

ANALYSIS OF PHYSICAL ACTIVITY IN 16 AND 18 YEAR-OLD GRAMMAR SCHOOL STUDENTS WITHIN INTERNATIONAL CONTEXT¹

by

KAREL FRÖMEL*, KRZYSTOF SKALIK**, ERIK SIGMUND, JANA
VASENDOVA, FILIP NEULS***, EVA WIRDHEIM****

The main aim of the research was to analyse the extent and structure of physical activity in 16 and 18 year-old grammar school students. A total of 68 first-grade and 58 third-grade students were monitored at grammar schools in Katowice, Halmstad and Olomouc. For monitoring of their one-week physical activity, Caltrac accelerometers, Omron pedometers and recording sheets were used. The highest average daily energy output during physical activity was found in first-grade boys (866.57 kcal·day⁻¹) and the lowest in third-grade girls (556.90 kcal·day⁻¹). First-grade students completed 12,824 steps on average while the third-grade students could only manage 10,169 steps. Our previous research works aside, the difference between level of physical activity on weekdays and weekends was not established. As regards physical activity in general, walking and cycling prevailed in girls; whereas walking and soccer were predominant in boys.

Key words: physical activity, accelerometer, pedometer, recording sheet, and grammar school

Introduction

Problematic tasks on physical activity in people's lives appear to be an important issue among the current global problems in contemporary science. From an ontogenetic aspect, physical activity in adolescent, mostly girls, is in the foreground of interests. Most previous researches have confirmed a decline

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* prof. PhDr. Karel Frömel, DrSc. Katedra kinantropologie, Fakulta telesne kultury, tr. Miru 115, Olomouc, 771 40, Czech Republic

** Academy of Physical Education, Katowice, Poland

*** Faculty of Physical Culture, Olomouc, Czech Republic

**** Halmstad University, Halmstad, Sweden

in the level of physical activity in young people with advancing age (Frömel et al. 1999; Frömel and Novosad, 1998; Sallis and Owen, 1999; van Mechelen and Kemper, 1995). We assume that this is also valid in its entirety for the adolescent period of young people while attending a grammar school. Until the present time, such a wide ranging study focused on the analysis of physical activity during adolescence in each particular year has not been conducted. Also there are other objective hindrances that make this problem more complicated, for instance the biological age factor or the influence of alternative school systems (different types of secondary school). Seeking essential determinants for physical activity in youth is typical for the present researches (Dishman and Sallis, 1994; King et al., 1995; Taylor et al. 1994; Sallis and Owen, 1999) because the determinants and their understanding could contribute towards a more effective influence on the life style of the youth. On a very general level, these determinants cover the aspects of health, prevention, social, ethnographic, life values, institutional (primarily the influence of school system), somatometric, educational (primarily the factors connected with family influence) and others. Taylor et al. (1994) and others (Sallis et al. 1992) mention a group of social determinants that includes socio-economic, ecological, individual factors and so on. Usage of various research techniques and methodological approaches pose restraints on making a general statement. That is why we considered researches that deal with physical activity in the different ethnic groups (Kelley, G. A. and Kelley, K. S., 1994; Sallis et al., 1992; Sallis and Owen, 1999) or solve the task on physical activity pertaining to different ethnographical conditions (Sallis et al. 1999) to be most valuable.

The aim of the research was to analyse physical activity in 16 and 18 year-old grammar school students in different ethnographic conditions in order to establish the amount, structure and nature of weeklong movement activity.

Further, we aimed to find the differences in weeklong physical activity in grammar school students between weekdays and weekends. We regard as most essential the task to find the gender differences in physical activity of first- and third-grade students.

We supposed that no difference would be ascertainable in a weeklong physical activity by students under differing regional conditions, although it was

not considered to be a research problem. It is evident that too low or too high level of physical activity narrows the differences among various groups.

