Adolescents’ Physical Activity in Education Systems Varying in the Number of Weekly Physical Education Lessons

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ABSTRACT

Purpose: School physical activity (SPA) is a significant component of daily PA. We investigated differences in PA between boys and girls in two differing education systems—Poland and the Czech Republic—which have four and two physical education lessons (PELs) per week, respectively. Method: This project was conducted from 2012–2016 at 17 Polish and 23 Czech secondary schools (N = 921; mean age = 16.2 ± 0.7 years). ActiTrainer accelerometers were used to monitor participants’ PA and heart rate during school days. Weekly PA was measured using pedometers. Subjective levels of weekly PA were self-reported on the International Physical Activity Questionnaire—long form. Results: The Polish education system enabled adolescents to meet the recommendations for moderate-to-vigorous PA more likely than did the Czech system. SPA also represented a higher portion of daily PA in the Polish (vs. Czech system); however, the differences in total daily step count between Polish and Czech adolescents were non-significant. SPA accounted for 30–37% of the daily PA (as measured by step count) of Polish girls (23–30% of Czech girls) and 28–39% of Polish boys (25–37% of Czech boys). Conclusions: Participation in PELs was associated with a higher rate of meeting SPA recommendations in both countries. Compared with the Czech Republic, more PELs in the Polish education system was associated with increased daily vigorous PA and a greater portion of SPA in daily PA. Differences in overall daily and weekly moderate-to-vigorous PA between Polish and Czech adolescents were non-significant.

Among all institutions, schools have the strongest influence on most young people; thus, schools play a substantial role in controlling the worldwide prevalence of physical inactivity and promotion of physical activity (PA) in adolescents (Dumith, Gigante, Domingues, & Kohl, 2011; Hills, Dengel, & Lubans, 2015). The level of daily and weekly PA in young people significantly depends on their level of school PA (SPA; Faulkner, Buliung, Flora, & Fusco, 2009). SPA is a significant component of daily PA (Griew, Page, Thomas, Hillson, & Cooper, 2010; Pate et al., 2006). Higher SPA is associated with higher overall daily moderate-to-vigorous physical activity (MVPA; Long et al., 2013), which has been demonstrated in Western countries (Duncan, Duncan, & Schofield, 2008) and in post-communist countries such as Poland and the Czech Republic (Nováková Lokvencová, Frömel, Chmelík, Groffik, & Bebčáková, 2011). However, we do not adequately know the associations between SPA and the remaining segments of the school day, especially on specific days of the week. It is important to measure these associations using a combination of objective (accelerometers) and subjective methods of PA monitoring. Newly emerging methods of self-reported SPA estimates, such as the Youth Activity Profile (Saint-Maurice et al., 2017) or the Evaluation of Activity Surveys in Youth (Pate et al., 2018), can make a significant contribution to a combination of objective and subjective SPA research.

An important part of SPA is represented by physical education (PE); although, its possibilities are limited, and we cannot expect PE to provide all the daily PA that adolescents need (McKenzie & Lounsbury, 2013). Nevertheless, PE plays a key role in creating habits for regular PA and in acquiring a healthy lifestyle in children and young people (McKenzie et al., 2006). The importance of PE to ensure vigorous PA is well-supported within the domain of SPA (Kerr et al., 2018) and concerning the acquisition of physical and health literacy (Cairney, Dudley, Kwan, Bulten, & Kriellaars, 2019; Lundvall, 2015). Active recesses play a similarly significant role in SPA (Zhou & Wang, 2019); although, their contribution to overall daily PA is limited (Reilly, Johnston, McIntosh, & Martin, 2016). School recesses cannot replace PE (Frömel, Svozil, Chmelík, Jakubec, & Groffik, 2016; Murray et al., 2013); however, they are indispensable to offset educational load (Svozil...
et al., 2015) and promote a healthy school environment (Glazzard, 2018; Morton, Atkin, Corder, Suhrcke, & van Stuijs, 2016).

