

## Pedometers as a Method for Modification of Physical Activity in Students

by

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*Developing the awareness of one's level of physical activity is an important prerequisite to change one's lifestyle into a more physically active and healthy style of living. The aim of the study is to verify the efficacy of pedometers in educational environments and to specify the differences between physical activity in boys and girls aged 17. Twenty seven boys and thirty seven girls from randomly selected classes in two high schools in Katowice, Poland participated in the study. Students wore Yamax SW-700 pedometers for three weeks, continuously recorded data from the pedometers, and used the motivational feedback booklets. The three-week intervention using pedometers was complemented with the IPAQ questionnaire to assess their physical activity during the last seven days.*

*For statistical analysis, we used basic statistical characteristics, Mann-Whitney test, repeated ANOVA, "effect size" coefficient  $\omega^2$  (Tolson, 1980), and other partial analysis programs in Statistica 6 and SPSS 15.*

*Both boys and girls were less physically active on weekend days during the analyzed period. The use of pedometers did not decrease the difference between physical activity on school days and weekend days. No significant differences were found in the average number of steps per day between boys and girls, as well as no significant differences were identified in the interaction of gender vs. school and weekend days.*

*Additional study is necessary to confirm whether the use of pedometers in physical education classes can help decrease the differences in physical activity between boys and girls.*

**Keywords:** physical activity, monitoring, steps, active lifestyle

### Introduction

Introducing change in the physical activity and behavior of students, and their awareness of the importance of a physically active and healthy lifestyle is an important challenge in education.

Notwithstanding the published literature on the positive and negative effects of physical ac-

tivity on adolescents, the urge to enhance physical activity and a healthy lifestyle remains a challenge worldwide (Cavill, Biddle & Sallis, 2001). Physical activity is among many factors that can contribute to a change in conditions which allow for the awareness of one's lifestyle and its major characteristics.

A simple reflection of one's activity profile can be based upon FITT characteristics (i.e., frequency, intensity, time and type of a physical

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activity (Corbin, C., Welk, G., Corbin, W., & Welk, K., 2007; Frömel, Novosad & Svozil, 1999; Jackson, Morrow, Hill & Dishman, 1999). Another important prerequisite of an effective change is experiencing feelings of satisfaction from the performed activity. This is regarded as a complex positive response, both on biological and psychosocial levels (i.e., experiencing feelings of satisfaction, happiness, friendly atmosphere, well-being, etc). To experience positive feelings from a successful change in the physically active behavior is also very important. The need for an adequate environment that would enhance a physically active lifestyle, or allow at least certain types of physical activities, has been also emphasized recently (Bedimo-Rung, Mowen & Cohen, 2005; Zimring, Joseph, Nicoll & Tsepas, 2005). In relation to education, it is necessary to provide at least minimal knowledge on a physically active and healthy lifestyle to children and adolescents.

Enhancement of a physically active and healthy lifestyle in adolescents is among the most important goals of physical education (Burgeson, Wechsler, Brener, Young & Spain, 2001; Fairclough & Stratton, 2005; McKenzie et al., 2006). The strategies that we choose to support physical activity in youth are based on models and theories of physical activity. The most notable are the ecological model and the "relapse prevention model" (Marcus, Forsyth & Blair, 2003; Sallis & Owen, 1999, 2002).

Among the tools used to influence physically active behavior in children and youth are interventional programs (Stone et al., 1998). Programs using pedometers as a motivational tool to increase physical activity in physical education and daily physical activity are often among the most widely utilized resources. (Oliver, Schofield & McEvoy, 2006; Pangrazi, Beighle & Sidman, 2003; Schofield, Mummery & Schofield, 2005; Zizzi et al., 2006).

Differences in physical activity levels between boys and girls, and their specific activities during adolescence, are a long-term issue relating to formation of lifestyle decisions regarding physical fitness. In a recent survey, Armstrong and Welsman (2006) indicated that European boys are more physically active than girls, especially within the context of vigorous physical activity. The research by Tudor-Locke

et al. (2006) further demonstrates that boys do more steps per day than girls and are more active in their leisure time than girls. Accordingly, opportunities to reduce the differences between physical activity levels of boys and girls need to be encouraged.

In this study, it is assumed that the use of pedometers at schools could positively contribute to the decrease in differences in physical activity levels between boys and girls under specific parameters as monitored in Polish schools.

The main aim of the study is to verify the application of pedometers at schools as a means of monitoring the differences in weekly physical activity between boys and girls.

### ***Further goals:***

To obtain detailed information on the physical activity of boys and girls during a three-week period.

To compare the results from PA monitoring with the results of qualitative analysis.

To determine the efficacy of conducting a more extensive investigation into the use of pedometers under Polish school conditions during physical education classes.