In addition, we expected that in this research the physical activity in girls would be lower than in boys and that a lower level of physical activity would appear in the third-grade students.

Material and Methods

Participants

The research was conducted in the spring of 1999 at grammar schools in Halmstad (Sweden), Katowice (Poland) and Olomouc (Czech Republic). The grammar school in Katowice, which is a fairly large town, conformed in type and conditions with the other two schools. The best material conditions for sport were at the grammar school in Olomouc and for out-of-school movement activity, at Halmstad. Two complete classes of first- and third-grade students were randomly assigned to the research project. A total of 30 first-grade girls (age 16.39 ± 0.38 year; body weight 57.62 ± 7.42 kg; height 166.63 ± 6.40 cm), 28 third-grade girls (age 17.89 ± 0.64 year; body weight 59.61 ± 5.83 kg; height 167.89 ± 5.81 cm), 38 first-grade boys (age 16.41 ± 0.37 year; body weight 68.50 ± 8.39 kg; height 180.00 ± 6.22 cm) and 30 third-grade boys (age 18.01 ± 0.58 year; body weight 71.63 ± 7.52 kg; height 179.63 ± 4.54 cm) were involved in the project.

Eleven students were excluded from the set because of various reasons (failure of monitoring technology, illness, etc.) and so monitoring of their one-week physical activity could not be finished.

Instruments and Procedure

Participating students wore for seven-day accelerometer test Caltrac™ (Muscle Dynamic, Torrance, Canada) and for pedometer test Omron HJ-102 (Omron Healthcare, Inc., Illinois, U.S.A.), on the condition that they could only take them off when sleeping or swimming (not waterproof devices). Students independently registered the measured data from each device into recording sheets every morning and evening and also at the beginning and at the end of all organised sport lessons (at school, after-school) led by a sports instructor. In the

evening they also filled in the duration and type of realised movement activity (for details see Frömel et al. 1999). Methodology of monitoring physical activity is modified according to Sallis et al. (1994). The same researchers in all three regions carried out an introductory assessment and further control. Students knew of similar measures being instituted abroad and it was stressed that their typical week needs to be monitored. Immediately after the research, all of them received feedback on their individual results with the possibility to compare them with the mean values of the class and with a brief characteristic of their own movement activity. The teachers and directors of the grammar schools got the average results for each class with respect to the characteristics of the level of physical activity.

Data Analysis

A special software designed for the Didactic Laboratory at the Faculty of Physical Culture was used to analyse the research results in order to give a summary on the individual physical activity and for comparison with the average group values. Statistical analyses were done by Statgraphic software using basic statistics parameters. Multivariate analysis of variance (MANOVA) was used to test differences between the physiological parameters estimated by the Caltrac accelerometers and Omron pedometers in two age groups of grammar school students. MANOVA was also used to test differences between the energy expenditure measured on weekdays and at the weekends in boys and girls.

Results

Energy expenditure

Significant differences were not found in energy expenditure during physical activity in first and third grade girls measured either by accelerometers ($F(1,3)=0.13$) or by pedometers ($F(1,3)=0.38$) (Table 1). However, significant differences were only found in the transcription of recording sheets, referring to the type and duration of physical activity, and its conversion into energy expenditure (in harmony with Compendium of Physical Activity according to Ainsworth et al., 1992). These differences must be interpreted with great circumspection.

The differences in girls' physical activity in specific regions represent characteristics typical for a given week and thus do not allow generalising them without repeated monitoring.

