, 11,000 steps for girls and 13,000 steps for boys [3,10]. The findings are significantly worse in comparison with values found in the past by Frömel (11,666 steps for girls and 13,786 for boys). Six-year old boys and girls are also not reaching the recommended values according to Tudor-Locke (2004) for children aged 6–12 (15,000 steps recommended for boys and 12,000 steps for girls). The group of boys in the sixth grade reached 10,544 steps and girls 10,205 steps. However, these values exceed the median values, 9,343 steps for boys and 9,311 steps for girls. Although the comparison of our sets with children with visual handicaps is not correct due to disability, the values of our sets are close to the conclusions of the study done on children with this disability [27]. This study has shown significant diversity among individuals. More significant variations are seen in average daily values for girls and boys according to the environment in which they are moving. While during a typical school week (including weekends), daily values in girls' sets ranged between 3,885 and 13,874 steps – an average 9,686 steps/day, the boys had a total of 3,437 to 16,166 steps – an average of 9,770 steps/day, in a camp environment with a program, girls reached an average value of 14,663 steps/day and the boys reached 16,321 steps/day. This study confirms the obvious – the existence of an optimally set motion program can increase the daily values of locomotive activity.

In comparison with a recent study by Vašíšková, et al. [26], adolescents in our sets lag behind similar-aged sets of Polish adolescents. The girls in this study reached  $12,3561 \pm 2,838$  steps during the school days, during the weekends  $12,567 \pm 3,511$  steps. The boys reached  $12,006 \pm 2,924$  steps during school days and  $11,014 \pm 3,511$  steps during weekends. The girls in our sets ( $n=292$ ) reached  $10,431 \pm 4,115$  and  $8,824 \pm 5,091$  steps in these indicators. The boys in our sets ( $n=347$ ) reached  $11,153 \pm 4,854$  during school days and  $9,040 \pm 5,552$  steps during weekends. It is obvious that these differences are significant. The difference showing the dispersion of values are interesting in both the Polish and in our sets and tells us about the unequal representation of differently active individuals in our sets. Surprisingly, the set of Polish girls had very similar daily values during both school days and weekends. Our sets of boys and girls decreased significantly during the weekend. This is also documented in Table 3. The relatively marked decrease of locomotive activities during the weekend can be associated with a different movement regime which is preferred by the adolescents in Northwestern Bohemia. Unfortunately, free time is not spent according to the idea of an optimal healthy lifestyle. Adolescents possibly have parents who are not trying to compensate minor or poor participation in physical activities during working days (school days) by spending weekends in an active way. On the other hand, the majority of probands showed a decrease in the values of participation in physical activity and many devote themselves to a sedentary leisure time. The decrease in weekend (especially Sunday) values is statistically significant against the values of days in work / school. Sunday's values of locomotive activity even differ significantly from Saturday's, so Sunday is the least active day of the week. During the weekend, boys and girls do not walk to school, nor do they walk in school or have physical education classes, sport clubs, etc. The weekend is, sadly, a very passive day for many adolescents. Only some children are engaged in physical activity. These children also seem to "save" average values during school days and especially weekends. The high values of standard deviation suggest that, besides active individuals, we create a major problem for public health with inactive individuals who, in the age of adulthood, will deal with the problem of disease. We might end the discussion by stating that investigated sets of children at secondary schools do not achieve optimal health in recommended levels of locomotive activities and the values found here in many ways lag behind the values found in other studies.

## CONCLUSION

The average values of reported physical activities in the form of daily steps taken are not reaching the recommended health level for our groups of children at the second level of primary schools (junior high schools).

The values of medians and standard deviation in the reported locomotion indicate a significant imbalance of sets. This is shown by the fact that, in addition to physically active individuals, there are also individuals with inactive behavior and sedentary lifestyles represented in the sets.

The reported values of locomotive activity indicators in our files are below the level of comparative studies performed in age-related sets.

A decrease in the completed physical activities detected by pedometers was recorded during weekend days. The decrease is at a level of statistical significance and Sunday seems to be the least active day of the week.

Boys show higher levels of absolved locomotion than the girls, the differences are not statistically significant and do not reach material significance. Only one day in the week (Monday), we recorded a statistically significant difference.

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