### ***Hypotheses:***

The use of pedometers for physical activity monitoring in high school students will increase physical activity in girls on weekends and, thus, decrease the differences in physical activity between weekdays and weekend days.

*Rationale of the hypothesis:* In the experiments carried out to date, girls were more willing to wear pedometers than boys, and girls' physical activity during weekends was significantly lower than on weekdays.

The dependant variable is physical activity represented by the daily number of steps, and the independent variables are gender and week day vs. weekend.

## ***Methods***

### ***Description of the sample***

In the experiment, 64 adolescents (37 girls and 27 boys) from two high schools consented to the survey, and participated in the

Table 1

Basic characteristics of a sample of adolescent girls and boys from Polish high schools

Characteristics	Boys			Girls		
	<i>n</i>	$\bar{x}$	<i>SD</i>	<i>n</i>	$\bar{x}$	<i>SD</i>
Age (years)	27	17.91	1.04	37	17.95	1.02
Height body(cm)	27	178.48	5.44	37	166.14	4.88
Body mass (kg)	27	67.46	8.00	37	58.89	9.00
BMI (kg·m <sup>-2</sup> )	27	21.13	1.77	37	21.32	2.92

 $\bar{x}$  – mean, *SD* – standard deviation

study (Table 1). The classes at the schools were selected randomly. Four students did not agree to participate and seven students were not included into the results due to incomplete data.

### Methods

In this research, the long administrative Polish version (in accordance with translation procedure recommended by Cull et al., 2002) of the “International Physical Activity Questionnaire” (IPAQ) was applied (Craig et al., 2003; [www.ipaq.ki.se](http://www.ipaq.ki.se)). The students wore Yamax SW-700 pedometers to monitor physical activity and recorded the data into a booklet that served both as a motivational and educational resource. Each day in the evening, the students recorded the number of steps made, distance covered—converted it into kilometers (km) and active energy expenditure (kcal).

### The course of the experiment

During the initial lesson, the students completed the IPAQ questionnaire to assess their physical activity within the last seven days. During the ensuing three weeks, the students wore the pedometers, recorded the data, and followed the instructions provided in the booklets ([www.vzpa.upol.cz](http://www.vzpa.upol.cz)).

### Result processing

Answers provided by the students were processed in accordance with the Guidelines for Data Processing and Analysis of The International Physical Activity Questionnaire (2005) ([www.ipaq.ki.se](http://www.ipaq.ki.se)). A single adjustment was made to convert vigorous physical activity into MET-min, set for 6 METs. For statistical analysis, we used basic statistical characteristics, Mann-Whitney Test, repeated ANOVA, “effect size” coefficient  $\omega^2$  (Tolson, 1980) and other partial analysis in Statistica 6 and SPSS 15 programs. Students’ records and opinions were processed using the qualitative analysis in *Atlas/ti 2005, Win 5.0 program*. The methods of open codification, categorization, axial codification, interconnection and association analyses were applied. In total, 155 extracts were processed (respondents’ views), clustered into 11 codes.

### Results

Both boys and girls were less physically active during weekends in all three weeks ( $p \approx 0.000-0.033$ ) (Table 2).

No decrease in differences between physical activity on weekdays and weekend days was shown. The differences in relative energy expenditure ( $\text{kcal} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$ ) confirm lower physical activity on weekend days ( $F=10.95$ ;  $p \approx 0.000$ ;  $\omega^2=0.437$ ), which was considered for analysis in

Table 2

Average number of steps (considered jumps, changes of position) on weekdays and weekend days

Week	Boys (n=27) - steps·day <sup>-1</sup>						Girls (n=37) - steps·day <sup>-1</sup>							
	Weekdays		Weekends		F	p	$\omega^2$	Weekdays		Weekends		F	p	$\omega^2$
	$\bar{x}$	<i>SD</i>	$\bar{x}$	<i>SD</i>				$\bar{x}$	<i>SD</i>	$\bar{x}$	<i>SD</i>			
1.	12138	3481	8928	4326				13267	4058	10283	5196			
2.	12539	2913	8522	3561	8.77	0.00	0.38	12616	5493	9401	5396	8.02	0.00	0.35
3.	12609	4179	8381	3072				12523	5263	9311	5507			

F - repeated ANOVA,  $\omega^2$  - effect size coefficient

Table 3

List of codes with frequency of statements (extracts)

Title of the code	Number of extracts in the code
1. Motivational factors that appeared during the experiment	24
2. Disadvantages associated with the experiment	4
3. Area of personal interests associated with the experiment	11
4. Area of personal interests before the experiment	3
5. Positive assessment of the experiment	20
6. Technical faults and deficiencies of the pedometer	10
7. The level of subjective changes in the participant during the Experiment	6
8. Advantages associated with the experiment	21
9. Relation and personal approach to the experiment	14
10. Independent variables in the experiment	4
11. Health and social impacts of the experiment	9

all three weeks ( $p \approx 0.001-0.006$ ) (Figure 1).