In addition to the family, sport clubs, and other leisure-time PA programs and facilities, the school serves as a key setting in which to adopt habits for performing daily PA. There is sufficient evidence that adolescents tend to have higher daily PA on school days when PE lessons are scheduled than when they are not (Ramstetter, Murray, & Garner, 2010). Recommendations to increase the efficiency of SPA (Hills et al., 2015; Pate et al., 2006; Sallis et al., 2012) are known and widely accepted. Nonetheless, their actual implementation in school practice, as associated with educational goals, the lack of physical literacy among pupils and teachers, and the negative impact of mobile technologies, remains inefficient globally.

Research on SPA, in different educational settings, could elucidate the efficient promotion of a healthy school lifestyle (and students’ habits) in diverse countries. Differences between countries could be due to the varying number of PE lessons (PELs) or the role of school sport clubs, the level of extracurricular school programs, or how PA is integrated into teachers’ lessons. Development of effective SPA recommendations (Frömel et al., 2016; Pate et al., 2006; Svozil et al., 2015) requires further research that clarifies the composition of SPA in different education systems. SPA recommendations could become basic guidelines in the development of the educational process and comprehensive SPA programs. Therefore, in this study, we examined the differences in boys’ and girls’ PA in two different education systems—Poland and the Czech Republic—which have four and two PELs weekly, respectively. Comparison of both education systems concerning adherence to SPA recommendations should provide new insight into the role of PELs in schools and overall daily PA among adolescents.

**Methods**

**Participants**

In total, 921 participants aged 16.2 ± 0.7 years (Table 1) participated. The sampling method was non-probabilistic. Of the total sample, 803 participants underwent pedometer monitoring to assess their weekly PA and estimated their weekly PA using the International Physical Activity Questionnaire–long form (IPAQ-LF).

Comparing Polish and Czech students, the differences in age (boys, \( p = .901 \); girls, \( p = .569 \)), body mass index (BMI; boys, \( p = .950 \); girls, \( p = .598 \)), and resting heart rate (HR; boys, \( p = .469 \); girls, \( p = .421 \)) were non-significant.

All participants and their parents agreed to be involved in the research and provided written, informed consent (response rate = 95%). Disagreement with the research occurred exceptionally (typically one or two per class).

**Setting**

The research was conducted at 17 Polish and 23 Czech secondary schools. We selected the participating schools according to the place of residence of the undergraduate students who were at the schools as student teachers at the time of this research. During school sampling, we sought to achieve the best possible match between Polish and Czech school types (general and vocational), the size of the city, and the widest possible regional coverage. The selected schools had a similar organization of the educational process, and PELs were organized as single-sex classes. They varied only in the number of weekly PELs (i.e., four in Poland and two in the Czech Republic). At all participating schools, we selected a class/group of participants who had a habitual weekly school program and their weekly schedule included an information-communication technology lesson that took place in a computer classroom. PELs in both countries lasted 45 minutes.

**Design**

The research was conducted by the same research teams at all schools in both countries and was performed under common school conditions without any disruption to the school program. During the introductory one-lesson session in a computer classroom, participants were introduced to the arrangement of the research, then were registered in the Indares web
application (www.indares.com), and their weight and height were measured using Tanita UM-075 and Leicester height measure.

Next, they completed a questionnaire on their weekly PA (estimate of PA over the last seven days) and were introduced to wearables for PA monitoring (Figure 1). Three-day PA and HR monitoring by accelerometers and seven-day monitoring of PA by pedometers occurred the very next day. Participants were asked to wear chest straps for at least one day and, if feasible for them, for three days. This period of PA monitoring using accelerometers (including chest straps to record HR) was shown to be optimal in previous research studies (Frömel et al., 2016; Svozil et al., 2015). Two weeks after collecting the accelerometers and pedometers, participants were provided with individual results of PA monitoring and school management received aggregate group results with recommendations and suggestions for positive changes in school lifestyle.

