Physical Activity and Sedentary Behaviour Surveillance in Czech Children and Adolescents: A Scoping Review of the Literature from the Past Two Decades

Eliška Materová

Palacký University Olomouc

Jana Pelclová (✉ jana.pelclova@upol.cz)

Palacký University Olomouc

Aleš Gába

Palacký University Olomouc

Karel Frömel

Palacký University Olomouc

Research Article

Keywords: prevalence, insufficient physical activity, youth, health

Posted Date: October 6th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-637632/v1>

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Version of Record: A version of this preprint was published at BMC Public Health on February 21st, 2022.
See the published version at <https://doi.org/10.1186/s12889-022-12766-0>.

Abstract

Background: This study aimed to map the available evidence related to physical activity (PA) and sedentary behaviour (SB) in Czech children and adolescents and suggest future directions and improvements to strengthen surveillance on PA and SB in the Czech Republic.

Methods: The search of studies published between January 2000 to December 2020 included the Medline and Medvik databases and a hand search in eight Czech journals related to the topic. This review followed the "Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews".

Results: Out of 350 identified studies, 79 met the selected criteria. The majority of studies were cross-sectional (89%), approximately two-thirds of the studies (61%) examined only PA, and half of the studies (51%) employed device-based assessments. Approximately 47% of studies reported the prevalence of physical inactivity based on inconsistently defined recommendations. Approximately, 14%, 23%, and 10% of studies focused on active transport, organized PA (including physical education or leisure-time PA), and parent-child PA, respectively.

Conclusions: Future studies need to focus on longitudinal design and interventions, randomly selected samples, a mix of device-based and self-reported methods, and recognition of health-related 24-h time-use patterns. This review advocates the governmental-supported development of a national surveillance system helping to the reduction of insufficient PA and excessive SB.

Background

In children and adolescents, physical activity (PA) is an important part of the healthy lifestyle. Sufficient PA is associated with improved physical fitness, cardiometabolic health, bone health, cognitive outcomes, mental health, and reduces adiposity [1, 2]. And conversely, insufficient PA accompanied by high sedentary behaviour (SB) negatively influence health [3] and they are considered as the key drivers of non-communicable diseases [4] with a possible transfer to adulthood [5]. Currently, the Global action plan on PA 2018–2030 which mission is to ensure access to safe and enabling environments and to diverse opportunities to be physically active to all people, draws attention to 81% of adolescents who are not sufficiently active [6]. Moreover, the prevalence of insufficient engaging in everyday PA increases over adolescence and seems to be higher among girls [7].

PA is complex movement behaviour and might be performed at varying intensities, body posture, domains, bout duration, and for multiple reasons. In many countries across the globe, the relevant issues related to insufficient PA resulted in the development of the national PA guidelines which provide consensus on the amount, intensity, frequency, and type of PA necessary for chronic disease prevention and for supporting collective health [8]. Besides promoting an optimal level of PA, limiting SB is also recommended in the majority of these countries. SB is defined as any waking behaviour characterized by an energy expenditure ≤ 1.5 metabolic equivalents (METs), while in a sitting, reclining, or lying posture [9].

Specifically, time spent using a device such as a computer, television, or games console, which is called “screen time” (ST), is a more specified component of total SB with several negative effects on health [10]. Achieving a required level of PA and SB offers significant health benefits and mitigates health risks which have been recently highlighted by the World Health Organization (WHO) in the last edition of “WHO Guidelines on Physical Activity and Sedentary Behavior” [1].

WHO also announced national surveillance on PA as an essential part of the global initiatives for the reduction in the global prevalence of insufficient PA by providing a means to assess compliance with PA and SB guidelines and subsequently serving for monitoring progress over time [11]. Moreover, the national data could help to adopt global PA and SB recommendations with adequate adjustment to the social, cultural, and environmental conditions of the state. In the Czech Republic, the national surveillance system, as well as country-specific recommendations for children and adolescents' PA, are lacking. The inadequacy in the area of PA research is seen in a recently published systematic review of global, regional, and national trends and patterns in PA research since 1950 where the Czech Republic with a total of 105 papers is in nineteenth place among high-income European countries [12]. Likewise, no study has summarized and reviewed existing research on PA and SB in Czech children and adolescents. Such a comprehensive analysis describing up-to-date surveillance and main findings is critical ahead of further steps which could lead to the development of a national surveillance system and recommendations.

Therefore, the purpose of this study was to systematically review the best available evidence on PA and SB in Czech children and adolescents published in the last two decades. Specifically, we aimed to (1) summarize the descriptive characteristics and main conclusions of the available evidence and (2) suggest future directions and improvements to strengthen surveillance on PA and SB in Czech children and adolescents.

Methods

The search strategy

This scoping review conforms to the “Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews” (PRISMA-ScR) [13]. The checklist was followed to report this study (Supplementary file 1). The search included the Medline (via Ovid) and Medvik databases. We searched for studies published from January 2000 to December 2020 but only studies whose data were obtained during this period were included in the review. The search strategy was arranged in three sets of terms that cover the target population (i.e., school-aged children), movement behaviors (i.e., PA and SB), and country (Czech Republic). The search strategy builds mainly on the Medical Subject Heading (MeSH) terms. Subsequently, selected free-text terms were included in the search strategy to increase the sensitivity of the search. The complete search strategy in electronic databases is presenting in Supplementary file 2. The search results were imported into the EndNote programme (Version X7; Thomson Reuters, San Francisco, CA, USA), all duplicates were deleted, and an online Excel spreadsheet was produced for screening purposes. The final database included several unique identifiers for each

study and several pieces of bibliographic information (article identifier, authors, year of publication, study title, abstract and journal title).

Then, the title and abstract of the studies were screened by two independent evaluators. The studies were divided into three groups: relevant, irrelevant, and potentially relevant studies. In the case of potentially relevant studies, their full-texts were analyzed, and then the studies were included or excluded. In the event of a disagreement between the evaluators concerning the relevance of a particular study, the final decision as to inclusion or exclusion was made by a third person.

In addition to searching the databases mentioned above, the authors performed a hand search in the references of studies included in the review. A hand search was also carried out in main Czech journals related to the topic of interest and which were not indexed in the Medline and Medvik databases during part or the whole period of past 20 years. Namely, we performed the hand search in *Tělesná kultura*, *Acta Gymnica*, *Česká Kinantropologie*, *Studia Kinanthropologica*, *Medicina Sportiva Bohemica et Slovaca*, *Tělesná výchova a sport mládeže*, *Acta Universitatis Carolinae – Kinanthropologica*, *Studia Sportiva*.

Study inclusion and exclusion criteria

Studies with any research design were included in this scoping review if they: a) targeted Czech children and adolescents aged 6–19 years, b) reported PA, SB, or both, c) were written in English or Czech language, d) were published between 2000 and 2020, and e) were published as a peer-reviewed journal article. The international studies without a clearly defined Czech sample were excluded. The minimal sample size was set at least 50 participants for cross-sectional studies and was not set for longitudinal studies.

Data extraction

The basic characteristics about included studies (design, primary outcomes, and main findings) and descriptive characteristics of the study samples (sample size, percentage of girls, age category or average age, and region of Czech Republic) were extracted. We also extracted information on the use of methods in measurement (self-reported, device-measured) and dealt with more detailed information on PA and SB. Finally, we summarized the main findings and results of the included studies.

