Original Article

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Sedentary behavior in relation to selected indicators of movement and characteristics of children in the lower-secondary school

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Abstract

Introduction: Sedentary behavior (SB) of adolescents is often associated with warning signs of emerging civilization diseases and reduced participation in physical activities (PA). Although some studies point out that SB does not necessarily mean avoiding PA, the opinion of the public prevails, that in addition to the time devoted to sitting during school lessons, the time spent watching monitors and screens is constantly increasing at the expense of PA. Our goal was to determine the indicators of the participation of lower-secondary school students in voluntary SB and to relate them to selected characteristics of their movement behavior or evaluate them from the point of view of compliance with medically recommended criteria. *Material and Methods*: The research was carried out using objective and subjective measurement techniques during a two-year period with pupils of the lower-secondary schools in the Usti Region (N = 512). A record sheet was used to record data on time indicators of participation in physical and SB and basic anthropometric characteristics. Physical activity was monitored by the Yamax SW-700 and SW-800 pedometer for 7 consecutive days, i.e., during regular school days and weekend days. *Results*: In daily values of time spent in SB, boys surpass girls. Both boys and girls spend more time voluntarily sitting in front of monitors and mobile phones on weekends than on school days (M_{BW} = 162.0 ± 141.4 min. × M_{BSD} = 129.0 ± 109.8 min.; M_{GW} = 133.0 ± 118.1 min. × M_{GSD} = 121.0 ± 110.1 min.). The time values of weekend days show statistical differences between boys and girls (p = 0.02). As pupils age, the time spent on SB increases. In connection with the volume of voluntary SB, neither the mutual relationship of the time of participation in PA (r = -0.006, p = 0.90) nor the volume of locomotor activities (r = -0.058, p = 0.199) was confirmed. *Conclusion*: The obtained data confirm the increased level of SB in relation to the recommended criteria. In proportion to the reported time of participation in PA or locomotion indicators, it is not sufficiently compensated. However, in many individuals this behavior is well beyond the tolerated recommended values.

Keywords: adolescent, lifestyle, sedentary behavior, step counts, pedometers

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INTRODUCTION

The occurrence of excessive sedentary behavior is often attributed to changes in production processes, the application of new technologies, different educational needs, etc. An increasing rate of sedentary behavior is one of the signs reflecting changes in lifestyle. The use of new technologies i.e., of mobile phones, tablets and other digital screens is increasingly penetrating the segment of leisure entertainment activities for children and youth [1]. It is necessary to enquire whether, and to what extent, the use of these technologies is simultaneously responsible for the decrease in physical activities (PA) and at increase in sedentary behavior [2]. Any behavior while awake characterized by energy expenditure of ≤ 1.5 METs while sitting or lying can be considered sedentary behavior (SB) [3]. Common SBs include using a smartphone/tablet, watching TV, playing video games, using a computer, driving a car, and reading/studying while sitting [4], which are currently widespread among children and adolescents [1]. However, SB cannot be confused with the term physical inactivity (PI), if only because the level of moderately intense and intense physical activities has not reached (MVPA) [5]. According to the energy expenditure measures, activities performed in an awake state at the level of 1.5–3 MET can be classified as PI. That is, activities to which a lot of time is devoted, and which are also characterized by selected professions (hairdresser, salesperson, etc.). As such, they are inactive, but not sedentary [5]. They play an important role in overall energy expenditure, although more significant health benefits can be attributed to MVPA [6–10]. SB is largely presented by excessive sitting. SB entails an increased potential for deterioration of health indicators (stress, hyperphagia, cardiometabolic health, etc.) [11] and has negative impacts on public health [2]. This needs to be addressed by adopting certain strategies as well as promoting PA [12].

Although there may be signs of association between PA participation and indicators of sedentary behavior (SB) [13–15], possible connections cannot always be expected. In fact, SB does not necessarily mean avoiding PA [16–20]. It turns out that SB, which is often forced by circumstances of education, employment or otherwise, can be well compensated by PA [20]. There is also an increase in PA due to the extension of SB [18,21]. It is more difficult for children and young people to be aware of these circumstances and to avoid them.

