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AGE AND GENDER PATTERNS OF PHYSICAL ACTIVITY: THE CONTRIBUTIONS OF PHYSICAL EDUCATION AND ORGANISED PHYSICAL ACTIVITY

VZORCI TELESNE AKTIVNOSTI GLEDE NA STAROST IN SPOL: DELEŽ ŠPORTNE VZGOJE IN ORGANIZIRANE TELESNE AKTIVNOSTI

Abstract

School physical education (PE) is an important component of promoting healthy physical activity (PA) patterns during childhood and adolescence. However, the proportion of school PE in daily PA has not been completely examined. The contribution of activity energy expenditure (AEE) spent in PE and organised PA was examined in 855 girls and 585 boys aged from 11 to 19 years. AEE was assessed using the Caltrac accelerometer and daily logs. The age-related proportion of AEE spent on PE is higher in girls in comparison to boys in all age categories. The proportion of AEE girls spend on organised PA is also higher than for boys in all age categories. PE and organised PA significantly helped reduce the age-related decrease of PA especially in girls. The current findings indicate both PE and organised PA can be effective intervention strategies for increasing youth PA, especially in girls. Therefore, policies and resources supporting these programmes should be strengthened.

Key words: activity energy expenditure, physical inactivity, Caltrac accelerometer, physical education in school

Izvleček

Športna vzgoja (PE) predstavlja pomembno komponento pri vzpodbujanju zdravih vzorcev telesne aktivnosti (PA) v otroštvu in adolescenci, kljub temu pa delež športne vzgoje v sklopu dnevne telesne aktivnosti še ni popolnoma raziskan. Kakšen delež k porabi energije pri telesni aktivnosti (AEE) prispeva športna vzgoja in organizirana vadba smo ugotavljali na vzorcu 855 deklet in 585 fantov starih od 11 do 19 let. AEE smo ocenili s pospeškometrom Caltrac in dnevnimi zapisi. Odstotek porabe energije pri aktivnostih v okviru športne vzgoje je v vseh starostnih skupinah večji pri dekletih kot pri fantih. Dekleta vseh starostnih skupin porabijo večji odstotek energije tudi v aktivnostih organizirane telesne vadbe. Športna vzgoja in organizirana telesna vadba predvsem pri dekletih pomembno zmanjšujeta upad telesne aktivnosti, do katerega pride zaradi vpliva starosti. Ugotovitve kažejo, da tako športna vzgoja kot tudi telesna vadba lahko predstavljata strategijo učinkovitega poseganja v povečevanje telesne aktivnosti mladostnikov, še posebej deklet. Zaradi tega je potrebno nameniti več pozornosti spodbujanju tovrstnih programov in oblikovanju ustrezne zakonodaje.

Ključne besede: poraba energije pri aktivnostih, telesna neaktivnost, pospeškometer Caltrac, šolska športna vzgoja

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INTRODUCTION

The fact that physical activity (PA) decreases with age during youth is well-documented around the world in longitudinal studies (Barnett, O'Loughlin, & Paradis, 2002; Bradley, McMurray, Harrel, & Deng, 2000; Telama & Yang, 2000; Van Mechelen, Twisk, Post, Snel, & Kemper, 2000), cross-sectional studies (Caspersen, Pereira, & Curran, 2000; Gavarry, Giacomoni, Bernard, Seymat, & Falgairette, 2001; Hovell, Sallis, Kolody, & McKenzie, 1999; Leslie, Fotheringham, Owen, & Bauman, 2001; Riddoch et al., 2004; Saelens, 2003; Trost et al., 2002), multivariate studies (Boreham & Riddoch, 2001; Sallis, 2000), and even in non-human species (Ingram, 2000). The age-associated decline in PA in adolescents appears to be stronger with boys than with girls (Gavarry et al., 2001; Leslie, Fotheringham, Owen, & Bauman, 2001; Sallis, 2000; Sallis, Prochaska, & Taylor, 2000; Telama & Yang, 2000; Trost, Pate, Freedson, Sallis, & Taylor, 2000; Van Mechelen et al., 2000) and in vigorous activities more than in moderate activities (Caspersen, Pereira, & Curran, 2000; Leslie et al., 2001; Van Mechelen et al., 2000). However, this phenomenon is not well understood. Given the strength and consistency of the age decline it is useful to examine the pattern of the decline by age, time of the day or week, gender, season, type of activity and other factors.