Results

Data extraction procedure and bibliographic characteristics

In the Medline and Medvik databases, a total of 316 studies were identified based on the search strategy, and 34 studies were identified by hand search (Figure 1). After the removal of duplicates, the exclusion of studies based on predetermined criteria was done. Out of 160 full-text articles assessed for eligibility, there was a disagreement between the evaluators concerning the relevance of a particular study in 8 studies, and the final decision as to inclusion or exclusion was made by a third person. Although these papers were related to PA and SB of Czech children and adolescents, the main reasons for exclusions

were: a) impossibility to separate Czech results from results of other countries [14], b) PA and SB results related to very specific samples (with different mental load or academic achievement) without clear summary findings [15–17], and c) specific studies examined test-retest reliability [18, 19].

The final sample included 79 studies, the overview of which is shown in Table 1. Sixty-one papers were published in the English language and 18 were published in the Czech language. Out of 79 studies, 18 studies [20–37] were part of international surveys with clearly identified results related to PA and/or SB in Czech children and adolescents.

Table 1.

Characteristics and findings of the included studies

^aLongitudinal study

^bInternational study

^cIntervention study

^dRepresentative sample

PA – Physical activity, SB – Sedentary behaviour, ST – screen time, AT – Active transport, PI – Physical inactivity, PE – Physical education, MVPA - Moderate to vigorous physical activity, MPA – Moderate physical activity, VPA – Vigorous physical activity, LPA – Light physical activity, BMI – Body mass index, OLTA – Organized leisure-time activities, HBSC – Health Behaviour in School-Aged Children, IPAQ-LF - International Physical Activity Questionnaire – long form, IPAQ-SF – International Physical Activity Questionnaire – short form, IPEN - International Physical Activity and the Environment Network, QPAP – Questionnaire on Physical Activity Preferences, SONIAA – Social Norms Intervention for Active Adolescents, COSI – Childhood Obesity Surveillance Initiative.

^e*Poznámka:* Kalman et al., 2015b [35]- Jednalo se o trendové analýzy v plnění doporučení u 32 států zapojených do HBSC z roku 2002, 2006 a 2010. Údaje o velikosti souboru nejsou pro jednotlivé studie uvedeny.

An apparent increasing trend of published studies is shown in Figure 2. Although the first two studies related to PA of Czech children and adolescents were published in 2007, data from identified studies cover the whole 20-year period with the first data collection in 1998–2000 [38], 2001 [39], and 2002 [40].

Descriptive characteristics of the available evidence

This scoping review identified 70 cross-sectional studies, 7 longitudinal studies, and 2 interventions. Out of all cross-sectional studies including school-aged participants, 18 studies focused on children, 54

First author and year of publication	Characteristics of study sample	Methods	Primary outcome(s)	Main finding(s)
Badura et al., 2018 [90]	n = 6 935 ^d 51% girls 13–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (OLTA (team sports, individual sports and other activities))	79% of respondents engaged in at least one OLTA per week. 34% of respondents engaged in overall unstructured activities daily or at least twice a week. The selected unstructured activities were strongly associated with an increased occurrence of adolescents' health-risk behaviors and low academic achievement.
Badura et al., 2017 [91]	n = 10 279 ^d 51% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (OLTA (team sports, individual sports and other activities))	48% of boys and 52% of girls participated in OLTA. With increasing age, participation in OLTA decreases. OLTA participation was associated with lower occurrence of repeated substance use and truancy and inversely with higher odds for physical fights and injuries. Girls, in general, were at lower risk when participating in OLTA than boys.
Badura et al., 2016 [92]	n = 10 483 ^d 51% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (OLTA (team sports, individual sports and other activities))	Youth involvement in OLTA was linked to general better school performance and attachment to school. Adolescents participating in more activities at the same time had the best school performance.
Badura et al., 2015 [93]	n = 10 503 ^d 51% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (OLTA (team sports, individual sports and other activities))	81% of respondents participated in one or more OLTA. Participation in OLTA was associated with better physical and mental health in adolescents. The association varies by pattern of activity participation and was partly gender- and age-specific.
Bešič et al., 2016 [48]	n = 174 48% girls 9–11 years Olomouc region	Device-measured (accelerometer ActiGraph GT3X and GT3X+, hip-worn, 7 consecutive days, >10 valid hours per day,	PA (total, LPA, MPA, VPA)	Boys had higher BMI, spent more time in VPA and showed better results in health-related physical fitness than girls. Children who spent more time in VPA were more likely to have better cardiorespiratory fitness.

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2005)

Bláha et al., 2019 [57]	n = 639 46% girls 11–16 years North-western Bohemia region	Device- measured (pedometer Digi-walker Yamax SW- 200 and SW- 700, at least 5–6 weekdays and 1 weekend day)	PA (steps/day)	Boys achieved more steps/day (by 1 000 steps) than girls. Weekday steps/day were significantly higher than weekend steps/day.
Bláha et al., 2010 [58]	n = 1 185 59% girls 11–16 years North-western Bohemia region	Self-reported (PA and SB questionnaire)	PA (leisure- time PA, PI)	The participation in leisure-time PA was on average by 8% higher in boys than girls on all days of the week and was decreasing with age, particularly in girls. Boys had 6% higher ST than girls in all days of the week.
Bucksch et al., 2019 [20]	n = 5 082 ^d 52% girls 11–15 years Czech Republic ^b	Self-reported (HBSC questionnaire)	PA (MVPA) SB (ST)	Meeting MVPA recommendation was reported by 21.5% of Czech adolescents. Low (less than 3.5 h/school day), middle (3.5–7) and high (more than 7) ST reported 30.7 %, 35 % and 34.4 % of Czech adolescents, respectively. Social and environmental correlates differed for MVPA ad ST of adolescents.
de Gouw et al., 2010 [45]	n = 30 966 ^d 56% girls 10–18 years Czech Republic	Self-reported (questionnaire)	PA (total, up to 7 hour/week or ≥ 7 hour/week) SB (ST)	60% of respondents performed PA during the week. Boys were more physically active, watched more television and used the computer more often than did girls. Watching TV more than 7 h a week was positively associated with being overweight/obese in 15– 18-year-old girls and was found to be negatively associated in boys of the same age group.
Dygrýn et al., 2015 [39]	n = 6 236	Self-reported (national 2011	PA (AT – commuting	A decrease in the proportion active commuting between

	50% girls 12–17 years Olomouc and Hradec Králové region	Czech Census of Population and Housing)	to/from school)	2001 and 2011 to school was observed in 47% respondents. Between 2001 and 2011, the proportion of adolescents actively commuting to school decreased by 47%, from an absolute rate of 49.1% to 26%. The proportion of active commuters fell in low walkable areas by 61% and in high walkable areas by 39%. The adolescents in 2011 were 2.7 times less likely to actively commute than in 2001.
Frömel et al., 2020a [21]	n = 1 462 64% girls 15–19 years Czech Republic ^b	Self-reported (IPAQ-LF)	PA (total, VPA, MVPA, AT)	A higher rate of AT was only significantly associated with higher well-being in girls. AT accounted for 22.5% and 24.9% of weekly PA of Czech boys and girls, respectively.
Frömel et al., 2020b [76]	n = 596 62% girls 15–19 years Czech Republic	Device- measured (pedometer Digi-walker Yamax SW- 700) Self-reported (IPAQ-LF)	PA (steps/day)	The stronger negative associations between depressive symptoms and PA (especially recreational PA) were confirmed. The girls who reported the fewest depressive symptoms had 2.12 times greater odds of meeting the 11,000 steps/day recommendation than did the girls with the most depressive symptoms.
Frömel et al., 2018 [30]	n = 1 117 60% girls 15–17 years Czech Republic ^b	Self-reported (IPAQ-LF)	PA (total, VPA, MPA, LPA, MVPA)	Girls were found to be less active than boys at high PA intensities. The recommendations for vigorous PA were met by 46% of Czech boys and 33% of girls.
Frömel et al., 2017 [31]	n = 6 371 60% girls 15–17 years Czech Republic ^b	Device- measured (pedometer Digi-walker Yamax SW- 700, at least 3 weekdays and 1 weekend day)	PA (total, VPA, MVPA, PA preferences, steps/day)	The agreement between preferred and PA actually undertaken was associated with higher odds for meeting the weekly PA recommendations and higher levels of well-being both in boys and girls.