Monitoring and procedures

The ActiTrainer accelerometers (Pensacola, FL, USA) and the YAMAX Digi-Walker SW-700 pedometers (Yamax Co., Yasama Corp., Tokyo, Japan) were used for objective PA monitoring. The ActiTrainer device is a combination of the ActiGraph accelerometer and a HR sensor (the Polar type), which provides feedback on PA (MVPA, steps) and HR (beats per minute).

The Digi-Walker pedometers, which we used throughout the research, are suitable for monitoring habitual PA (Schneider, Crouter, & Bassett, 2004). To limit the impact of PA monitoring reactivity, participants began wearing the pedometers during the introductory session; however, weekly PA monitoring only began on the following day.

Participants used the ActiTrainer accelerometers and pedometers to monitor their PA from morning (after morning hygiene) throughout the day (except showering and bathing) to the evening (hygiene before bedtime). Participants wore both the devices on their right hip and took them on and off when changing their clothes or performing other activities concurrently. Individual resting HR was measured in accordance with the exact instructions in the morning after waking up, repeatedly three times in 15-second intervals. The measured values for each measurement were converted to the number of beats per minute and recorded on the record sheet. Individually measured HR resting values were used to calculate the mean value that was, in the case of higher values, corrected according to the lowest

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Figure 1. Research flow in schools. Note. PA = physical activity, HR = heart rate.
daily HR value as measured by the ActiTrainer. During the day, participants filled in the following times of: putting the devices on, arrival at school, school hours including school breaks, after regular school schedule, departure from school, participation in organized PA, and taking the devices off before bed. In this main segments of the day, they also recorded their step counts.

To obtain information about the weekly PA composition prior to PA monitoring by accelerometers, we surveyed participants’ weekly PA using the IPAQ-LF. We used the Polish and Czech versions of the questionnaire, which were subject to generally recognized translation procedures of the EORTC Quality of Life group (Cull et al., 2002). Both versions were previously used in comparative Polish-Czech surveys (Kudláček, Frömel, Jakubec, & Groffik, 2016; Mitáš, Sas-Novoselská, Groffik, & Frömel, 2018). Coefficients of concurrent validity between weekly PA (METs-min) from the IPAQ-LF questionnaire and weekly step counts ranged from $r = 0.231$ to 0.283, per Pearson’s correlation coefficient for both versions of the questionnaire. Cronbach’s alpha, as an indicator of internal consistency reliability, was 0.848 for the Polish version and 0.845 for the Czech version. In the IPAQ-LF questionnaire, participants estimate the structure of their PA in job/school, transportation, home (housework, housekeeping, and family care), recreation, and time spent sitting.

**Recommendations for SPA**

Based on previous studies (Frömel et al., 2016; Svozil et al., 2015), we set the following SPA recommendations for objective PA monitoring: a) at least 500 steps/hour during school time, b) at least 25% PA of overall school time, c) at least 20 minutes of MVPA (≥3 METs) during school time; d) at least 20 minutes of MVPA (≥60% HRmax) during school time.

Other SPA recommendations related to the self-rated estimate of the weekly PA in the IPAQ-LF respect the generally accepted guidelines of ≥60 minutes daily for MVPA among adolescents (European Commission, 2008; U.S. Department of Health and Human Services, 2018; World Health Organization, 2010), and we derived them from the category of job/school-related PA. For vigorous PA, we set a minimum criterion of three or more days/week for at least 20 minutes a day (3 × 20 minutes/on school days); and, for moderate PA, it was at least 30 minutes on each school day (5 × 30 minutes/on school days).

**Data processing**

We included only those participants who wore the accelerometer for at least 15 minutes before the beginning of school, at least 180 minutes in school (excluding PE), and at least 120 minutes after school. The total minimum time of PA accelerometer monitoring was set at 600 minutes/day. Failure to meet the criteria for each segment of the day meant that given participant was excluded from analyses. Overall, 243 participants were excluded for this reason. We transformed all the data to an hour of wearing an accelerometer in each segment of the day. We included the results of the PA and HR monitoring of the day, in which the participants met the specified minimum requirements. If participants managed to record their PA on more than one day in line with the requirements, we included the first day of such monitoring.