Table 1. Daily energy expenditure during physical activity in 16 and 18 year-old grammar school girls

Set	Energy expenditure (kcal·kg ⁻¹ ·day ⁻¹)								
	Accelerometer			Pedometer			Recording sheet		
	<i>M</i>	<i>SD</i>	<i>F</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>M</i>	<i>SD</i>	<i>F</i>
1 st grade	9.90	0.70	0.13	7.40	0.44	0.38	5.78	0.51	4.16*
3 rd grade	9.54	0.76		7.00	0.52		4.28	0.55	
Halmstad	10.74	1.12		6.99	0.76		4.09	0.81	
Katowice	8.02	0.78	2.98	5.81	0.57	8.79**	4.53	0.58	4.04*
Olomouc	10.41	0.80		8.80	0.45		6.47	0.58	

Notes. *M* - arithmetic mean; *SD* - standard deviation; *F* - MANOVA
Statistically significant values * p<0.05; ** p<0.01.

Significant differences in physical activity in first- and third-grade boys were found in the data obtained by accelerometers (F(1,3)=4.47*), by pedometers (F(1,3)=7.82**) and from the record sheets (F(1,3)=7.97**) (Table 2). The differences between physical activity in boys from the Halmstad, Katowice and Olomouc region were not the main aim of the analysis but were taken into account as a mean for more efficient establishment of physical activity determinants in adolescent people. Higher level of physical activity in boys from the Olomouc region was influenced by greater participation in sports club activities, better facilities for sports in the school and probably the effort to perform for best results.

Table 2. Daily energy expenditure during physical activity in 16 and 18 year-old grammar school girls

Set	Energy expenditure (kcal·kg ⁻¹ ·day ⁻¹)								
	Accelerometer			Pedometer			Recording sheet		
	<i>M</i>	<i>SD</i>	<i>F</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>M</i>	<i>SD</i>	<i>F</i>
1 st grade	12.45	0.82	4.47*	9.80	0.76	7.82**	7.10	0.58	7.97**
3 rd grade	9.76	0.93		6.44	0.97		4.59	0.65	
Halmstad	8.68	1.03		6.44	1.05		3.78	0.73	
Katowice	9.65	1.05	10.15**	6.97	1.27	6.97**	4.98	0.74	12.29**
Olomouc	14.99	1.10		10.96	0.84		8.77	0.77	

Notes. *M* - arithmetic mean; *SD* - standard deviation; *F* - MANOVA
Statistically significant values * p<0.05; ** p<0.01.

The decline in physical activity during weekends is evident in all groups (Figure 1), although in first-grade girls the difference is not statistically significant. The results presented in Figure 1 show relevant finding on very low physical activity level in third-grade boys. The decline in physical activity in 18 year-old boys was considerable compared to those in the 16 year-olds.

Lower physical activity level in boys, apart from girls of the same age, is a unique phenomenon. From tables 1 and 2, it is obvious that boys from the Halmstad region had lower level of physical activity than girls and that is why the presented results exhibit such a difference.