		Self-reported (IPAQ-LF, PA preferences questionnaire)		
Frömel et al., 2016a [70]	n = 641 68% girls Mean age: 16.6 years Czech Republic	Device- measured (accelerometer ActiTrainer, hip-worn, 3 school days; pedometer Digi-walker Yamax SW- 700; heart rate sensor Polar)	PA (school, MVPA during PE lessons and recess, steps/hour, steps/day)	Both boys and girls participating in a PE lessons reported significantly better results compared with nonparticipating individuals regarding all indicators of volume and intensity of school PA. An increase in school PA and an improved lifestyle in adolescents on school days were significantly supported more by PE lessons than by longer recess time.
Frömel et al., 2016b [32]	n = 236 70% girls Mean age: 16.0 years Czech Republic ^b	Device- measured (accelerometer ActiTrainer, hip-worn, at least 1 school and 1 weekend day, 15 s epoch; heart rate sensor Polar)	PA (total and school steps/hour, PI)	Boys and girls participated in more PA at lower intensities on the weekends compared with school days. Sitting (lying) at a computer was 60 min/day longer in boys than in girls.
Frömel et al., 2007 [72]	n = 440 53% girls 15–20 years Czech Republic	Self-reported (IPAQ-LF)	PA (total and school, VPA, participation in organized PA and sport)	Boys were more active than girls. Increasing age was associated with lower leisure- time PA, AT and school or work PA in boys, and lower leisure- time and higher PA in household and at school or work in girls.
Gába et al., 2020a [81]	n = 659 58% girls 8–18 years Czech Republic	Device- measured (accelerometer ActiGraph GT9X Link or wGT3X-BT, non-dominant wrist, 7 consecutive days, >16 valid hours per day, at least 4 weekday and 1 weekend day)	PA (multi- day 24-h data; LPA, MVPA) SB (total sedentary time)	Children had by 26 min/day more LPA and by 19 min/day more MVPA than adolescents. Adolescents had by 111 min/day more SB than children. In children, being a short sleeper was associated with higher SB by 95 min/day and lower MVPA by 16 min/day. In adolescents, being a short sleeper was associated with a higher amount of time spent in SB by 67 min/day and lower LPA by 2 min/day.
Gába et al.,	n = 425	Device-	PA (total,	The children spent 87% of their

2020b [55]	58% girls 7–12 years Moravia region	measured (accelerometer ActiGraph GT3X, hip-worn, 7 consecutive days, 60 s epoch, >10 valid hours per day, at least 4 weekday and 1 weekend day, CoP by Evenson)	LPA, MVPA) SB (total sedentary time)	total SB time in sedentary bouts that were shorter than 30 min. Boys spent on average 9.9 min/day less in short sedentary bouts and 7.5 min/day more in long sedentary bouts compared with girls. Adiposity status could be improved by increasing MVPA at the expense of time spent in middle sedentary bouts. Some benefits for adiposity were found for replacing middle sedentary bouts with short sedentary bouts.
Gába et al., 2017 [56]	n = 365 ^d 57% girls 7–12 years Moravia region	Device-measured (accelerometer ActiGraph GT3X, hip-worn, 7 consecutive days, 60 s epoch, >10 valid hours per day, at least 3 weekday and 1 weekend day, CoP by Evenson)	PA (total, LPA, MVPA, VPA, steps/day) SB (total sedentary time)	In terms of the overall PA, boys were more active than girls. No associations were found between LPA and all body fatness indicators. MVPA was negatively associated with all body fatness indicators only in girls. In contrast, vigorous PA was strongly negatively associated with body fatness indicators only in boys.
Groffik et al., 2020 [33]	n = 629 66% girls Mean age: 16.2 years Czech Republic ^b	Device-measured (accelerometer ActiTrainer, hip-worn, 4 consecutive days, at least 1–3 days, 15 s epoch; pedometer Digi-walker Yamax SW-700; heart rate sensor Polar) Self-reported (IPAQ-LF)	PA (total and school, MVPA, steps/hour)	Participation in PE lessons was associated with a higher rate of meeting school PA recommendations. Compared with the Czech Republic, more PE lessons in the Polish education system were associated with increased daily VPA and a greater portion of school PA in daily PA.
Hamřík et al., 2015 [34]	n = 4 404 ^d 52% girls 11–15 years	Self-reported (HBSC questionnaire)	PA (total, VPA) SB (ST)	VPA was positively associated with healthy development of adolescents. Screen-based behavior showed an inverse relationship with adolescents' healthy development,

	Czech Republic ^b			especially in the group of 11- and 13-years old children.
Hamřík et al., 2014 [80]	n = 4 365 ^d 52% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	SB (ST)	The prevalence of SB rises with growing age with the most visible increase in prevalence between ages 11 and age 13. SB was significantly more prevalent among adolescent boys compared with adolescent girls. Czech adolescents were more likely to not meet the recommendation of 2 hours for watching TV at weekends compared to weekdays. Playing computer games was more common among boys contrary to chatting online, which was more common among girls.
Hamřík et al., 2012 [83]	n = 4 425 ^d 52% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	SB (ST)	More than 55% of girls and 60% of boys spent more than 2 hours a day in front of a TV, DVD or video screen in the working week. With age, the proportion of children who spent 2 or more hours a day using computer increases.
Hollein et al., 2018 [87]	n = 4 404 52% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (AT – commuting to/from school)	58% of children used AT for commuting to and from school. Children actively commuted more often in schools which had formally processed health promotion objectives than in school without these goals. In addition, children who had a school in the same village or city had a higher chance for AT than children who had a school elsewhere than in the place of residence.
Hollein et al., 2017 [88]	n = 1 522 52% girls 15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (AT – commuting to/from school)	School policies and programs promoting AT to and from schools in the Czech Republic contributed to the use of AT. The association between school policies and programs and AT was stronger in boys compared to girls.
Jakubec et al., 2020 [60]	n = 679 57% girls 8–18 years	Device-measured (accelerometer ActiGraph GT9X Link or	PA (multi-day 24-h data; LPA, MVPA)	No associations were found between meeting all three recommendations (≥ 60 min/day of MVPA, < 2 h/day of recreational ST, and