Data processing from the ActiTrainer accelerometer followed the same procedure as previous studies that used the same methods (Frömel, Kudlacek, Groffik, Chmelik, & Jakubec, 2016; Frömel et al., 2016; Svozil et al., 2015). We used IntPA13 software (https://upol.cz/fileadmin/userdata/FTK/Fakulta/Verejnost/Navod_IntPA13.pdf), which was developed in-house) to process the data (records in 15-second intervals). The software enabled us to evaluate data before, during, and after school time; in non-PELs, during recesses, in PELs; and for aggregate school time. PA intensity level was determined according to HR in 30–100% HRmax in 10% intervals and in METs as a metabolic equivalent. The intensity zones were determined according to strength of correlations between time spent in these zones throughout the day, METs, and 10% HRmax. The strongest correlation was found between time spent in the zone ≥60% HRmax and ≥3 METs ($r_s = 0.288$) within our all-day PA and HR field monitoring. The intensity zones were classified as follows: low (50–59.9% HRmax; <3 METs), moderate (60–84.9% HRmax; 3–5.9 METs), or vigorous PA (85–100% HRmax; ≥6 METs).

The extreme values of pedometer-derived data were adjusted in line with experience from previous studies. Data for any single day indicating <1,000 steps were removed and values of >30,000 steps on any single day were truncated or replaced to 30,000 steps (Tudor-Locke, Giles-Corti, Knuiman, & McCormack, 2008). Valid pedometer data meant that at least three school days and one weekend day were included. Missing step count data were replaced by data from the previous day. If the missing data concerned the first school or weekend day, the data from the following day were used.
The data from the IPAQ-LF were calculated following the IPAQ scoring protocol (https://sites.google.com/site/theipaq/scoring-protocol). The MET-min of VPA were multiplied by six (vs. eight, which was recommended in the original scoring protocol), the estimated minutes of weekly PA in different PA domains were converted to average PA minutes per day, the acceptable maximum average daily sum of minutes of PA, and transportation and sedentary behavior was set as 960 minutes/day. The maximum amount of MET-min per week was set to 20,000 MET-min. Of the 921 participants, 118 participants were excluded from the accelerometer monitoring for failing to meet the noted conditions. The sample including data from pedometer monitoring and the IPAQ-LF questionnaire involved 803 participants. The key moderating variables included age, BMI, and country.

Data analysis

We used SPSS 22 (IBM, Armonk, NY: IBM Corp.) and Statistica 13 (StatSoft Inc., Prague, Czech Republic) programs for statistical processing of data. Specifically, Kruskal-Wallis’ analyses of variance (ANOVAs) were conducted for IPAQ-LF results, two-way ANOVAs were conducted to assess the interaction effect 2 (countries—Poland and Czech Republic) × 2 (participation in PELs—yes and no) in daily (and average school day) step count measured by pedometers. The repeated measures ANOVAs were conducted for pedometer data, k analyses interaction effect 5 (school days) × 2 (countries—Poland and Czech Republic) × 2 (participation in PELs—yes and no) in daily step count. The Box's M test and Mauchly’s sphericity test were used to test if the ANOVA assumptions were not violated. Pearson’s correlations and binary logistic regression analyses (enter method) were conducted to analyze accelerometry data. The logistic regression model included participation in PELs (non-participation—reference group) and time of PA in recesses (sum < 60 minutes of PA—reference group). The model 2 further contained control variables: gender (boys—reference group), age (<16 years—reference group), BMI (<25 kg.m⁻²—reference group), and country (Czech Republic—reference group). The η² and w effect size coefficients were evaluated as follows: 0.01 ≤ ηp² < .06 (0.10 ≤ w < 0.29) = a small effect size, 0.06 ≤ ηp² < 0.14 (0.3 ≤ w < 0.50) = a medium effect size, and ηp² ≥ 0.14 (w ≥ 0.50) = a large effect size (Cohen, 1988; Sheskin, 2007). Significance was set at p < .05.