Although the decline of PA is stronger in youth than adulthood (Sallis, 2000), the most critical age for a considerable decrease needs to be determined. Recent studies have documented a marked decrease in participation in vigorous PA among children aged 9 to 14 (Bradley et al., 2000) and in PA overall among adolescents aged 13 to 18 (Sallis, 2000). However, this decrease is not evident during preschool years (Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004). Thus, studies of a broad age range during youth are needed.

Differences in the decrease of PA between weekdays and weekends, schooldays and holidays, or summer days and winter days are also not well known. Compared with weekdays, children have demonstrated significantly higher moderate-to-vigorous PA on weekends, while adolescents have exhibited significantly lower moderate-to-vigorous PA on weekends (Trost et al., 2000). Gavarry and colleagues (2001) in their cross-sectional study pointed out the influence of gender and type of day on the PA of children and adolescents, whereby a significant decrease in PA during growth was observed during weekdays in boys. A great decrease in PA from primary to high school during weekdays was not observed during weekends. Hovell, Sallis, Kolody and McKenzie (1999) reported that girls' and boys' PA selections are similar across weekdays, weekends and summer, but the general trend involves the decrease in PA levels with the age of children on weekdays, weekends and over summer. On the other hand, Pratt, Macera and Blanton (1999) stated that vigorous, moderate, and recommended activity peaks in the summer months, whereas inactivity peaks in the winter. The range between the highest and lowest months is 10.4% for inactivity (January vs. August) and 7.6% for recommended physical activity (August vs. December). Similarly, Pivarnik, Reeves, and Rafferty (2003) examined Michigan adults and discovered significantly higher weekly leisure-time energy expenditure during spring and summer (about 15-20%) in comparison with autumn and winter.

A longitudinal study of Finnish youth (Telama, Yang, Laakso, & Viikari, 1997) discovered that their participation in organised sport during childhood was a significant predictor of participation in PA during early adulthood. Similarly, participation in organised sporting activities in school age predicted leisure time PA in adulthood (Kraut, Melamed, Gofer, & Froom, 2003). This relation was consistent in the various subgroups of age, body mass index,

marital status, shift work, smoking and religious observance (Kraut et al., 2003). Likewise, Trudeau, Laurencelle, Tremblay, Rajic, and Shephard (1999) investigated the influence of daily primary school physical education (PE) on PA, attitudes to PA, and perceptions of barriers to PA during adulthood. They compared an experimental group of women and men (N = 147) participating in five PE sessions per week throughout their six years of primary school education during the 1970s to a control group (N = 720) with one PE session per week, supervised by the home-room teacher. Their data strongly suggest that daily PE at the primary school has a significant long-term positive effect on the PA habits of women, despite the similar perceived barriers, attitudes and intentions regarding PA in these two groups. In men the only positive influence of the daily primary school PE programme is a greatly reduced risk of regular current smoking. An early experience of PA at the age of 16 decreased the risk of becoming inactive at the age of 34 years (Barnekow-Bergkvist, Hedberg, Janlert, & Jansson, 1996). School PE is characterised by moderate and vigorous PA, which positively influences PA habits in adulthood (Stone, McKenzie, Welk, & Booth, 1998). Therefore, school PE is identified as providing important infrastructure for promoting healthy PA patterns during childhood and adolescence (Corbin, 2002; Daley, 2002; Stone et al., 1998).

Regular participation in school PE and organised sport is a considerable component of one's daily energy expenditure (Katzmarzyk & Malina, 1998; Van Mechelen et al., 2000). Van Mechelen et al. (2000) reported that organised sports activities were at low levels in every age category from 13 to 27, but these activities did not decline with the increasing age of young people. Katzmarzyk and Malina (1998) found that young people aged 12-14 who participated in organised sports had higher total daily energy expenditure and moderate-to-vigorous energy expenditure and spent less time watching television than those who did not participate. Although a large proportion of children is involved in PE at school, the contribution of PE classes to overall PA depends on their quantity and quality (Sallis & McKenzie, 1991).

The purpose of the present study is to examine the proportion of weekly activity energy expenditure (AEE) spent in PE and organised sport in youth aged 12-19 and to explore how these components of PA may contribute to, or slow down, the age-related decline. The second purpose is to analyse how weekday and weekend physical activity and inactivity are related to age.