	Czech Republic	wGT3X-BT, non-dominant wrist, 7 consecutive days, >16 valid hours per day, at least 3 weekday and 1 weekend day)	SB (ST)	uninterrupted sleep for 9–11 h/day (for children) or 8–10 h/day (for adolescents) within the 24-hour movement guidelines and adiposity indicators. However, meeting ST only recommendation and the combination of the ST and sleep recommendations was associated with a reduced risk of excess adiposity.
		Self-reported (HBSC questionnaire)		
Kalman et al., 2015a [61]	n = 4 385 ^d 52% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (total, MVPA, VPA, motives for PA)	A substantial part of boys and girls were not participating in MVPA and VPA as recommended. MVPA and VPA among girls significantly decreased from age 11 to age 15. Boys compared to girls reported significantly more MVPA and VPA in all age groups, except 11 years old adolescents where the level of MVPA among girls and boys did not differ. Girls appear to be more influenced by social motives. Importance of these motives became higher with increasing age. Achievement motivation for PA was more important for boys and it also was increasing with age.
Kalman et al., 2015b [35]	n = n/a ^{d,e} 11–15 years Czech Republic ^b	Self-reported (HBSC questionnaire)	PA (total, MVPA)	In Czech adolescents, there was a decrease in meeting MVPA recommendation at least 60 min daily (4% and 3% for boys and girls, respectively) between 2002 and 2010.
Kleszczewska et al., 2020 [36]	n = 11 553 11–15 years Czech Republic ^b	Self-reported (HBSC questionnaire)	PA (AT – commuting to/from school)	In Czech sample, passive means of transport, walking and biking were found in 35, 62.1 and 2.9 % of adolescents, respectively. Biking to school was protective against reports of health complaints. Adolescents actively commuting to school were less likely to report especially psychological symptoms.
Kokko et al.,	n = 10 501 ^d	Self-reported	PA (total,	Sixty-two % Czech children and

2018 [37]	11–15 years Czech Republic ^b	(HBSC questionnaire)	VPA, participation in sports club)	adolescents (boys: 70 %; girls: 55 %; 11-, 13-, and 15-year-old: 66, 64, and 57 %, respectively) took part in sports club activities. Sports club participants were more likely to meet the overall PA recommendations and VPA recommendation than non-participants.
Kopčáková et al., 2017 [22]	n = 3 481 ^d 11–15 years Czech Republic ^b	Self-reported (HBSC questionnaire)	PA (total, MVPA) SB (ST)	An environment perceived as activity-friendly was associated with higher odds that adolescents met recommendations for PA and lower odds for excessive screen-based activities.
Kudláček et al., 2020 [23]	n = 2 334 65% girls 15–18 years Czech Republic ^b	Device-measured (pedometer Digi-walker Yamax SW-700) Self-reported (IPAQ-LF, QPAP)	PA (steps/day, VPA, MVPA, preferences for fitness PA)	The preference for fitness PA in boys was highly stable over the 8-year study period, with fitness PA third ranked after team and individual PA. For girls, an increasing trend was observed in the preference for fitness PA at the expense of dance and outdoor PA. In boys and girls, those who preferred fitness PA were more likely to achieve the recommended weekly PA level than those who did not prefer fitness PA.
Kudláček, 2015 [49]	n = 238 55% girls Mean age: 17.0 years Olomouc and Hradec Králové region	Self-reported (IPAQ-LF; questionnaire - Sport Preferences Surve)	PA (total, MPA, VPA, walking, leisure-time PA, school PA, PA preferences)	The students from Vrchlabí showed a significantly higher level of leisure-time PA as opposed to the students from Olomouc, who report a significantly higher level of school-based PA.
Maliňáková et al., 2018 [106]	n = 4 182 ^d 51% girls Mean age: 14.4 years Czech Republic	Self-reported (HBSC questionnaire)	PA (OLTA) SB (ST)	Both, spirituality and religious attendance of adolescents decreased the likelihood of excessive watching TV and playing computer games. Adolescent religious attendance and spirituality were associated with a more active way of spending leisure-time (sporting and non-sporting activities and regular reading books or playing a musical instrument).

Miklánková et al., 2013 [107]	n = 124 6–11 years Czech Republic	Device-measured (accelerometer Caltrac, pedometer Digi-walker Yamax SW-200, hip-worn, 7 consecutive days)	PA (steps/day, active energy expenditure)	High level of PA was found in all segments of the day and week (except of weekend days) in 10–11-year-old children compared to 6–9-year-old children.
Mitáš et al., 2020 [62]	n = 1 908 59% girls 15–19 years Czech Republic	Device-measured (pedometer Digi-walker Yamax SW-700; heart rate sensor Polar) Self-reported (IPAQ-LF)	PA (steps/day, MVPA)	Considering average steps/day and an achievement of 11,000 steps/day, continuous significant decrease was found between 2010 and 2017 in adolescent girls (by 18 %) and boys (by 28 %). The estimates of meeting the recommended weekly PA expressed as MET-min/week were not so convincing about the decrease. Given the lowest amount of PA on Sunday, the combination of weekend days with Monday represents a great risk for youths in terms of health.
Mitáš et al., 2009 [71]	n = 302 54% girls 14–15 years Czech Republic	Self-reported (IPAQ-LF)	PA (total, MPA, VPA, walking) SB (total sedentary time)	Girls were significantly more likely to be sitting than boys. Children living in a middle-sized to large-sized community, and living in an apartment, were significantly more likely to be sitting.
Ng et al., 2020 [24]	n = 4 809 ^d 52% girls 11–15 years Czech Republic ^b	Self-reported (HBSC questionnaire)	PA (MVPA)	Czech girls had better perceived school performance than boys, yet more boys participated in daily MVPA than girls. The associations between perceived school performance and MVPA were inverted U shaped. The strongest association for very good perceived school performance was among young adolescents who reported 5 to 6 days MVPA after controlling for family affluence scale.
Nováková Lokvencová et al., 2011 [25]	n = 383 53% girls	Device-measured (pedometer Digi-walker)	PA (total, steps/day)	Czech boys and girls showed a significantly higher number of steps on school days than on weekend days. The differences

	15–16 years Czech Republic ^b	Yamax SW-700, 7 consecutive days)		in the daily number of steps between Czech boys and girls were not significant on any day. Respondents reached the largest number of steps on Friday and the lowest number of steps on Sunday.
Pavelka et al., 2017 [86]	n = 12 273 51% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (AT – commuting to/from school)	AT to school decreased sharply among Czech children of school age from 2006 to 2014 (by 21.7% in boys and by 23% in girls). Walking was the most frequently used mode of AT. The boys were significantly more likely to cycle to school compared to the girls.
Pavelka et al., 2016 [26]	n = 418 ^d 54% girls 11–15 years Olomouc region ^b	Self-reported (HBSC questionnaire)	SB (ST)	Two-thirds of the respondents watched television or used a computer for at least two hours a day. The older children spent excessive amounts of time watching television.
Pavelka et al., 2012 [63]	n = 4 425 ^d 52% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (AT – commuting to/from school)	AT to and from school was opted for in the Czech Republic by approximately two-thirds of children aged 11 to 15. Differences between genders were not significant; most children opting for AT were aged 11 (69%). An important factor increasing the probability of AT as much as 16 times was whether a child's place of residence was in the same municipality as the school.
Pelclová et al., 2010a ^a [50]	n = 13 85% girls Mean age: 15.6 years Olomouc region	Device-measured (pedometer Omron HJ-105, waist, 10 months, >10 valid hours per day)	PA (steps/day, organized after-school PA)	Regardless of the day, month and season, high-school pupils participating in regular organized after-school PA achieved approximately 4 000 more mean step counts/day than the pupils not participating in after-school PA.
Pelclová et al., 2010b ^a [51]	n = 12 83% girls Mean age: 16.0 years	Device-measured (pedometer Omron HJ-105, hip-worn, 10 months, >10	PA (steps/day, school PA)	Across all months and seasons, high-school pupils achieved notably more steps on weekdays than on weekends, and on PE days than on non-PE days. The total