Results

Actitrainer-determined structure of SPA and rates of meeting the recommended level of SPA

Participants who engaged in PELs met the determined SPA recommendations significantly more than did their counterparts in all four recommendations (p < .001). This result was similar for those who had longer recesses (except for the recommendation of at least 20 minutes MVPA ≥ 60% HRmax/school time; Table 2). Significant differences between Polish (40.8%) and Czech participants (28.6%) were observed only concerning the recommendation for at least 20 minutes MVPA (≥60% HRmax/school time). The differences in achievement of SPA recommendation (concerning at least 25% PA of overall school time) were significant (besides participation in PELs and longer recess time) for sex, age, and BMI. Differences in daily step counts by country and participation in PELs were non-significant (F(1,917) = 2.68; p = .102; ηp² = .003).

The predictors in meeting SPA recommendations

Participation in PELs and longer recesses (≥60 minutes) were strong predictors for meeting the SPA recommendations (Table 3). Participation in PE was a main predictor in fulfillment of all types of SPA recommendations: at least 500 steps/hour, at least 25% PA, at least 20 minutes of MVPA (≥3 METs/school time), and at least 20 minutes of MVPA (≥60% HRmax/school time). The time of recesses (≥60 minutes in total) was a significant predictor for SPA recommendations, except for “at least 20 minutes MVPA (≥60% HRmax/school time).” The confounding variables of sex, age, BMI, and country (model adjusted for difference between the education systems) did not reduce the significance of either predictor.

Pedometer-determined SPA on school days (steps/day)

Regarding the daily steps counts conducted in school days by country and participation in PELs days, we did not find any significant differences (F(3,799) = 0.03; p = .866; ηp² < .001). Likewise, we reached similar findings regarding repeated measures for specific school days (F(15,3196) = 2.00; p = .092; ηp² = .002).

On average, Polish girls reached 3,520 steps/school-time; i.e., 33% of the average daily step count (Czech girls reached 3,188 steps/school-time, 27%). Polish boys reached 3,683 steps/school-time; i.e., 34% of their average daily step count (Czech boys reached 3,316 steps/school-time, 28%). The lowest portion of school-based step count per school day
Table 2. Meeting the recommendation for school physical activity (N = 921).

| Variables | At least 500 steps/hour in school time | At least 25% PA of overall school time | At least 20 minutes MVPA (≥3 METs/school time) | At least 20 minutes MVPA (≥60% HRmax/school time) |
|-----------|--------------------------------------|--------------------------------------|---------------------------------------------|---------------------------------------------|
|           | Yes n (%)                             | No n (%)                             | Yes n (%)                                   | No n (%)                                   |
| Gender    |                                      |                                      |                                             |                                             |
| Boys      | 129 (39.8)                            | 195 (60.2)                           | 241 (74.4)                                 | 83 (25.6)                                  |
| Girls     | 224 (37.5)                            | 372 (62.5)                           | 371 (62.1)                                 | 226 (37.9)                                 |
| Country   |                                      |                                      |                                             |                                             |
| Czech Republic | 240 (38.2) | 389 (61.8) | 406 (64.6) | 223 (35.4) |
| Poland    | 113 (38.7)                            | 179 (61.3)                           | 206 (70.6)                                 | 86 (29.4)                                  |
| Age       |                                      |                                      |                                             |                                             |
| <16 years | 143 (41.2)                            | 210 (58.8)                           | 254 (73.2)                                 | 93 (26.8)                                  |
| ≥16 years | 204 (58.8)                            | 364 (41.2)                           | 358 (62.4)                                 | 216 (37.6)                                 |
| BMI       |                                      |                                      |                                             |                                             |
| <25 kg·m⁻² | 318 (38.6) | 505 (61.4) | 558 (67.8) | 265 (32.2) |
| ≥25 kg·m⁻² | 35 (35.7) | 63 (64.3) | 54 (55.1) | 44 (44.9) |
| PEL       |                                      |                                      |                                             |                                             |
| No        | 154 (26.0)                            | 438 (74.0)                           | 325 (54.9)                                 | 267 (45.1)                                 |
| Recess    |                                      |                                      |                                             |                                             |
| <60 min   | 146 (30.6)                            | 331 (69.4)                           | 287 (60.2)                                 | 190 (39.8)                                 |
| ≥60 min   | 207 (46.6)                            | 237 (53.4)                           | 325 (73.2)                                 | 119 (26.8)                                 |