For adolescents, excessive sitting can be considered a risk phenomenon, as its permanent effect leads to the formation and consolidation of such life habits, which are often incompatible with an active lifestyle. With the natural decrease in the desire to move, there is an increase in the use of "comfortable and pleasant activities" realized individually or connected with a community of friends and acquaintances, but often weakened by the appropriate exercise of movement activities. If these trends are supported by deficiencies in eating, lack of sleep, and especially the absence of PA, the individual begins to underlie to a sedentary lifestyle. This already leads to significant decreases in physical fitness and the gradual outbreak of lifestyle diseases [22]. Higher duration/frequency of screen time and television (TV) watching were associated with adverse body composition and decreased fitness [23]. The mix of measures against these unwanted phenomena must therefore necessarily include reducing SB and supporting the application of PA. Therefore, in addition to accepting health-oriented recommendations for the implementation of PA, approaches are also taken to reduce or establish acceptable limits of SB. These restrictions respect SB within the framework of education, in the development and strengthening of appropriate life habits. However, they strive for the interruption of SB and recommend its reduction without quantification [24] or for children and youth, they limit it to two hours a day (not counting the time necessary for schoolwork) [25]. Therefore, attention is rightly paid to the SB of children and youth spent in their free time as a specific segment in the total sitting time and a variable related to some health indicators [24]. Even when reducing or interrupting sessions, positive changes can be observed [26].

Also in the Czech Republic, the problem of SB and insufficient participation in PA is being discussed. The occurrence of SB and search for reasons, use of techniques and equipment that accompany them are recorded by trend studies [27–30]. The use of computers during free time among younger children is prevalent and increases the time spent on voluntary SB [31]. Notwithstanding the time allocated to education and study, the SB indicators in the Czech Republic are relatively high. Lower SB time is confirmed in the younger years, with increasing age and especially in adolescents,

there is an increased use of time spent at computers (boys up to four hours a day, girls two hours a day) [32]. The recent "National Report on Physical Activity of Czech Children and Youth 2022" [33] indicates that only 26% of adolescents fulfill the recommended limit of sitting in front of screens to the level of two hours a day (a total of 19% boys and 39% girls) and the relatively high level of SB does not improve. Adolescents in the Czech Republic who report at least two or more hours of voluntary sitting per day on school and weekend days are more associated with obesity [34]. Higher SB is also associated with increased BMI values [35]. The increase in SB and the decrease in the application of PA is an observable trend in the Czech Republic, and confirmed by studies [36], which requires clarification and especially a solution.

Along with physical activity, SB appears to be an important consideration when examining the contribution of both types of behavior to child and adolescent health [37]. That is why we wanted to focus on some of the problems mentioned above.

Our goal was to establish indicators of the participation of lower-secondary school pupils in voluntary sedentary behavior and to relate them in particular to selected characteristics of their movement behavior or evaluate them from the point of view of compliance with the medically recommended SB criteria.

MATERIAL AND METHODS

The survey was carried out with objective (pedometer) and subjective measurement techniques (record sheet) during a two-year period among pupils of lower-secondary schools in the Usti Region (N = 512).

Participants

The set of pupils came from a stratified selection from the end of 2019 to the beginning of 2021. The survey took place in a climatically acceptable period and with a steady movement regime of the pupils. 73% of pupils were measured before the COVID-19 pandemic. The research design was presented to the school management and the involved teachers. On this occasion, the measuring technique was handed over for testing and for assessment. We recorded the specifics of the school for the implementation of exercise programs at the school and discussed the rules for cooperation with parents and their pupils. The teachers received training in the research process and in the use of assessment and recording techniques. At the same time, possible problems were consulted (consent of parents and pupils to participate in the research, loss of the device, social status of the family, absence of selected data, GDPR rules etc.). Teachers and then students were provided with recording sheets containing a request and a message to parents about the purposes of the research and the possibilities of the pupil's involvement in the research. The pupils were subsequently informed about the progress of the survey, received pedometers, and were instructed in their use [38]. After the trial (approx. 3–4 days), the students started the application of measuring and evaluation techniques at the instruction of the teacher.