	Olomouc region	valid hours per day)		contribution of PE lesson (90 minutes) to pupils' daily PA was 10.0% additional steps per PE day. The lowest mean step counts were in February and the highest in June.
Roubalová et al., 2018 ^a [41]	n = 22 100% girls 6–11 years Moravia region	Device-measured (accelerometer ActiGraph GT3X+, hip-worn, 7 consecutive days, 60 s epoch, >10 valid hours per day, at least 3 weekday and 1 weekend day, CoP by Evenson)	PA (total, LPA, MVPA) SB (total sedentary time)	Seasonal differences were found in volume of PA (LPA, MVPA) and SB in younger school-age girls. The highest values of SB were found in autumn (November). The lowest values of SB and the highest values of LPA and MVPA were found in spring (May). Younger girls reported lower values of SB and higher values of PA in all monitored season, then older girls.
Rubín et al., 2020 [64]	n = 679 56% girls 8–18 years Czech Republic	Device-measured (accelerometer ActiGraph GT9X Link or wGT3X-BT, non-dominant wrist, 7 consecutive days, >16 valid hours per day, at least 4 weekday and 1 weekend day)	PA (multi-day 24-h data; LPA, MVPA) SB (ST)	Approximately 6.5% of children and 2.2% of adolescents met all recommendations of the combined 24-h movement guidelines and several correlates related to family were identified. In children, girls and participants with overweight or obese fathers had significantly lower odds of adherence to the combined movement guidelines.
Sigmund et al., 2020a [77]	n = 796 4–16 years Mean age: 10.0 years Czech Republic	Device-measured (pedometer Digi-walker Yamax SW-200, 8 consecutive days, >6 valid hours per day)	PA (steps/day, OLTA) SB (ST)	The mother's overweight/obesity significantly increases her children's odds of overweight/obesity. Concerning fathers, active participation in OLTA and reaching 10,000 steps per day significantly reduce the odds of overweight/obesity in their children and adolescent offspring.
Sigmund et al., 2020b [82]	n = 1 114 ^d 51% girls 6–16 years	Device-measured (pedometer Digi-walker Yamax SW-200, hip-worn, 8 consecutive	PA (steps/day, OLTA)	Regardless of parents' overweight/obesity, the children who participated in OLTA $\geq$ three times a week had a lower prevalence of obesity than the children without

	Czech Republic	days, >8 valid hours per day), at least 4 weekdays and 2 weekend day,		participation in OLTA (5.0% vs. 11.1%).
Sigmund et al., 2018a [78]	n = 649 ^d 51% girls Mean age: 9.3 years Czech Republic	Device-measured (pedometer Digi-walker Yamax SW-200, hip-worn, 8 consecutive days, >8 valid hours per day), at least 4 weekdays and 2 weekend day,	PA (total, steps/day, OLTA) SB (ST)	The mother's PA (achievement of at least 10 000 steps/day) was associated with the achievement of recommended daily steps in overweight/obese preschool and school-aged children.
Sigmund et al., 2018b [65]	n = 18 250 ^d 51% girls 10.5–16.5 years Czech Republic	Self-reported (HBSC questionnaire)	PA (MVPA) SB (ST)	A significant decrease was revealed in the rates of meeting the MVPA recommendation in low-family affluence boys (from 28.9 % in 2002 to 23.3 % in 2014) and girls (22.3 % in 2002 to 17.3 % in 2014). A significant trend-related increase in excessive ST was evident in adolescents regardless of gender and family affluence category. While in the high- family affluence boys category of adolescents, achieving 60 min of MVPA daily and the absence of excessive ST on weekdays significantly reduced their odds of being overweight/obese, in low- family affluence adolescents this was not the case.
Sigmund et al., 2015a [66]	n = 19 940 ^d 51% girls 10.5–16.5 years Czech Republic	Self-reported (HBSC questionnaire)	PA (MVPA, VPA) SB (ST)	Between the years 2002 and 2014, significant decreases in meeting MVPA recommendations were evident for both adolescent boys and girls. Moreover, increases in excessive ST on weekdays and weekends were found in boys.
Sigmund et al., 2015b [85]	n = 485	Device-measured	PA (total, steps/day)	A quantifiable relationship between parent-child steps/day

	51% girls 9–12 years Czech Republic	(pedometer Digi-walker Yamax SW-200, 7 consecutive days, >10 valid hours per day, at least 4 weekdays and 2 weekend days)	SB (ST)	and mothers' ST and children's steps at weekends was found. Each 1 000 steps increase in mothers' (fathers') steps/weekend day was associated with an extra 523 steps/day in their daughters and 508 steps/day in their sons. A reduction in mothers' ST by 30 minutes per weekend day was associated with an extra 494 steps/day in their daughters and 467 steps/day in their sons.
Sigmund et al., 2014 [67]	n = 338 50% girls 9–11 years Czech Republic	Device-measured (accelerometer ActiTrainer, waist, 2 consecutive days, >12 valid hours per day, 15 s epoch)	PA (LPA, MVPA) SB (total sedentary time)	Participation in PE lessons led to higher school and daily MVPA in the overweight/obese and normal-weight girls and boys. Participation in PE lessons also reduced school-time SB in the overweight/obese children and normal-weight girls.
Sigmund et al., 2013 ^a [52]	n = 176 ^d 48% girls 10–12 years Olomouc region	Device-measured (pedometer Digi-walker Yamax SW-200, hip-worn, 7 consecutive days, >12 valid hours per day)	PA (steps/day)	The study indicated favorable effects of an everyday school-based PA intervention programme on lower overweight/obesity incidence, which was maintained two years after the end of the direct involvement of the researchers.
Sigmund et al., 2012 ^c [53]	n = 176 48% girls 6–9 years Olomouc region	Device-measured (accelerometer Caltrac, pedometer Digi-walker Yamax SW-200, hip-worn, 7 consecutive days, >8 valid hours per day)	PA (steps/day)	School-based PA (PE lessons, PA during short breaks and longer recesses, PA at after-school nursery) in compatible active environments (child-friendly gym and school playground, corridors with movement and playing around corners and for games) had a vital role in obesity and overweight reduction among younger pupils.
Sigmund et al., 2011 ^c [54]	n = 176 48% girls 6–8 years	Device-measured (accelerometer Caltrac, pedometer Digi-walker)	PA (steps/day)	Higher school PA significantly enhances the inhibition of the decline in daily PA and the increase of obesity in 6–8 year-old children. After two years of the intervention program, there

	Olomouc region	Yamax SW-200; hip-worn, 7 consecutive days, >8 valid hours per day)		was no occurrence of obesity in any child in the experimental group, yet there were 22% girls and 23% boys obese in the control group.
Sigmund et al., 2009 ^a [108]	n = 176 48% girls 5–7 years Czech Republic	Device-measured (accelerometer Caltrac, pedometer Digi-walker Yamax SW-200; hip-worn, 7 consecutive days, >8 valid hours per day)	PA (steps/day)	First-grade school children had lower PA than pre-schoolchildren on weekdays and at weekends. Decline in PA on weekdays was during time spent at school and not during after-school children's leisure-time.
Sigmund et al., 2008 [46]	n = 193 44% girls 8–13 years Olomouc region	Self-reported (IPAQ-SF)	PA (total, organized PA, VPA, MPA, walking) SB (sitting time)	A longer duration of total PA in daughters, sons and their fathers and mothers was related to a shorter daily period of time spent sitting. A longer time spent daily in sitting in parents was associated with a longer time spent sitting in their children. Children, both daughters and sons, and their mothers, who participate in organized PA twice or more times a week, showed a significantly longer time spent performing VPA than children whose mothers are without any participation in organized PA.
Sigmund et al., 2007 [47]	n = 67 48% girls 9–11 years Olomouc region	Device-measured (accelerometer Caltrac, pedometer Digi-walker Yamax SW-200, 7 consecutive days)	PA (steps/day)	More than 73% of participating children, who were physically active at weekend at least at the same level as at school days, met the health-related PA recommendations for this age category. The weekly number of steps for children who met the health recommendations was 6000 steps/day higher than for children who did not meet the health recommendations.
Sigmundová et al., 2020a [95]	n = 1 795 4–16 years Czech Republic	Device-measured (pedometer Digi-walker Yamax SW-200; hip-worn, 7 consecutive	PA (steps/day)	A strong parent-child step counts relationship was found in children younger than eight years of age. In older children, the parent-child step counts association was gender-specific and dominated by the