OR (95% CI) p

Table 3. The predictors of meeting the SPA recommendations.

| Variables | Category | At least 500 steps/hour in school time | At least 25% PA of overall school time | At least 20 minutes MVPA (≥3 METs/school time) | At least 20 minutes MVPA (≥60% HRmax/school time) |
|-----------|----------|--------------------------------------|--------------------------------------|---------------------------------------------|---------------------------------------------|
|           |          | Yes n (%)                             | No n (%)                             | Yes n (%)                                   | No n (%)                                   |
| Model 1   | PEL      |                                      |                                      |                                             |                                             |
| No        | Ref.     | 4.40                                 | (<3.29–5.90)                         | (<3.91–8.10)                               | (<2.81–5.35)                               |
| Yes       |          |                                      |                                      |                                             |                                             |
| Recess    | <60 min  | Ref.                                 | (<1.52–2.70)                         | (<1.82)                                    | (<2.96)                                    |
| Yes       | ≥60 min  |                                      |                                      |                                             |                                             |
| Model 2   | PEL      |                                      |                                      |                                             |                                             |
| No        | Ref.     | 5.03                                 | (<3.67–6.90)                         | (<3.88–8.32)                               | (<3.11–6.30)                               |
| Yes       |          |                                      |                                      |                                             |                                             |
| Recess    | <60 min  | Ref.                                 | (<1.48–2.64)                         | (<1.79)                                    | (<3.38)                                    |
| Yes       | ≥60 min  |                                      |                                      |                                             |                                             |
| Gender    | Boys     | Ref.                                 | (<0.66–1.21)                         | (<1.89)                                    | (<1.90)                                    |
| Girls     |          |                                      |                                      |                                             |                                             |
| Age       | <16 years | Ref.                                 | (<0.72–1.31)                         | (<1.42)                                    | (<1.88)                                    |
| ≥16 years |          |                                      |                                      |                                             |                                             |
| BMI       | <25 kg·m⁻² | Ref. | (<0.60–1.54)                         | (<0.868)                                  | (<1.76)                                    |
| ≥25 kg·m⁻² |          |                                      |                                      |                                             |                                             |
| Country   | Czech Republic | Ref. | (1.11–2.16)                         | (<0.11)                                  | (<0.89)                                    |
| Poland    |          |                                      |                                      |                                             |                                             |

OR (95% CI) p

MPVA = moderate-to-vigorous physical activity; PEL = physical education lesson; BMI = body mass index; HRmax = maximum heart rate; p = level of significance.

Subjective estimates of SPA according to IPAQ-LF

The results of subjective PA estimation performed prior to PA monitoring correspond to the results of objective PA monitoring. PA in MET-min/day at school accounted for 34% of the daily PA of Polish girls (25% among Czech girls) was found in Czech girls on Fridays (23%), but at the level of 12,677 steps/day; while the highest portion was observed for Polish girls on Tuesday (37%), but at the level of 10,190 steps/day (Figure 2a). Similar results were found for boys (Figure 2b).
girls) and for 42% of the daily PA of Polish boys (31% among Czech boys). Polish girls ($\chi^2 = 24.67; p < .001; \omega = 0.203$) and boys ($\chi^2 = 10.78; p < .001; \omega = 0.179$) were more likely to meet the recommendation of at least 20 minutes of vigorous PA on 3 or more days/week, compared with Czech girls and boys. The same pattern was found for the recommendation of at least 30 minutes of moderate PA on 5 or more days/week (girls $\chi^2 = 5.16; p = .023; \omega = 0.105$; boys $\chi^2 = 10.83; p < .001; \omega = 0.179$).