Table 1. Basic characteristics of selection files (N = 512)

Sex	Age	*n*	Weight [kg]		Height [cm]		BMI [kg·m^{-2}]	
			M	*SD*	*M*	*SD*	*M*	*SD*
Boys	≤12	88	50.2	12.4	156.4	9.5	20.4	4.1
	13	77	61.0	15.8	166.2	8.6	21.9	4.7
	14	64	60.8	14.2	169.8	7.1	21.0	4.2
	≥15	34	68.7	15.7	174.9	8.2	22.3	4.3
	Total	263	58.3	15.6	164.9	10.8	21.2	4.4
Girls	≤12	91	48.0	8.2	157.4	8.0	19.4	3.1
	13	81	55.0	10.2	163.7	6.6	20.6	3.7
	14	52	56.4	6.1	165.3	7.4	20.8	2.8
	≥15	25	55.5	7.2	163.9	4.8	20.7	2.7
	Total	249	52.8	9.2	161.7	7.8	20.2	3.3

n – sample size; BMI – Body Mass Index; *M* – mean; *SD* – standard deviation

The choice of schools was subordinated to the character of the settlement and the geographical layout of the region. Schools from larger cities to agglomerations (over 30,000 inhabitants) in industrial areas, smaller municipalities with an industrial character of settlement (under 10,000 inhabitants) and municipalities in agricultural areas were thus represented. The region's problems include a significant scale of industrial production, persistent ecological burden, increased migration of the population, which for the most part does not reach the level of education and qualification usual in the Czech Republic [39]. These circumstances are also behind the sources of social problems in the area and the perception of a reduced quality of life [40] and they are also reflected in the sphere of leisure time and adolescent participation in PA. Table 1 shows the characteristics of the sample files. After discarding incomplete documents, we evaluate the data obtained from 512 participants.

Procedures and Measurements

A record sheet designed for seven days a week was used to record data on time indicators of participation in movement and sedentary behavior and basic anthropometric characteristics. This recording sheet contained a part intended for filling in the time of participation in PA within the framework of school exercise programs, organized by a sports club or team and in their free time. The sheet also requested communication about SB time in relation to the use of digital technologies. Physical activity was monitored by the Yamax SW-700 and SW-800 pedometer for seven consecutive days, i.e., during regular school days and weekend days. The obtained values were entered into the recording sheets. Extremely low (fewer than 500) and high (more than 32,000) steps counts (SC) per day were eliminated. The pedometers were fitted with new batteries and calibrated (5% tolerance). After wearing the pedometers, the students completed filling in the recording sheets with the questionnaire part about the period of their application. The teacher immediately collected the recording sheets and pedometers, checked the quality of the completed data and helped with their administration. To determine the limit of the recommended level of SB, we stated a value of 120 minutes of voluntary sitting per day [25].

Data analysis

Data normality was rejected using the Shapiro-Wilk test. For this reason, statistical processing was used for non-parametric procedures. Non-parametric ANOVA was used to determine whether there were significant differences in SB volume between independent sets (e.g., between individual years) (Kruskall-Wallis). Statistical significance was pre-determined as $p < 0.05$. Mann-Whitney test was used for post-hoc analysis, effect size was calculated as follows [41]: small effect $r > 0.1$, medium effect $r > 0.3$, large effect $r > 0.5$. Differences between dependent groups were statistically treated using the Wilcoxon test. Whether there is a dependence between the variables was determined using the Spearman correlation coefficient and the coefficient of determination. Statistical analysis was performed in the R programming language (version 3.5.2), used in the IDE Rstudio (version 1.1.463).

RESULTS

In daily values of time spent in sedentary behavior (TSB), girls are equal to boys. However, mutual differences are noticeable during the weekend days (TSB_W: $p = 0.02$, $r = 0.10$). Both boys and girls spend more time voluntarily sitting in front of monitors and mobile phones during weekend days than during school days (Table 2). The high value of the TSB_W standard deviation stands out especially for boys (SD_{BW} = 141.4 min.), which exceeds the not insignificant values of standard deviations of TSB on one day per week (TSB_1) and TSB per day of school attendance (TBS_{SD}) for both sexes. The observed tendencies were also confirmed during the evaluation of the entire group of pupils ($p < 0.001$, $r = 0.22$).