		days, < 8 valid hours per day)		father-son relationship, particularly on weekends.
Sigmundová et al., 2020b [79]	n = 1 284 51% girls 4–16 years Czech Republic	Device- measured (pedometer Digi-walker Yamax SW- 200, 8 consecutive days)	PA (steps/day) SB (ST)	Despite the different mother-/father–child behavioral associations, daily step counts of parents were positively associated with daily step counts of their children. For both overweight/obese and non-overweight children, the odds of reaching the recommended daily step counts were increased by their regular participation ($\geq$ twice per week) in OLTA and non- excessive entertainment ST ($\leq$ 2 h per day) in the mother- child and nuclear family triads.
Sigmundová et al., 2018 [73]	n = 649 ^d 51% girls 7–11 years Czech Republic	Device- measured (pedometer Digi-walker Yamax SW- 200; hip-worn, 8 consecutive days, >8 valid hours per day, at least 4 weekdays and 2 weekend days)	PA (steps/day) SB (ST)	High levels of parents' PA contributed to the achievement of the recommended daily PA in children on weekdays and at weekends. Excessive weekend ST of parents reduced their odds of their children achieving the recommended daily PA; however, the influence of parents' PA on their children's achieving the recommended daily PA was stronger than the inhibitory effect of ST.
Sigmundová et al., 2017 [84]	n = 16 535 ^d 51% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	SB (ST)	The boys and girls surveyed in 2014 were up to two times more likely to meet the recommendations for watching television in comparison with groups of schoolchildren of the same age surveyed in 2002. In contrast, computer use by adolescents increased markedly between 2006 and 2014. Taking total ST into account, spending two hours per day or less on it decreased significantly among boys and girls between 2006 and 2014.
Sigmundová et al., 2014 [74]	n = 485 51% girls 9–12 years Czech Republic	Device- measured (pedometer Digi-walker Yamax SW- 200; 7 consecutive days, >10 valid hours per day)	PA (steps/day) SB (ST)	The children of fathers and mothers who met the weekend recommendation of 10 000 steps were 5.48 and 3.60 times, respectively more likely to achieve the weekend recommendation than the children of less active parents. The children of mothers who reached the weekday

pedometer-based step count recommendation were 4.94 times more likely to fulfil the step count recommendation on weekdays than the children of less active mothers.

Sigmundová et al., 2013 [40]	n = 14 219 ^d 51% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire)	PA (MVPA) SB (ST)	In comparison with 2002, increased sedentary time and a decline or stagnation of the proportion of children meeting recommendations for PA were found among Czech school-aged children in 2010.
Sigmundová et al., 2011 [38]	n = 520 60% girls 14–18 years Czech Republic	Device-measured (pedometer Digi-walker Yamax SW-701 or Omron HJ-105, hip-worn, 7 consecutive days, >10 valid hours per day)	PA (total, steps/day) SB (total sedentary time)	A secular decrease in PA were found amongst adolescents between 1998–2000 and 2008–2010. The significant interaction effects (cohort × age; and cohort × gender) that this study found suggested that secular trends in PA differ by age and gender.
Šimůnek et al., 2017 [68]	n = 701 60% girls Mean age: 17.0 years Czech Republic	Self-reported (IPAQ-LF)	PA (total, AT, LPA, MVPA) SB (sitting time)	The differences in the overall weekly PA between secondary school boys and girls and between university boys and girls were significant, when secondary school and university boys were more active than secondary school and university girls.
Šnobllová et al., 2015 [94]	n = 169 50% girls 9–10 years Czech Republic	Device-measured (accelerometer ActiTrainer, hip-worn, 2 days, >12 valid hours per day, 15 s epoch)	PA (total, steps/day, MVPA)	Boys were more physically active than girls during their stay at school, both in terms of the step count (800 steps/day more than girls), and duration of MVPA.
Valach et al., 2017 [59]	n = 653 59% girls Mean age: 17.3 years Plzeň region	Self-reported (IPAQ-LF, questionnaire - Sport Preferences Survey)	PA (total, MPA, VPA)	The preference of fitness activities was associated with a higher level of PA in spare time of boys, and with VPA of boys and girls, compared to those, who did not prefer these activities. In addition, in case of boys, significant correlations

were found between the preference of team sports and PA at school. Individual sports (swimming, cycling, and downhill skiing) are the main PA preferred by girls. These activities were followed by team sports, rhythmic and dance activities. In case of boys, team sports (football, floorball, and basketball), individual sports, and fitness activities appear at top positions.

Valová et al., 2013 [42]	n = 55 100% girls Six grade class Opava region	Device-measured (accelerometer ActiGraph GT3X, hip-worn, 7 consecutive days)	PA (total, coordination skills)	There wasn't difference in PA between girls from cities and villages.
Vašíčková et al., 2013 [27]	n = 786 66% girls 15–16 years Czech Republic ^b	Device-measured (pedometer Digi-walker Yamax SW-700) Self-reported (IPAQ-LF)	PA (steps/day)	Young people on average recorded lower numbers of steps on weekends compared to schooldays with Sunday being the most critical day of the week. No significant differences between boys and girls were found in terms of average number of steps per day.
Vašíčková et al., 2008 ^a [43]	n = 9 100% girls Mean age: 15.6 years Olomouc region	Device-measured (pedometer Omron HJ-105, hip-worn, 10 months, >10 valid hours per day)	PA (steps/day)	The variability in year-round PA was found across days and autumn, winter and spring months. Saturdays and Sundays were the days with the lower number of steps. The highest number of steps was obtained on days with PE lesson. The months with the lowest and highest average steps/day were February and June, respectively.
Vindiš et al., 2019 ^a [44]	n = 27 100% girls 11–15 years	Device-measured (accelerometer ActiGraph GT3X+, hip-worn, 7	PA (total, LPA, MPA, VPA)	The volume of SB and PA was different on the days with training, on the days without training and during the seasons. On the days with PE lessons, the girls had 27.6%

	Czech Republic	consecutive days, 60 s epoch, >13 valid hours per day, at least 3 weekdays and 1 weekend day, CoP by Evenson)	SB (total sedentary time)	more MPA, 37.7% more VPA and 8% fewer than on the days without PE lessons.
Vorlíček et al., 2020 [89]	n = 1 586 48% girls 11–15 years Czech Republic	Self-reported (HBSC questionnaire and IPEN Adolescent questionnaire)	PA (AT – commuting to/from school)	Most of the Czech adolescents misperceived the active commuting norms of their peers. 68% of the Czech adolescents in this study were daily active commuters (walking, cycling, or riding a scooter or skateboard).
Vorlíček et al., 2019 [69]	n = 1 586 48% girls 11–15 years Czech Republic	Self-reported (Questionnaire of study SONIAA from Czech version questionnaire (Youth Activity Profile)	PA (MVPA on Saturday)	The level of the real PA of an individual and perceived level of Saturday's PA in peers significantly differed among Czech adolescents. Pupils believed that 41.9% of their classmates had had at least one hour of PA on Saturday. This estimation differs by 18 percentage points from the reported situation.
Vorlíček et al., 2017 [75]	n = 1 745 49% girls 11–19 years Czech Republic	Device-measured (pedometer Digi-walker Yamax SW-700, 7 consecutive days) Self-reported (IPEN Adolescent questionnaire)	PA (AT – commuting to/from school, steps/day)	A greater proportion of pupils, who met health recommendations for PA, occur in the group using the active forms of commuting to school, such as walking or riding a bike or skateboard. The majority (85%) of pupils, who commuted actively to school, lived within a 20-minute walking distance.
Weinberg et al., 2019 [28]	n = 4 847 ^d 11–15 years Czech Republic ^b	Self-reported (HBSC questionnaire)	PA (MVPA, VPA)	Daily involvement in MVPA decreased with age (from 4.62 days with MVPA/week in 11-year-old adolescents to 3.99 days with MVPA/week in 15-year-old adolescents) while weekly VPA increased (from 1.99 hours/week in 11-year-old

to 2.52 hours/week in 15-year-old adolescents).