**Discussion**

The key finding is that the differences in girls' and boys' rates of achievement of the SPA recommendations at secondary schools between the different education systems in Poland and the Czech Republic were not crucial. They are reflected only in partial aspects, which corresponds to previous studies (Frömel, Groffik, Chmelík, Cocca, & Skalik, 2018). Significant differences in compliance with the recommendation of at least 20 minutes of MVPA ($\geq 60\%$ HRmax/school time)—which we found by objective SPA monitoring—and compliance with the recommendation of at least 20 minutes of VPA on 3 or more days/week—investigated through subjective estimates—were most likely the result of more PELs per week in Polish schools. However, other factors could significantly impact on these indicators of PA intensity. The Polish (vs. Czech) concept of PE is more performance- and sports-oriented (Frömel et al., 2014). Alternatively, PE can be more associated with the specialization (single-major) of Polish PE teachers (Groffik, Frömel, Mitáš, Garbaciak, & Svozil, 2018).

Throughout the research period, PELs in Polish and Czech schools were held in a habitual manner without any interventions. Therefore, we consider the higher school...
MVPA, as well as overall PA, in Polish than in Czech adolescents to be evidence-based. PEL participation was a main predictor of SPA recommendations in both countries. The significant role of PE in increased VPA was found also in 11–12-year-old schoolchildren (Kerr et al., 2018). In same-aged students, Mooses et al. (2017) found increased in MVPA by 12.8 minutes on days with PEL, compared to days without PEL. In their meta-analysis of interventions in primary and secondary schools, Lonsdale et al. (2013) confirmed that PELs contributed to 24% of MVPA, compared with common conditions without PELs. Using pedometer monitoring, Gralla and Alderman (2013) observed boys to reach a higher step count on days with PEL (11,404 steps/day) than on days without PEL (9175 steps/day). The same applied to girls (8301 steps/day vs. 7238 steps/day). Our research showed that mean daily step count on specific days of week ranged from 10,000 to 11,700 steps/day (except for Polish girls on Thursday: 9591 steps/day), which may be associated with 60 minutes of MVPA throughout the sample (Tudor-Locke et al., 2011).

The role of participation in PELs in promotion of daily PA in secondary schools is vital because adolescents’ MVPA decreases with age (Katzmarzyk, Lee, Martin, & Blair, 2017). However, our research did not confirm the benefit of more PELs weekly and participation in them for adolescents’ overall daily and weekly PA. Analyses of PEL participation in the context with organized PA participation are still needed. Participation in organized PA cannot be fully substituted by participation in PELs. This holds true especially for those sorts of PA, which are associated with families’ socio-economic status (Eime, Charity, Harvey, & Payne, 2015), but also for complex adoption of physical literacy (Silverman & Mercier, 2015). However, participation in organized PA is more beneficial for adolescents’ cardiorespiratory fitness than unorganized PA (Lagestad & Mehus, 2018), which should be considered when advocating for more PELs in the school curricula.

The effects of participation in PELs must be assessed as a part of the contribution of overall SPA to daily or weekly PA as a significant component of daily PA (Griew et al., 2010; Pate et al., 2006). Therefore, our results are noteworthy because they provide information on the contribution of SPA to overall PA on specific days of the week. In a previous study (Tudor-Locke, McClain, Hart, Sisson, & Washington, 2009), SPA represented 42% to 49% of the daily step count in boys and 41% to 47% of the daily step count in girls, which were higher than what we revealed.

PELs represent a main component of SPA, which should be aligned with physically active recesses between lessons, active lunchbreaks, physically active academic lessons, and the promotion of physically active teaching methods in school programs. Unfortunately, unlike in primary schools, we still have limited knowledge about adolescents’ PA during recesses at secondary schools (Erwin, Ickes, Ahn, & Fedewa, 2014; Ridgers, Salmon, Parrish, Stanley, & Okely, 2012). Despite numerous analyses and practical guidelines (Centers for Disease Control and Prevention, 2018; Kohl & Cook, 2013), interventions supporting the effects of physically active lessons are scarce (Martin & Murtagh, 2017), and there is a complete lack of comprehensive facts about the effectiveness of classroom PA at secondary schools. Further, Da Costa et al. (2019) noted the importance of classroom PA for girls, older adolescents, and overweight students.