METHOD

Participants

Adolescents for the cross-sectional analysis were recruited from 17 primary schools and 31 high schools in the Czech Republic – Middle and Northern Moravia, and Eastern Bohemia. These 48 urban and rural schools were randomly chosen from 69 invited schools that agreed to participate in this research. Participants for the accelerometer monitoring were identified by randomly selected classes of urban and rural schools. A total of 855 girls and 585 boys completed the one-week monitoring of PA and physical inactivity. To examine age- and gender-related trends, the adolescents were grouped into four categories: 11.5-13.4 years (66 girls, 51 boys), 13.5-15.4 years (262 girls, 135 boys), 15.5-17.4 (282 girls, 250 boys), and 17.5-19.4 years (245 girls, 149 boys). The study was approved by the university ethics committee.

Instruments

The monitoring of PA and physical inactivity was based on simultaneous multiple measurement, using the Caltrac accelerometer (AEE) and individual 7-day logs (intensity of PA and frequency, time and type of PA and physical inactivity) (Frömel, Novosad, & Svozil, 1999). Combinations of various approaches and technologies are recommended for the most accurate measurement of young people's PA patterns (Bassett, 2000). Given the lack of a single, commonly accepted measure of PA, and the fact that different measures assess different aspects of adolescents' PA behaviour, a combination of the Caltrac accelerometer and individual 7-day logs was used.

Field and laboratory studies have supported the validity of accelerometers in assessing PA patterns of children and youth (Janz, Witt, & Mahoney, 1995; Trost et al., 2002; Welk, Corbin, & Dale, 2000). Accelerometers have been used for several-day, full-week or longer monitoring periods (Freedson & Miller, 2000; Janz, Witt, & Mahoney, 1995; Trost et al., 2000; Welk, Corbin, & Dale, 2000).

To assess energy expenditure the Caltrac accelerometer has been validated by heart-rate monitoring in field conditions (Montoye, Kemper, Saris, & Washburn, 1996) and in a 7-day monitoring study of Czech adolescents (Frömel, Novosad, & Svozil, 1999). The Caltrac AEE has significantly correlated with steps recorded with an Omron pedometer ($r_S = 0.62$) and time of PA from the 7-day log ($r_S = 0.48$) in the 7-day field monitoring of 11-12-year-old children (Sigmund, 2000). Most validation studies in children have used the Caltrac accelerometer solely as an activity monitor with energy expenditure given in activity counts. However, valid caloric expenditure values obtained from the Caltrac accelerometer could provide a more meaningful estimation of PA patterns in children than activity counts alone (Bray, Morrow, Pivarnik, & Bricker, 1992).

The Caltrac accelerometer was programmed to provide a read-out of total and activity energy expenditure calories by setting personal data for each subject (weight, height, age and gender). An AEE means the net cost of activity calculated as total energy expenditure – resting metabolic rate from the Caltrac accelerometer. In determining caloric expenditure values, the Caltrac accelerometer uses an equation that estimates the resting metabolic rate based on the subject's personal data – weight, height, age and gender (Bray et al., 1992). The two-page, seven-day logs (the first page is for the Caltrac accelerometer and the second is for performed activities) contained tables with seven columns (one for each day). The first table with physical activities included 21 items concerning transport, conditioning, occupation, sports and leisure activities. The second table with types of physical inactivity included six items – sitting or lying and watching TV, sitting in front of a computer, sitting or lying while studying, sitting at school, sitting in a park, pub etc., sitting in a car, bus, train etc. Additional space was provided for any activities that were not listed.

Procedure

Each of the monitored adolescents wore a Caltrac accelerometer for seven consecutive days of their weekly habitual school routine. All participants were instructed in detail on how to use the Caltrac accelerometer and the 7-day logs. They were instructed to wear the accelerometer fixed on their right hip during the whole day, except when sleeping, bathing or swimming. An elastic belt with a pocket for the Caltrac accelerometer device provided for an accurate and

fixed placement. A small pencil and the 7-day logs were placed in the accelerometer pocket. Monitoring started on a randomly selected day of the week. Whole classes were monitored at the same time and accelerometers were reset to begin monitoring the morning after the instructions were given, and they were not reset for seven days. The adolescents recorded the time and total and active energy expenditure values in their 7-day logs every morning after waking up and in the evening before sleeping. In the evening, they also recorded FITT characteristics (frequency, intensity – moderate or vigorous, time/duration, and type) of daily PA and the duration of daily types of physical inactivity in their 7-day logs. Further, on weekdays (schooldays) the students recorded the time and the total and active energy expenditure variables at the beginning of school, at the beginning and at the end of PE classes, at the end of school and at the beginning and end of any type of organised sport. The participants were instructed to make entries only for activities with a duration ≥10 min. A check of the correctness of the 7-day logs was conducted with each class at the end of the 7-day monitoring. The number of participants who filled in the 7-day logs incorrectly varied from 5% to 15% across the classes. Correctly filled in 7-day logs were considered those that included at least 6 days of data (2 weekend days and 4 weekdays) from the Caltrac accelerometer and data about PA and physical inactivity.