Whiting et al., 2020 [29]	n = 1 406 ^d 52% girls 6–9 years Czech Republic ^b	Self-reported (questionnaire form the COSI)	PA (active play, OLTA, AT – commuting to/from school) SB (ST)	Approximately, 98% Czech children actively playing for at least 1 hour/day, 37% were not members of sports/dancing clubs or did not do sports or dance at all. Approximately, 45% Czech children used AT (walking or cycling) to get to and from school, 64% children spent <2 h of ST per day, and 95% children slept for 9–11 hour per night.
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studies on adolescents, and 7 studies on both. The age of the study participants ranged between 6 and 19 years. The intervention studies employed only children aged 6–9 years. Girls represented more than 50% of the study sample in most of the studies and boys have not been included in 4 studies [41–44]. Out of all 79 studies, the randomly selected representative samples were identified in 28 studies.

In cross-sectional studies, the sample size varied from 55 [42] up to 30,966 participants [45]. Longitudinal studies employed samples with 9 to 176 participants.

This scoping review identified data on PA and SB of Czech children and adolescents in 18 international and 61 national studies. Some of the national studies narrowed their selection only to specific regions: 12 studies from the Olomouc region [26, 39, 43, 46–54], 2 studies from the Hradec Králové region [39, 49], three studies from the Moravia region [41, 55, 56], two studies from the North-western Bohemia region [57, 58], one study from the Plzeň [59] and Opava region [42].

All studies reported the measurement tool for PA or SB assessment (Table 1). The number of studies using self-reported (n = 39), device-measured (n = 32), and a combination of both (n = 8) assessments of PA and SB is shown in Figure 3. Out of 40 studies using device-based measurements, accelerometers (ActiGraph GT3X, GT3X+, GT9X Link, wGT3X-BT, Caltrac, and ActiTrainer) were used in 19 studies, while pedometers (Digi-walker Yamax SW-200, SW-700, SW-701, Omron HJ-105) were used in 28 studies. Studies using self-reported measurements used the HBSC questionnaire (n = 27), IPAQ-long form (n = 13), IPEN Adolescent questionnaires (n = 2), IPAQ-short form (n = 1) and other types of questionnaires (n = 9).

Of the 79 included studies (Figure 2), PA-only studies comprised the largest proportion (61%), followed by both PA and SB studies (34%) and SB-only studies (5%). PA was expressed as minutes, MET-minutes or steps on an average day (waking time or 24h) or a specific segment of the day (unorganized or organized leisure-time physical activity (OLTA), school PA in physical education (PE) lessons, or during recesses, active transport (AT). SB studies reported minutes of total SB, sitting time, or ST, which was defined as TV viewing, playing games on PC/console, chatting online, internet, emailing, etc.

Main findings related to PA and SB

Prevalence of sufficient/insufficient PA and SB

Thirty-seven studies (Supplementary file 3) also reported the prevalence of sufficient/insufficient PA, SB, or both. The prevalence of the adherence to the PA and ST recommendations ranges between 12.6–73% and 17.5–73.6%, respectively. However, the definition of sufficient PA level was different in the included studies, from meeting 60 minutes of moderate to vigorous physical activity (MVPA) daily or five times a week [20, 21, 23, 30, 31, 35, 37, 52, 56, 60–70], 20 minutes of VPA at least three times a week or 30 minutes of MPA or walking at least five times a week [21, 23, 30, 31, 37, 59, 61, 66, 68, 71, 72], daily step counts ranging between 11 000–14 000 for boys and 10 000–13 000 for girls [27, 31, 38, 47, 62, 70, 73–79]. Moreover, the recommendation for school PA (i.e., 500 steps/school time) was met by 39% Czech adolescents [33] and 83% of boys and 69% of girls in days with PE lesson [70]. Excess SB was mostly defined as ≥ 2 hours/day of ST [66, 73, 74, 80] and was accomplished by 40.4–80.7% of children and adolescents.

Higher likelihood of meeting recommended level of PA was associated with lower age [24, 28, 37, 40, 41, 60, 61, 64, 66, 69, 72, 81], an environment perceived as activity-friendly [22], participation in PE lessons or intervention programs [53, 67, 70], active transportation [21, 69], OLTA [78, 82] or more specifically in sports clubs [37], sufficient PA at weekend days [27, 74], preferences of fitness activities [23, 59], different kind of motives [31, 42, 48, 49, 61] and the agreement between preferred and PA actually undertaken [31].

The proportion of children and adolescents not meeting recommendation for SB or ST was positively associated with age [26, 60, 80, 83, 84] and more ST at weekend days compared to weekdays [32, 40, 58, 66, 74, 80, 84, 85]. Furthermore, longitudinal studies confirmed the variability of the achievement of sufficient PA and SB across seasons, months, and days of the week [41, 43, 44, 50, 51].

Studies investigating the trends of sufficient PA or SB found an increasing prevalence of sedentary time [40, 66], the decreasing prevalence of children and adolescents meeting PA guidelines [35, 38, 62, 66], and active commuting [86]. However, one study suggested that the way how children and adolescents spent their time being sedentary has shifted from watching TV to computer use during 2002 and 2014 [84].

Weekdays versus weekend days

In all studies, a greater PA level was found for weekdays compared to weekend days. Moreover, this was confirmed in longitudinal studies [43, 51] which revealed that across all months and seasons, children and adolescents achieved notably more minutes in MVPA or steps on weekdays than on weekends, with Sunday being the least active day [43, 50, 51, 62]. Conversely, weekend days seem to be the “risk time” for excessive ST and insufficient PA level [40, 62, 66, 74, 80, 85].

Active transport

Out of 11 studies examining AT, 9 studies focused on active commuting to and from school including walking, cycling, and riding a scooter or skateboard. The proportion of children and adolescents using actively commuting to school ranged between 22.5% and 74.3% across studies [29, 36, 39, 63, 75, 86–

89]. Living within a 20-minute walking distance to school [75], a place of residence being in the same municipality as the school [63, 87], high walkable areas [39], and attending schools with policies and programs promoting AT [87, 88] were positively associated with active commuting to school. Based on one study [21], AT accounted for 22.5% and 24.9% of the weekly PA of Czech boys and girls, respectively. A long-term decrease in AT of Czech adolescents was found in two studies. One study [39] found a decrease in the proportion of active commuting in 47% of respondents and suggested 2.7 times decrease in likelihood to actively commute in 2011 than in 2001. The second study [86] showed an overall decrease in AT by 21.7% in boys and by 23% in girls between 2006 and 2014.