The comparison of differences between distinct education system with different number of PELs weekly according to SPA recommendation was suitable. A recommendation of 500 steps/hour (3,000 steps/school time) should motivate school administrators and teachers to make positive changes to the school environment and in their education program. This recommendation (in its simplified form of 3,000 steps/school time) induces an association with the recommendation for walking activities (3,000 steps/30 minutes) at a moderate PA level (Marshall, Levy, Tudor-Locke, & Kolkhorst, 2009). We know that feedback on step count increases individuals’ awareness of PA (Lubans, Morgan, & Tudor-Locke, 2009) and that the use of simple wearables in children and youths still offers a great potential for positive lifestyle changes (Lubans et al., 2014). These recommendations can help improve students’ SPA and physical literacy and increase the emphasis on monitoring sedentary time, physical activity, and cardiorespiratory fitness (Bouchard, Blair, & Katzmarzyk, 2015). Using SPA recommendations in school practice can also improve the quality of SPA programs, which may improve students’ social and emotional well-being, especially at-risk youth (Lubans, Plotnikoff, & Lubans, 2012). Increased weekly PELs and adolescents’ participation in PELs is thus crucial for MVPA promotion in adolescents, especially concerning the association with their physical fitness and in the context of other school physical activities and other segments of the school day within the framework of comprehensive SPA programs.

**Strengths and limitations**

The strengths of the present study lie in its comprehensive assessment of SPA in different educational settings—Poland and the Czech Republic, in the identical methodology of PA monitoring, and using the web
application (www.indares.com). Furthermore, this research was conducted under habitual school conditions in both countries, without intervening in the school programs.

The main limitation of the study was the demanding all-day HR monitoring using chest straps, which could have disrupted some participants’ habitual physical activities and resulted in a loss of several participants. Weekly monitoring of PA and HR by accelerometers is still very challenging to conduct, despite the current technological advances in school practice. These demands on arrangement and conduct of the study could have affected the way our cross-sectional study was conducted. Lastly, despite the same process of school and participant selection, generalizing these results across other education systems must be done with caution.

**Conclusions**

The Polish education system, which has more PELs weekly, was associated with a higher level of adolescents’ MVPA during school time as compared with the Czech system. Share of SPA in the daily PA ranges from 30% to 37% in Polish girls (23–30% in Czech girls) and from 28% to 39% in Polish boys (25–37% in Czech boys); however, the differences in the total daily step counts were non-significant. Both participation in PELs and a longer total time of recesses were associated with higher rates of adolescents meeting the SPA recommendations. The SPA recommendations of at least 500 steps/hour in school time, at least 25% PA of overall school time, at least 25% of MVPA (≥60% HRmax/school time), and at least 20 minutes of MVPA (≥3 METs/school time) were good instruments for evaluating the role of PELs in SPA. Increasing the number of PELs in secondary schools needs to be addressed in coherence with the promotion of physical fitness, physical literacy, PA in specific segments of a school day, and as an inherent part of comprehensive SPA programs. It is essential to develop educational, evaluation, and legislative conditions for PE, which will enable participation of all the students in PE.

Future research supporting the increase in the number of PELs should pay attention to the associations between types of PEL and organized, unorganized, and preferred types of PA in adolescents’ leisure time.

**What does this article add?**

This study is supportive of increasing the number of weekly PELs, especially because of a demonstrable increase in secondary school adolescents’ MVPA. However, it also pinpoints the need for more detailed investigation of the benefits of increased PELs concerning adolescents’ overall daily and weekly PA. The prevalence of SPA recommendations, as applied, might be used for positive changes in PE in comprehensive SPA programs, but also in students’ and teachers’ school-related lifestyles. With a certain level of caution, the present findings could be applicable in similar education systems in Central and Eastern European regions.

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**IRB approval**

The study protocol was approved by the Faculty of Physical Culture, Palacký University Olomouc Institutional Review Board under the registration number 38/2017.

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