The monitoring took place in the spring and autumn semesters from 2000 to 2005 during school weeks without any important examinations, days off (school and public holidays), and without any special sports courses or competitions lasting more than one day. Organised sport meant any intentional PA led by a teacher, trainer or instructor (Frömel, Novosad, & Svozil, 1999).

It is necessary to compare the different age and somatic groups of girls and boys. Therefore, AEE is expressed in a relative value – ($kcal \cdot kg^{-1} \cdot day^{-1}$). For the statistical analysis of age- and gender-related AEE ($kcal \cdot kg^{-1} \cdot day^{-1}$) and time of physical inactivity ($min \cdot day^{-1}$), two different two-way (age x gender) MANOVA were used. Weekdays and weekends were used as the dependent variables. Scheffe post-hoc comparisons were used to identify the significant main effects. The estimate of the strength of the relationship between the independent and dependent variables was represented as the coefficient ω^2 (Thomas & Nelson, 2001).

The Kruskal-Wallis non-parametric test was used for a statistical comparison of the percentage representation of PE classes or organised sport. The effect size reported for the Kruskal-Wallis procedure was η^2 (Morse, 1999).

The standard amount of PE for all these students was two classes of 45 minutes per week led by a certified PE teacher. The active participation of adolescents in at least one of the two PE classes was a necessary precondition for statistical analysis of the percentage representation of PE classes or organised sport.

RESULTS

An age-related decline in AEE ($kcal \cdot kg^{-1} \cdot day^{-1}$) assessed by the Caltrac accelerometer was evident in both girls and boys, especially on weekends (see Figure 1). The negative values of Spearman's correlation coefficient between weekend or weekday AEE and the age of girls ($r = -0.11$, $p = 0.0012$ or $r = -0.21$, $p = 0.0000$), and boys ($r = -0.16$, $p = 0.0000$ or $r = -0.25$, $p = 0.0000$) indicated these results. Girls and boys were more physically active on weekdays than weekends in all age categories (days $F(1, 2880) = 125.13$, $p = 0.0000$, $\omega^2 = 0.076$); (age F (3,

2880) = 24.65, p = 0.0000, ω^2 = 0.043). The interaction effect of days x age was not significant (F (3, 2880) = 1.49, p = 0.2165, ω^2 = 0.001. However, Spearman's correlation coefficients between weekday and weekend AEE in girls (r = 0.58, p = 0.0000), and boys (r = 0.55, p = 0.0000) demonstrated that adolescents who are active on weekdays are also active on weekends. This pattern is strengthened with the increasing age of boys (r = 0.30 at age from 11.5 to 13.4 years, r = 0.45 at age from 13.5 to 15.4 years, r = 0.54 at age from 15.5 to 17.4 years, and r = 0.61 at age 17.5 to 19.4 years), and girls (r = 0.53 at age from 11.5 to 13.4 years, r = 0.59 at age from 13.5 to 15.4 years, r = 0.51 at age from 15.5 to 17.4 years, and r = 0.63 at age from 17.5 to 19.4 years). According to AEE, boys were more physically active than girls in all age categories (F (1, 2880) = 63.92; p = 0.0000, ω^2 = 0.004). The interaction effect of gender x age was significant (F (3, 2880) = 3.98, p = 0.0077, ω^2 = 0.006). Although the interaction effect of gender x day was not significant (F (1, 2880) = 1.86, p = 0.1726, ω^2 = 0.001), the gender differences were greater on weekdays (Scheffe post-hoc test p = 0.0000) than weekends (Scheffe post-hoc test p = 0.0000).