As the pupils get older, the time devoted to SB increases. TSB_1 trend indicators are evident despite the lower count of pupils in the highest age groups (Figure 1). While for all age-limited sets of boys lower values of TSB_{SD} than TSB_W are observable, for girls, these indicators appear to be equal in individual age groups. In each age group of girls, the differences between TSB_{SD} and TSB_W values are negligible. The difference between TSB_{SD} and TSB_W values is more pronounced in boys of each age

group. The lowest difference between TSB_{SD} and TSB_W values was found in boys aged 13 years (28 minutes), with the highest difference in boys recorded at just over 15 years old (41 minutes). TSB_W values for boys up to 12 years of age reach 146.81 ± 129.26 min, with increasing age, TSB_W values increase, up to the level of 185.00 ± 122.02 min in boys older than 15 years. For boys, there was a significant shift in TSB_W compared to the youngest age category already at fourteen (p = 0.05), even more so for fifteen-year-olds (p = 0.03). Similarly, for girls up to 12 years of age, the value of TSB_W rises from an average of 116.92 ± 92.84 min. to a value of 168.36 ± 203.27 min. in girls over fifteen years of age. However, TSB_{SD} values increase faster in girls of different age groups; most clearly in fourteen-year-olds (p = 0.01).

In the duration of SB, Saturday leads both in boys and girls (TSB_{BSat} = 174.15 ± 165.54 min, TSB_{GSat} = 13823 ± 135.52 min), followed by Sunday (TSB_{BSun} = 150.54 ± 143.69 min, TSB_{GSun} = 127.37 ± 126.28 min) and by Friday (TSB_{BFri} = 144.33 ± 130.53 min, TSB_{GFri} = 125.75 ± 125.15 min). While for boys we observe significant differences between individual days (χ^2 = 25.38, p = 0.01), we do not observe differences in SB volume in girls (χ^2 = 5.10, p = 0.53).

Individual SB values could be compared with the recommended limit values for the duration of voluntary SB, which we set at 120 min [25]. 54.75% of boys (n = 263) fulfilled these recommendations during weekdays, during school days (49.81%) and during weekends 62.36% of them. For girls (n = 249), 62.25% fulfilled during weekdays, 54.62% during school days and 64.26% during weekends. It follows from the above that during the weekend the proportion of boys and girls who spend less than 120 minutes sitting increases. This would mean that a smaller part of boys (37.64%) and girls (35.74%) who exceed this limit are engaged in SB for a significantly longer time, as the values of the average TSBW of all boys and girls are significantly higher during Saturday and Sunday (Table 3).

Table 2. Time spent by pre-secondary school pupils during the week on sedentary behavior

Sex	n	TSB_1		TSB_{SD}		TSB_W		TSB_{SD} vs. TSB_W	
		M	*SD*	*M*	*SD*	*M*	*SD*	*p*	*es*
Boys	263	138.80	114.93	129.38	109.80	162.38	141.43	0.01	0.30
Girls	249	124.04	108.77	120.52	110.07	132.84	118.12	0.01	0.14
All pupils	512	131.62	112.11	125.07	109.91	148.01	131.32	0.01	0.22

TSB_1 – sedentary time on one day per week (minutes); TSB_{SD} – time of sedentary behavior per day of school attendance (minutes); TSB_W – time of sedentary behavior in one day of weekend days (minutes); n – sample size; *M* – mean; *SD* – standard deviation; p – p-value; *es* – effect-size