No significant differences were found between boys and girls in the average number of daily steps ( $F=0.36$ ;  $p=0.551$ ) and in the interaction of gender vs. weekdays and weekend days ( $F=0.34$ ;  $p=0.887$ ) (Figure 2). Prior to the start of monitoring, no significant differences between weekly physical activity in boys ( $Mdn=4704$  MET-min-week<sup>-1</sup>;  $IQR=7152$  MET-min-week<sup>-1</sup>) and girls ( $Mdn=3312$  MET-min-week<sup>-1</sup>;  $IQR=4223$  MET-min-week<sup>-1</sup>) were found ( $U=0.38$ ;  $p=0.706$ ).

On the basis of the analysis of students' responses, mainly positive assessment prevails. The course and the results can serve as an important motivational factor, not only for students, but also other people close to them. This is confirmed by codes no. 1, 5, 8 and 9 (Table 3). As far as qualitative hierarchical structure and

meaning density and saturation are concerned, the most significant code is the "Health and social impact of the experiment", which includes other four-meaning links to other codes.

Predicated upon the questionnaire, the effect of the experiment with pedometers has caused positive changes in behavior in the physical activity level of six study-participants. Further confirming the value of the study are answers commenting on technical and recording aspects of the experiment; most particularly including suggestions related to solving problems with physical activity (code No. 6).

#### *Students' responses extracted from the qualitative analysis:*

R1 (S. P.): "I think the experiment using pedometers was good and useful. The results from the pedometers have informed us

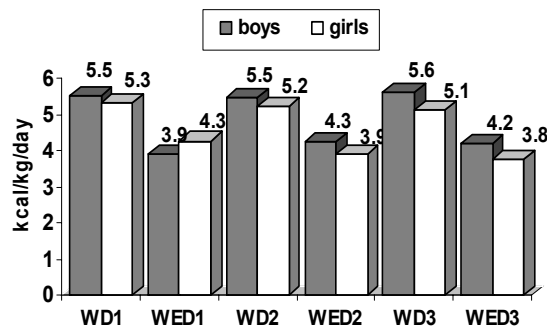
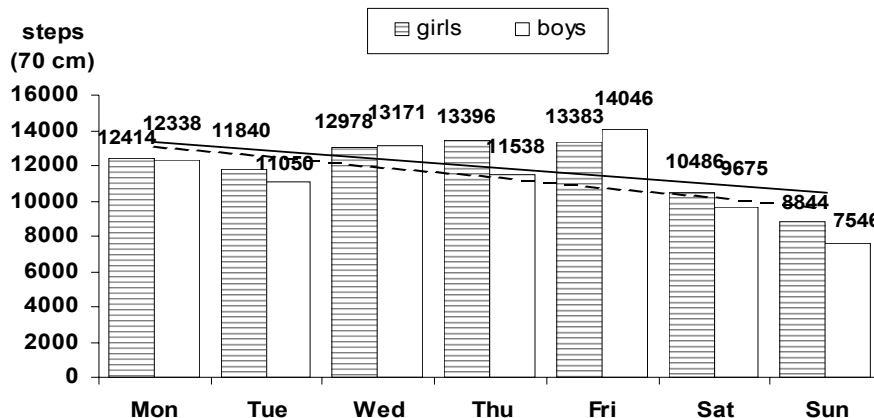


Figure 1

Relative energy expenditure ( $\text{kcal} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$ ) on weekdays (WD) and weekends (WED) during the three week evaluation



**Figure 2**

Average number of steps of weekly physical activity in boys and girls (steps-day<sup>-1</sup>)

how little physical activity we do. Thanks to that I mobilized myself and was more physically active. The most difficult aspect of the experiment was that I had to be careful with the pedometer during trainings and to remember to record the data. "

R2 (E. K.): "I liked the idea with the pedometers. To check the number of steps was interesting. The number of steps encouraged me to do more physical activity."

R4 (M. G.): "Daily number of steps is to a great extent dependant on the weather. The third week, I did much fewer steps, because it was freezing outside, etc. I really liked the program of physical activity. It took a commitment and did not cost me anything, and I could control my energy expenditure and number of steps with the pedometers. I am happy that I took part in the experiment. I would be happy to do it again. I tried to do more steps every day. I went more often for walks, exercised, tried to walk more."

R8 (J. M.): "In my opinion the research of physical activity using the pedometers was interesting and useful. I had the awareness of number of steps and kilometers made. The only thing that made me nervous was that I had to remember to record the data in a special booklet every day."