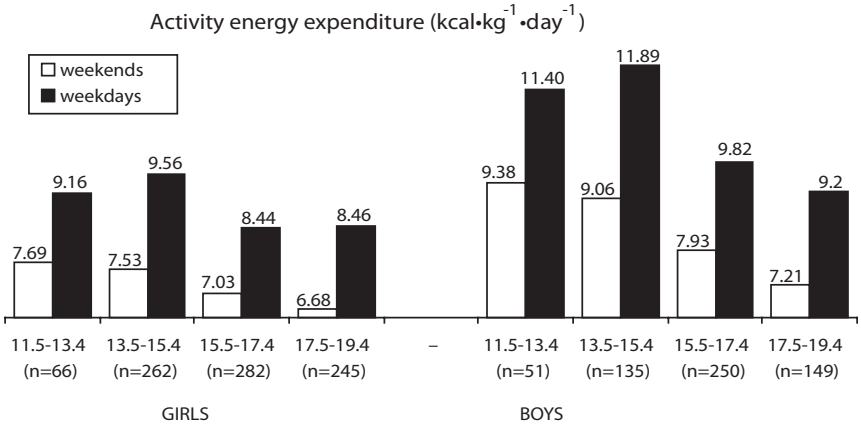

Figure 1: Comparison of AEE (kcal·kg^{-1}·day^{-1}) in the weekly habitual school routines of adolescents of different age categories

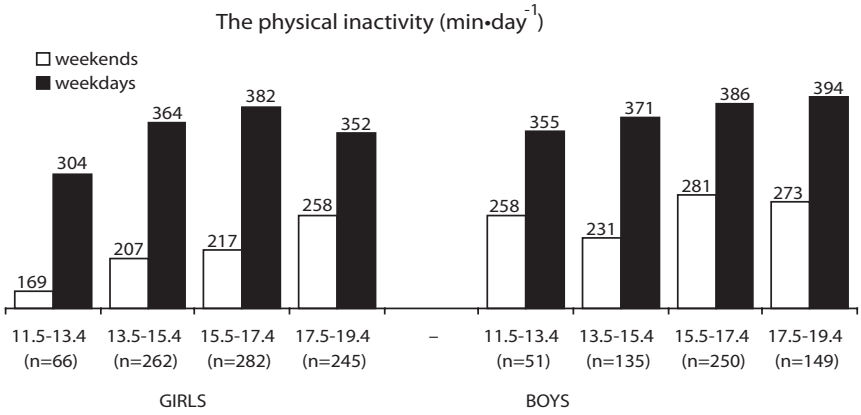

Figure 2: Comparison of physical inactivity (min·day^{-1}) in the weekly habitual school routines of adolescents of different age categories

An increase in physical inactivity with advancing age was evident in girls on weekends and in boys on weekdays (see Figure 2). Although Spearman's correlation coefficients between weekend or weekday time of physical inactivity and the age of girls and boys are low (girls: $r = 0.21$, $p = 0.0000$ or $r = 0.08$, $p = 0.0883$; boys: $r = 0.11$, $p = 0.0500$ or $r = 0.14$, $p = 0.0160$), they support these findings. According to the activity logs, girls and boys were more physically inactive on weekdays than weekends in all age categories (days: $F(1, 2880) = 331.53$, $p = 0.0000$, $\omega^2 = 0.1840$; age: $F(3, 2880) = 7.56$, $p = 0.0000$, $\omega^2 = 0.011$). The interaction effect of days x age was significant ($F(3, 2880) = 2.94$, $p = 0.0319$, $\omega^2 = 0.003$). Spearman's correlation coefficients between the weekday and weekend time of physical inactivity in girls ($r = 0.51$, $p = 0.0000$), and boys ($r = 0.52$, $p = 0.0000$) indicate the striking relationship between weekday and weekend physical inactivity patterns.

Physical inactivity in girls and boys represented from 4.5 to 5.7 hours per day in all age categories (see Figure 2). Sitting at school accounted for about 60-70% of the weekday physical inactivity of adolescents of both genders. For girls, watching TV and using computers comprised 23-33% and 6.9-8% (71-83 minutes and 18-27 minutes) of daily time spent on physical inactivity. For boys, watching TV and using computers comprised 21-31% and 18-24% (72-101 minutes and 57-83 minutes) of daily time spent on physical inactivity. The proportion of physically inactive time calculated from the time of watching TV and using the computer was considerably higher on weekends than weekdays for both girls and boys in all age categories. The ratio of PA (including walking) to physical inactivity (excluding sleeping), according to the times noted in the adolescents' individual self-reports, was from 1:2.38 to 1:3.3, which was similar for girls and boys.