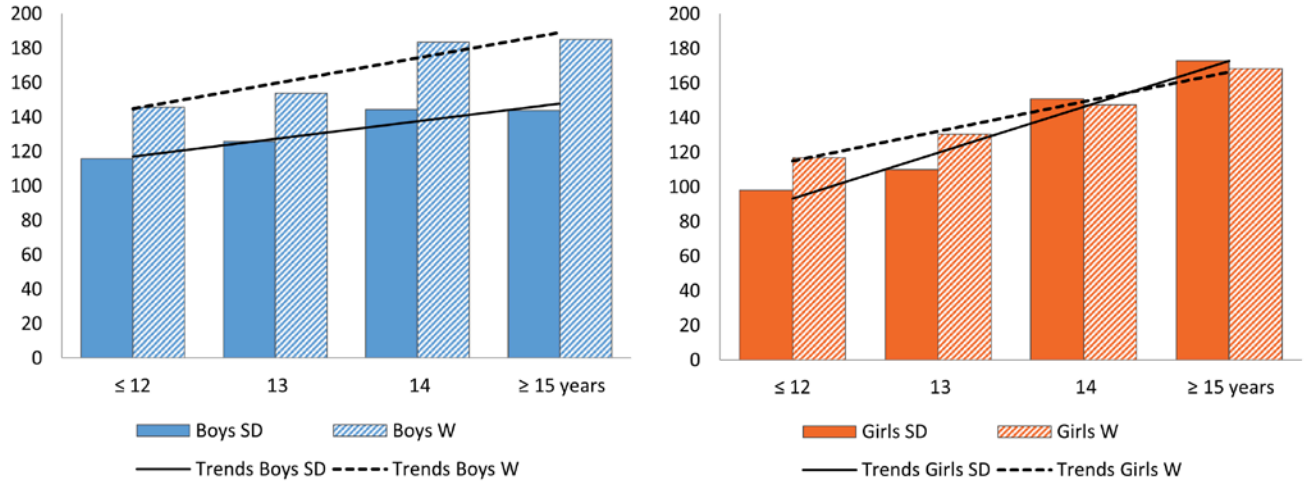

Figure 1. Age-related trend of increasing voluntary sedentary time in boys and girls. *Note*: SB units in minutes.

Table 3. Duration of voluntary SB for pupils meeting (up to 120 min·day^{-1}) and not meeting the health-recommended criteria during the week.

Sex	Criteria	*n*	TSB_1		TSB_{SD}		TSB_W	
			M	*SD*	*M*	*SD*	*M*	*SD*
Boys	No	119	228.21	113.49	211.28	112.74	270.59	139.10
	Yes	144	64.92	37.70	61.71	37.49	72.95	53.68
Girls	No	94	221.72	117.44	219.24	119.74	227.94	129.65
	Yes	155	64.79	36.96	60.65	35.98	75.17	58.76

No – did not meet the criteria; Yes – meet criteria; TSB_1 – sedentary time in one day per week (minutes); TSB_{SD} – time of sedentary behavior per day of school attendance (minutes); TSB_W – time of sedentary behavior in one day of weekend days (minutes); *n* – sample size; *M* – mean; *SD* – standard deviation

Table 4. Locomotion volumes reported (step counts) for groups of boys and girls with different fulfillment of the medically recommended criterion for the duration of voluntary SB (up to min·day^{-1})

Sex	Criteria	SC_1				SC_{SD}				SC_W			
		M	*SD*	*p*	*es*	*M*	*SD*	*p*	*es*	*M*	*SD*	*p*	*es*
Boys	No	10277	4262	0.59	0.02	10739	4219	**0.01**	**0.11**	9123	5583	0.84	0.01
	Yes	11334	4757			11491	4782			10941	5851		
Girls	No	10537	4408	0.31	0.04	10766	4129	**0.01**	**0.13**	9965	6168	0.11	0.06
	Yes	9665	3321			9934	3331			8995	4606		

No – did not meet the criteria; Yes – meet criteria; SC_1 – step counts of individual on one day of the week; SC_{SD} – step counts of individual in the course of a school day; SC_W – step counts of individual in the course of a weekend day; *M* – mean; *SD* – standard deviation; *p* – p-value; *es* – effect-size

We tried to relate the fulfillment of the recommended SB values for pupils (max 120 min·day^{-1}) to the indicators of movement behavior. Our groups of boys and girls achieved relatively low values of daily locomotion – steps taken (M_B = 10,702 ± 4,473.60 steps, M_G = 9,841 ± 3,721.75 steps). We assigned the obtained values of boys and girls to groups according to meeting or not meeting the recommended SB values (Table 4). While in boys during the days of school attendance we observe that the group that meets the recommendation for SB shows a higher volume of locomotion, in girls the opposite is true. Girls who exceed the recommended SB time show higher volumes of locomotion. During weekend days, we do not observe differences between groups meeting/not meeting SB recommendations.

The second of the indicators of movement behavior that we tried to relate to the length of SB was the time spent in reported PA. With the exception of the set of boys aged 13 (r = -0.24, p = 0.032, r^2 = 0.06), we found no dependence of TSB values on PA time.