R11 (K. S.): "I liked the program a lot. Thanks to that I could see my level of physical activity. I am excited about that. However, I was bothered by the pedometer, because it

distracted me during training and kept falling. A different way to carry the pedometer needs to be developed.

R12 (M. S.): "I think that such a type of research motivates young people to a more active lifestyle."

R13 (A. B.): "This program with pedometers did not bring anything new to my life, but it was good fun."

R15 (D. Z.): "The program is interesting. I learned what our physical activity is. This way I knew everyday how much I walked and I could control if I met the health norms. I agree with a change of lifestyle in compliance with the health norm and with more physical activity. Thanks to the research I realized I do almost no walking on the weekend and I feel determined to do something about it. I really liked it and I agree with this type of research."

R18 (T. S.): "Pedometer has mobilized me on a personal level of physical activity. I tried to walk larger distances and use less public transportation."

R21 (D.A.): "I liked the idea with pedometers because I can see the number of steps I made and my physical abilities. It motivates to improve one's results. The pedometer sometimes did not register the number of steps made so I did not have an exact result."

R23 (R. C.): "I think that everyone is obliged to check if they covered respective distance and respective number of steps daily. It is

very useful to check the number of calories consumed, especially for people on a diet. I personally really liked the pedometer. I worry the moment when I have returned it. I would be happy to keep it. I was happy to participate in this research."

R24 (M. T.): "Wearing a pedometer is a bit limiting because of the frequent need to register the data, and also due to the risk of damage or loss because of its small size. And it does not count steps correctly!!!"

R25 (M. W.): "According to me the survey was positive, because my physical activity improved. The pedometer mobilized me to do more physical activity."

### Discussion

According to the results and the experiences gained from the experiments carried out at elementary schools, pedometers can encourage students to perform more physical activity and they can additionally serve as an important motivational tool in physical education classes (Pangrazi, Beighle & Sidman, 2003). The fact that girls value the usefulness and information from the experiment with pedometers more positively than boys can, in connection with other motivational factors, help increase and balance their physical activity both in school and during leisure time. Physical education teachers should attempt to create more conditions to apply pedometers in girls' classes.

Another important positive aspect of the use of pedometers is the awareness of one's lifestyle. Pedometers can provide a more qualified approach to changing physical activity behavior, better understanding of the association between physical activity and nutrition, and in the overall enhancement of "fitness awareness" in students.

Motivational aspects of the pedometer positively influenced participants and resulted in an increased "waking effect", as was stressed by Zhu (2008), Welk (2008), Chan and Tudor-Locke (2008). Beneficial influence of pedometer on increased physical activity of 16-year-old girls was also noted during two-week monitoring by Schofield, Mummery et al. (2005). Pedometers were also utilized in a study by Lubans et al. (2008) to assess levels of extra-curricular physical activity in 14-year-old boys and girls and

documented an increased level of activity during the assessment period.

Notwithstanding the negative comments on the recording of the number of steps (provided by three of the participants), the recording of data and the analysis are very useful for the individual to become more aware of their volume and type of physical activity. The useful affects of pedometers also encompass energy expenditure, nutrition, and the awareness of a healthy lifestyle.

It is expected that there will be an increased use of pedometers in Polish schools with the launch of an internet-based diagnostic system. The software allows recording and analysis of data, comparison of the results on intra- and inter-individual basis, and the use of pedometers with students' other physical activity ([www.indares.com](http://www.indares.com)).

### Conclusions

- The use of pedometers at the high school level did not decrease the differences in physical activity by girls during weekdays and weekends.
- Non-significant differences in physical activity between boys and girls using pedometers cannot be generalized at the present stage of research.
- Pedometers are useful monitoring devices when properly installed and utilized in schools.
- Pedometers enhance effective self-reflection of physical activity and are a practical teaching tool in physical education.
- Girls demonstrate a more positive approach to the use of pedometers for longer time spans. Proper use of pedometers in physical education can help to decrease the differences in physical activity between boys and girls.
- More effective use of pedometers can support the on-line system of recording, analyzing PA data, and enhance a more physically-active lifestyle.
- The most significant finding from the experiment is the validation of the ability to conduct a three-week monitoring of physical activity of students directly at schools.

### *Research limits*

- Only an excerpt of the international comparative data is presented herein. Accordingly, the conclusions and recommendations are based on the extensive experience gained in research using pedometers at schools.
- Pedometers monitor not only steps, but also jumps and changes of position, yet their accuracy is lowest among monitoring devices.
- The generalization of results with the use of pedometers will be possible only after repeated experiments in different school environments are conducted using the scientific method.

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### **Acknowledgments**

The study has been supported by the research grant from the Ministry of Education, Youth and Sports of the Czech Republic (No. MSM 6198959221) "Physical Activity and Inactivity of the Inhabitants of the Czech Republic in the Context of Behavioral Changes"

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