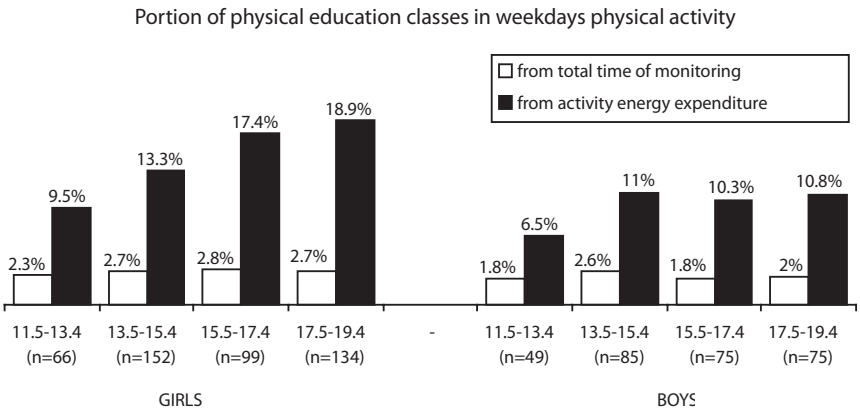

Figure 3: Percentage of weekday activity energy expenditure accounted for PE classes, by age and gender

Since students were only included in the analyses if they participated in at least one required PE session during the monitoring week, the percentage of time devoted to PE was similar across all subgroups (see Figure 3). However, the share of AEE contributed by PE increased with the advancing age of youths. These increases were significant for both girls ($H(3, 451) = 10.12$, $p = 0.0175$, $\eta^2 = 0.036$, $r_{S\times AGE} = 0.23$, and boys ($H(3, 284) = 20.53$, $p = 0.0001$, $r_{S\times AGE} = 0.25$). The Kruskal-Wallis non-parametric test revealed that PE accounted for a higher proportion of girls' AEE compared to that of the boys ($H(1, 735) = 45.45$, $p = 0.0000$, $\eta^2 = 0.062$).

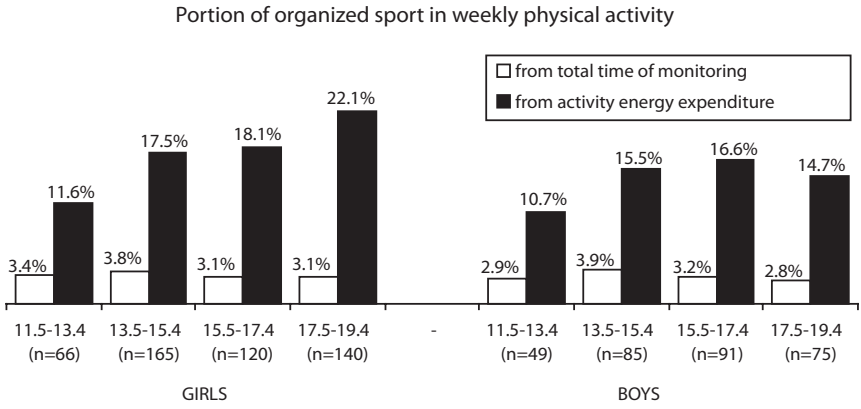

Figure 4: Percentage of weekly activity energy expenditure accounted for organised sport, by age and gender

There was a small significant age-related decline in the percentage of time in organised sport for both genders (girls: H (3, 491) = 7.87, p = 0.0496, η^2 = 0.016, $r_{S\times AGE}$ = -0.03; boys: H (3, 300) = 9.55, p = 0.0231, η^2 = 0.032, $r_{S\times AGE}$ = -0.09) (see Figure 4). However, the results of the Kruskal-Wallis non-parametric test indicate considerable significant increases with age in the proportion of AEE contributed by organised sport for girls (H (3, 491) = 26.61, p = 0.0000, η^2 = 0.054, $r_{S\times AGE}$ = 0.19), and for boys (H (3, 300) = 15.06, p = 0.0018, η^2 = 0.050, $r_{S\times AGE}$ = 0.14). The contribution of organised sport AEE was significantly higher in girls than in their male peers (Kruskal-Wallis non-parametric test H (1, 791) = 12.27, p = 0.0005; η^2 = 0.016).