DISCUSSION

The presented study summarizes the values of the daily reported time of voluntary SB; i.e., the time that was not related to teaching and studying on school days. In addition, we worked with reported step volumes and PA participation time. Specifying sedentary behavior turns out to be a complex problem, but we cannot do without defining it. In our study, we focused on the evaluation of SB in the free time segment, which is only a part of the total SB. The use of free time often determines the lifestyle that adolescents tend to follow and whether they lead to health risks and problems. With this, we wanted to comment on the evaluated indicators of movement behavior in the past and to open or supplement more recent regional studies [38] for data that can refine the view of adolescents in the affected region.

During weekend days, boys outperform girls in the duration of voluntary SB. In the days of school attendance, the differences are not statistically significant, apparently due to the lack of free time and participation in other activities (also exercising PA) or further study. During weekend days, however, the differences are already significant (p = 0.02, *es* = 0.10) and many boys, compared to girls,

will use the free time to sit at computers, mobile phones, etc. more (Table 2). Of the two weekend days, it is Saturday that completely dominates the SB length for both boys and girls (M_{BSat} = 174.15 ± 165.54 min.; M_{GSat} = 138.23 ± 135.52 min.) and significantly outperforms Monday (p = 0.002), Tuesday (p = 0.001), Wednesday and Thursday (always p < 0.001). Although from a time point of view it provides the greatest scope for the realization of PA, in the form of the day with the longest voluntary SB, it appears to be a "missed opportunity". Sunday can now be devoted more to preparing for school, etc. On the other hand, the question arises as to why these days were not devoted more to e.g. PA, activities with parents, in the club, etc.

Recommended voluntary SB values are exceeded by both boys and girls to a greater extent during weekend days than during school days. The set of girls reaches the limit of recommendation during their school days (M_{GSD} = 120.52 ± 110.07 min), the set of boys moves above this limit more significantly (M_{BSD} = 129.38 ± 109.80 min). High values of standard deviations (especially during weekend days) testify to the dispersion of the data and sometimes even towards warning values (individually even all-day sitting at the computer). If we accept 120 minutes a day as the recommended limit for the duration of voluntary SB, then from the point of view of meeting the daily recommendations, girls are more successful than boys (62.25% of girls meet the criterion compared to 54.75% of boys). These values appear significantly better than the values of adolescents in the "National Report on the Physical Activity of Czech Children and Youth 2022" [33]. Larger differences appear to result from different methodology. Deeper analysis of SB indicators and fulfillment of medically recommended criteria (120 min·day^{-1}) pointed to the problem of adolescents who exceed this limit (Table 3) and do not meet the recommendations for SB. In both boys and girls who do not meet the recommendations, the average values of TSB1 and especially TSBW in boys (M = 270.6 min.) are really high and in this case, they can negatively affect health in the long term. We consider it appropriate to try to reach these individuals and their parents and find out if SB is compensated.

The increasing values of the time spent in voluntary SB with the advancing age of the pupils confirms the trends of other studies [31,32]. Pupils in higher years are more burdened by school, and their free time is also apparently reduced, but again it is devoted to more siting, or is spent by SB. The frequency of groups older than 15 years allows us to take only cautious opinions; however, the post-hoc analyses performed in boys bear witness to the fact that, compared to the youngest age category, a significant shift in TSBW already occurred among fourteen-year-olds, and even more so among fifteen-year-olds. Among girls, a significant shift in TSB was manifested in fourteen-year-olds (n = 52), especially on weekdays. We consider these "rebounds" to be a logical outcome of the changes that adolescents go through. Their priorities change, they organize their time differently, and they also communicate and observe their surroundings in different ways. Prior studies have discussed similar trends [36].

We also attempted to identify certain links between SB and PA [15]. The existence of a limited amount of free time, which consists of different segments according to its content, led us to this decision. We assumed that in the case of the distribution of sections in the free time segment, the links between PA and SB indicators would manifest themselves [14]. It is necessary to realize that PA can appear precisely as a desirable compensation for sedentary behavior. On the other hand, we were aware that most studies approach the demonstration of direct links with caution, or even report surprising data. In our group, we noted the often-reported absence of leisure PAs, which is quite problematic from the point of view of respecting health-recommended criteria. Only the inclusion of school exercise programs, which made up a non-negligible part of all daily PA, made it possible to evaluate certain links. Although possible relationships were signaled in thirteen-year-old boys, in the groups of boys and girls we examined, the correlations between the time of participation in PA and SB were not confirmed.