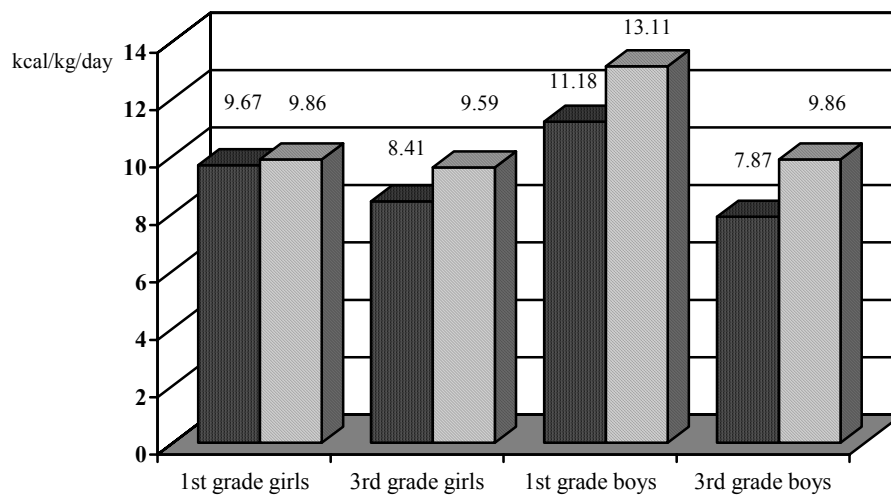


Fig. 1. Mean daily energy expenditure in 16 and 18 year-old students

Structure of movement activity

The established structure of movement activity is in harmony with previous research findings (Figure 2 and 3). Physical activity in 16 and 18 year-old students does not differ significantly in terms of type of physical activity. Only the time spent playing soccer in first-grade boys is a little bit higher than proved in our previous results. Walking fulfils more than half of students' movement activity. Apart from walking, girls spent some time cycling (second most frequent activity) and helping at home. Boys during a weeklong measurement devoted some time to cycling, jogging and playing games.