DISCUSSION

As expected, the present study documented a significant decline in PA for girls and boys during teenage years, which is consistent with previous findings from Europe (Riddoch et al., 2004; Telama & Yang, 2000; Van Mechelen et al., 2000), Australia (Leslie et al., 2001) and North America (Barnett, O'Loughlin, & Paradis, 2002; Bradley et al., 2000; Gavarry et al., 2001; Hovell et al., 1999; Trost et al., 2002). The present study has extended the previous findings by showing that the decline is similar on weekdays and weekends for both genders, and that the gender difference in PA is mainly due to boys being more active than girls on weekdays.

A notable finding for both genders and all age categories is that adolescents are much more active on weekdays than on weekends. An extremely low value of AEE (4 $kcal \cdot kg^{-1} \cdot day^{-1}$) characterised only 3.4% of girls and 2.7% of boys on weekdays. However, on weekends 21.9% of girls and 16.6% of boys had an AEE lower than 4 $kcal \cdot kg^{-1} \cdot day^{-1}$. Increasing physical activity on weekends should be a high priority but this may be a challenging task because there is no opportunity to intervene through schools on weekends.

Physical inactivity, particularly from TV viewing and computer use, occupied at least four and half hours per weekday for all subgroups, and about 60-70% of sedentary time was due to sitting in class. There were few differences by gender or age, and the greater inactivity time on

weekends was largely explained by time at school. Due to the well-documented associations of inactivity time and risk of being overweight in youth (Saelens, 2003), the present results indicate that reducing inactivity time in Czech adolescents should be a priority. It is important to find effective methods for shifting time away from physical inactivity towards physical activity in youths' leisure time.

This study documents the important role that can be played by PE and organised PA in the overall PA of adolescents. A quality PE class can reduce disparities in PA between girls and boys (Katzmarzyk & Malina, 1998; McKenzie et al., 2000), higher- and lower-skilled boys (Hastie & Trost, 2002) and participants and non-participants of organised sports (Katzmarzyk & Malina, 1998). Although adolescents in the current study spent only 2-3% of their non-sleeping time in PE classes, those classes contributed 10% (boys) and 15.5% (girls) of weekly AEE. Much PA in youth is done outside of school, yet a few studies have documented the contribution of organised PA to total PA. In the present study, organised sport on average contributed 18.2% of weekly AEE for girls and 14.8% for boys. Both PE and organised sports were larger contributors to girls' than to boys' weekly AEE, and that contribution significantly increased with age for girls. The present findings indicate both PE and organised sport can be effective intervention strategies for increasing youth PA. So policies and resources supporting these programmes should be strengthened. However, these structured opportunities for PA are especially important for girls, who have lower PA levels than boys (Sallis, 2000). We completely identified with Corbin's (2002) belief that PE programmes should make special efforts to help all children develop positive self-perceptions (self-esteem) in PA situations. Positive physical self-esteem relates positively to lifelong PA (Corbin, 2002; Daley, 2002). However, PE alone is not the answer to ensure the adopting of a physically active lifestyle. Corbin (2002, pp. 140) stated: "We can teach children to be active, but parents must help in this effort by giving their children the opportunity to be active daily".

Strengths of the study include the substantial sample of Czech adolescents involved, drawn from a wide age range. Recruiting young people from multiple schools should increase the generalisability of the findings, although the generalisability vis-à-vis other countries needs to be tested. Although validated accelerometers were used for an entire 'normal' school week, there are some limitations of the measures. The accelerometer protocol was a combination of objective and self-report measurement because the students recorded accelerometer scores on logs several times per day. In addition to the inability of the Caltrac accelerometer to record some activities (Freedson & Miller, 2000), the need for careful recording introduced additional errors. Although the completeness of recording was found to be relatively high, the accuracy cannot be evaluated. Despite some limitations of the measures, the current study did use an objective monitor and was designed to answer questions about the decline in youth PA that rarely have been addressed.

In conclusion, the present study documents the need for additional programmes to boost PA, especially on weekends, and to reduce the time devoted to undesirable forms of inactivity, especially watching TV and using computers. The substantial promise of PE and organised sport programmes to contribute to youth PA was shown, suggesting that improvements in quantity, quality and enrolment in such programmes could be effective for promoting PA. It was notable that PE and organised sport contributed more to girls' overall AEE and that this contribution increased with age. Without PE and organised sport programs, the decline in

girls' AEE would be even more pronounced. Further studies are needed to examine how PE and organised sport programmes may contribute to adolescent AEE in other countries.

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