We also attempted to determine the relevance between the degree of locomotion and SB. We have described in detail the volumes of locomotion and their fulfillment from the point of view of health-recommended criteria [38]. Compared to girls, boys achieved higher values of locomotion and similarly showed higher values of SB time. This shows the differences in the way of life of boys and girls. When analyzing the "arrangement" of results from the area of locomotion and SB, we note a significant unevenness of the group members. It turns out that in addition to physically active

adolescents, we have a number of very passive members of this population. Interesting results were shown by the evaluation of locomotion in relation to the fulfillment of the medically recommended SB criteria (Table 4). Girls who do not meet these criteria therefore exceed the recommended SB length, achieve higher SC_1 values, while the difference in SCSD values is significant (p = 0.01, es = 0.13). The opposite is true for boys who also do not meet these criteria. Here we already note lower SC1 values, while the difference in SCSD values is significant (p = 0.01, es = 0.11). From the above results, we believe that the connection between SB and locomotion cannot be inferred, or in girls it signals the compensation of SB by increasing energy expenditure [18]. The problem can arise at the moment of an excess of SB, which interferes with the time segment of the application of locomotion activities.

Although the voluntary SB values we found appear to be better than the above report [33], the results are not encouraging. We also state this with regard to our further survey [38]. It is not possible to convince adolescents of the need to make up for the lack of PA during school days during days off. The reasons for this insufficient involvement of adolescents can probably be attributed primarily to errors in the family's influence and blind spots in educational activities. But the solution would certainly be easier to find in the further offer of activities of clubs and sports clubs during the weekends, in the offer of sports grounds and, in general, by creation of a suitable environment for these activities. During the days of school attendance, one can see the benefits associated with transport to school, movement of pupils in the school environment, teaching of the subject of physical education, and - for active adolescents - also in the activities of clubs and sports clubs. Even in these cases, certain limits of parents' responsibility for creating an optimal exercise regime for their children can be encountered. Here, deficiencies in the economic background of families, the education of parents, the locality, and the amenities of the environment are often encountered. Unfortunately, some negative trends can also be anticipated in connection with the effects of the COVID-19 pandemic of 2020–21 [42].

CONCLUSION

The recommended SB time is exceeded for our group of pupils. SB becomes the property of more boys, who significantly outnumber girls during SB on weekend days (mainly Saturdays). The trend of increasing the time of SB continues with the increasing age of the pupils. In both boys and girls, there are significant differences both in the time of SB and in the values of reported locomotion. A warning symptom is the absence of participation in PA, which, together with high indicators of SB in adolescents who do not meet the recommended criteria for SB (120 min·day^{-1}), can create conditions for the formation of a bad lifestyle and the development of lifestyle diseases. In the adolescents we monitored, the connection between the time of voluntary SB and the time of participation in PA, as well as the level of locomotion, was not confirmed.

Strengths and limitations

It was possible to evaluate the relevant data for a relatively comprehensive set, the basic characteristics of which were clearly determined. The locations of data collection were chosen judiciously with regard to the nature of the environment, the motivation of collaborators and participants. The strength of the study appears to be the combination of two research techniques, which provide a more comprehensive picture of the surveyed phenomena. The coverage of data on locomotion activities during the whole week, i.e., both on school days and on weekend days, is suitably supplemented by time data on PA and SB. The willingness of parents to support the involvement of their children in the survey proved to be a specific problem, although we guaranteed anonymity and the absence of demands for compensation for damaged material. The success of the work with the probands and the quality of the data obtained was reflected in the involvement of the teacher. Some sheets had to be discarded anyway due to incompleteness. We believe that the reality of the state of SB and the application of PA may be worse in many respects than what the identified indicators show us. The reason for this is the absence of data from the segment of participants who refused to engage in the survey, and those who did not fill in the data correctly.

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