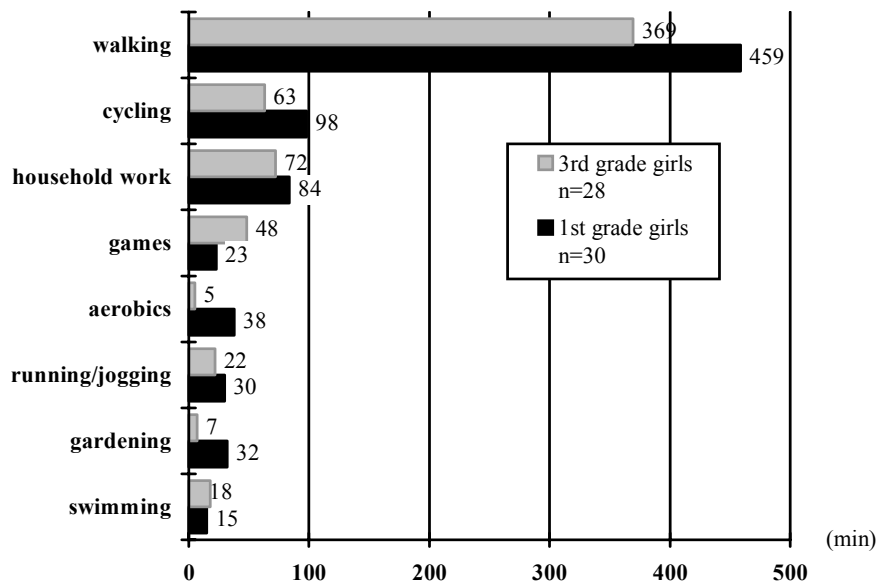


Fig. 2. Structure of weeklong movement activities in grammar school girls

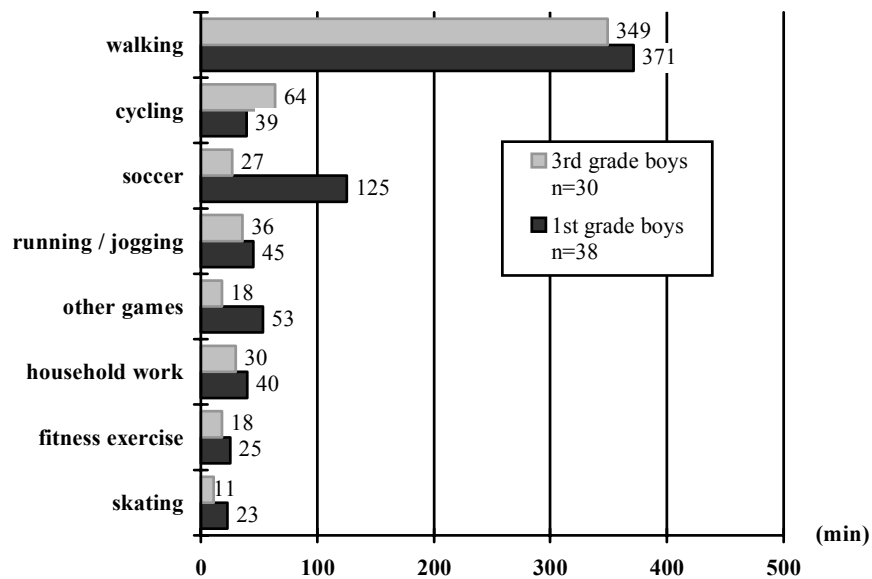


Fig. 3. Structure of weeklong movement activities in grammar school boys

Discussion

If we take the average results into account, all four groups exceeded the energy expenditure of $500 \text{ kcal}\cdot\text{day}^{-1}$ - the norm determined by Pate et al. (1995). The lowest values for energy expenditure of $556.90 \text{ kcal}\cdot\text{day}^{-1}$ was indicated by accelerometers Caltrac in third-grade girls ($570.44 \text{ kcal}\cdot\text{day}^{-1}$ in first-grade girls). The highest values for energy expenditure of $866.57 \text{ kcal}\cdot\text{day}^{-1}$ was established in first-grade boys ($661.64 \text{ kcal}\cdot\text{day}^{-1}$ in third-grade boys). Our findings are not favourable from a regional point of view. Also, some of the individual results were not found to be sufficient to maintain health. A total of 48 % of girls and 26 % of boys did not meet the above mentioned norm. We assume that the indicators determined in our previous researches for adolescent girls ($9 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$) and adolescent boys ($11 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$) allow to assess the findings more easily and efficiently (Frömel et al. 1999). According to the indicators, 53 % of girls and 55 % of boys were far below the required level of physical activity.

Participating students appreciated the given information on the number of steps, skips and position changes the most. The 16 year-old girls accomplished on average 11,667 steps (18 year-old girls 10,821 steps), while the 16 year-old boys completed 13,939 steps (18 year-old boys only 9,353). Minimum of average daily number of steps in girls was 5,076 (in boys 6,159) and maximum of average daily steps in girls was 24,678 (in boys 24,308). These findings meet the norm for girls in both groups to make 9,000 steps per day. Third-grade boys do not meet the norm for secondary school students to reach a target of 11,000 steps per day.

Information on the number of steps and the distance reached in a day (counted from the number of steps) appealed to the students because they could feel the real situation. Our empirical knowledge from previous monitoring of youth's physical activity revealed the absence of basic knowledge about body movement and physiological basis of human movement activity in young people. This lack is most startling in grammar school students. Biological education in grammar school students is not sufficiently connected with the needs in one's life. That is why the demands for integration between physical education and other school subjects (Werner, 1999), more efficient solving of inter-subject relationships (Cone et al. 1998) and the correlation between school education and life of children/youth (Ernst et al. 1998; Pennington and Krouscas, Jr., 1999) are highly relevant.

According to FITT characteristics (Sharkey, 1997), boys demonstrated higher energy expenditure ($12.45 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$) because of higher share of regular participation in sporting activities, more time devoted to physical activity and suitable type and intensity of physical activity, for example a high tendency towards soccer.

Comparative research was very effective, thereby allowing analysis of physical activity in adolescents and an effective assessment of the determinants and correlation in physical activity. Triangulate research that necessitates monitoring of physical activity using different methods at the same time is a pre-requisite for research credibility. Further, in spite of the check on most accessible variables (weather, school and after school facilities for sporting activities, engaging students in organised sporting activities and so on) and without repeating the measurements for weeklong movement activities in the same set of students, an overall generalisation is not possible.

Conclusions

Monitoring of physical activity under different ethnographic and social conditions proved to be a valuable contribution for analysis of physical activity determinants. Repeated monitoring in the same set of students is necessary for further possible generalisation. No significant differences were found in the level of weeklong physical activity between 16 and 18 year-old grammar school girls. On the other hand, lower level of physical activity in boys was found in older students. Girls and boys were less physically active during weekends. No substantial differences were established in the structure of physical activity either in the first and third grade girls or boys. Walking has the highest share in the structure of students' movement activity.

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