PE lessons and organized leisure-time activities

Participation in regular PE lessons contributed considerably to increment of the volume and intensity of school PA [33, 67, 70], steps/day [43, 51], daily MVPA [67] and decrease of school-time SB [67]. This was apparent across all months and seasons [43, 44, 51]. In intervention studies [52–54], PE lessons as a part of the school PA program performed in the compatible active environments were found to have a vital role in obesity and overweight reduction among younger pupils.

The proportion of children and adolescents who participated in OLTA ranged between 41–81% across studies [90–93] and was decreasing with age [58, 91]. More specifically, 62% of Czech children and adolescents took part in sports club activities [37]. Moreover, OLTA was positively associated with better physical and mental health [93], lower occurrence of repeated substance use and truancy, and inversely with higher odds for physical fights and injuries [91], higher school engagement, lower levels of school-related stress, and better academic achievement [92], and a lower prevalence of obesity [82]. Longitudinal engagement in OLTA increased daily PA, regardless of the month and season [50]. In contrast, 34–37% of Czech children and adolescents were not engaged in any OLTA [29, 90]. However, the involvement in peer-oriented unstructured activities was strongly associated with an increased risk of smoking, getting drunk, experience with sexual intercourse, and worse academic achievement in 34% of adolescents [90].

Differences between boys and girls

The majority of studies investigating PA in both sexes suggested that boys are more active than girls [56, 72, 94]. This was obvious particularly in total PA [32, 37, 72], MVPA [24, 30, 31, 35, 40, 55, 56, 61, 62, 65–67, 94], school-based PA [32, 33, 70], leisure-time PA [58, 72, 82, 90, 92, 93] and active transportation [21, 39, 86, 88]. Although the most studies found a higher daily number of steps in boys than in girls [25, 31, 33, 52–54, 56, 57, 62, 70, 73, 74, 79, 82, 85, 94, 95], four studies conversely suggested higher steps/day in girls compared to boys [32, 38, 76, 78]. Sex-specific patterns related to PA were found in several studies. For example, boys were more likely to cycle to school [86] and the association between school policies and programs and AT was stronger in boys compared to girls [80]. On the other hand, a higher rate of AT was significantly associated only with higher well-being in girls [21]. Girls had significantly lower odds of adherence to the combined movement guidelines [64], appeared to be more influenced by social motives [61] and their participation in leisure-time PA was decreasing with age more than in boys [58]. PA preference differed between boys and girls and was longitudinally more stable for boys than for girls [23].

In SB studies, the results related to sex differences were not so clear. In some device-based studies, girls were found to be more sedentary [38, 56, 67, 71], while in others, time spent in SB was higher in boys compared to girls [45, 58, 65, 80, 83]. Moreover, in self-reported studies, boys reported higher overall ST [58, 83], computer use [32, 45, 80], or TV watching [45] than girls. On the contrary, chatting online was more common among girls [80]. The sex-specific SB was found also in the device-based study [55], where boys spent on average 9.9 min/day less in short sedentary bouts and 7.5 min/day more in long sedentary bouts compared with girls. Also, longitudinal increases in excessive ST on weekdays and weekends were found only in boys [66].

Parent-child PA

The relationship between the parent's and children's PA and SB was investigated in 8 studies [46, 73, 74, 78, 79, 82, 85, 95]. In conclusion, high levels of parents' PA contributed to the achievement of the recommended daily PA in children [73, 74, 78, 79, 85, 95], and excessive ST of parents was associated with a longer time spent sitting in their children [46] and reduced likelihood of their children of achieving the recommended daily PA [73, 85]. The parent-child PA or SB relationship was found to be stronger for children younger than eight years of age [78, 95], on weekend days [73, 74, 85, 95], and in families participating in organized PA [46].

24h time use

In four studies, 24-h movement behaviours were considered including SB, PA, and sleep. Based on one self-reported study [29], 95% of Czech children slept for 9–11 hours per night. Approximately three-quarters of children (71 %) and adolescents (75.3 %) slept less than 9 and 8 hours, respectively [81]. In children, this short sleep duration was associated with higher SB by 95 min/day and lower MVPA by 16 min/day. In adolescents, a higher SB by 67 min/day and lower light intensity PA (LPA) by 2 min/day were found to be associated with a short sleep duration. [81]. Also, meeting combined 24h movement guidelines (≥ 60 min/day of MVPA, < 2 h/day of recreational ST, and uninterrupted sleep for 9–11 h/day for children or 8–10 h/day for adolescents) was investigated in two studies [60, 64]. All recommendations of the combined 24h movement guidelines were met by approximately 6.5% of children and 2.2% of adolescents [64]. While no associations were found between meeting all three (combined) recommendations and adiposity indicators, meeting ST only recommendation or the combined ST and sleep recommendations was found to be negatively (favorably) associated with adiposity [60]. Furthermore, significantly lower odds of adherence to the combined movement guidelines were in girls and participants with overweight or obese fathers [64].

Discussion

This scoping review examined 79 original articles related to PA or SB of Czech children and adolescents and summarized the descriptive characteristics and main conclusions of the available evidence. The majority of studies were cross-sectional (88.6%), approximately two-thirds of the studies (61%) examined only PA, and half of the studies (50.6%) employed device-based assessments. Approximately 47% of

studies reported the prevalence of sufficient/insufficient PA and 14%, 23%, and 10% of studies focused on AT, organized PA (including PE or OLTA), and parent-child PA, respectively.

Although we searched for the articles published in the past two decades, the articles included in this review have been not published until 2007. Since then, the number of PA and SB research has been on the rise with 79 papers being published till December 2020. This is in line with the gradual increase of Czech studies dealing with the PA of children and adolescents, often connected with international cooperation and participation in global studies, such as International Physical Activity and the Environment Network, Health Behaviour in School-Aged Children, or Childhood Obesity Surveillance Initiative. Although the first two papers were published in 2007, data from identified studies cover the whole 20-year period. This is mainly apparent in trend studies with the first round of assessments in 1998–2000 [38], 2001 [39], and 2002 [40].

In this review, we found a high proportion of cross-sectional studies and only nine studies with a longitudinal design. The follow-up period of longitudinal studies ranged between 10 to 24 months and revealed differences across days of the week, months, and seasons, and in one specific life transition (e.g., from kindergarten to school). However, these studies employed mainly very small convenience samples with limited possibility to generalize the results to the Czech school-aged population. Considering longitudinal studies as the way how to define the causality and determinants of PA and SB, more longitudinally designed studies with the random sample are needed in the Czech Republic. Additionally, these studies should consider the year-round movement behaviours concerning different life transitions.

This study critically reviewed only the PA and SB research in target populations, although the importance of sleep has been recognized and was included as an important health outcome when considering the impact of PA and SB [81]. This was done for two reasons. Firstly, the vast majority of Czech studies focused only on PA and/or SB, with exception of four studies [55, 60, 64, 81] published very recently which examined movement behaviours (i.e., PA, SB, and sleep) using 24-h wear time protocol. Secondly, this approach agrees with a recently published edition of “WHO Guidelines on Physical Activity and Sedentary Behavior” [1]. However, in recent years, the univariate paradigm in movement behaviour research has been substituted by a 24-h time-use paradigm that integrates all daily movement behaviours being analyzing relative to each other, rather than as individual entities [96]. This approach is apparent in world initiatives, such as developing time-use epidemiology [97] and in the creation of 24-h movement behaviour recommendations in several countries, such as Australia [98], Canada [99], Croatia [100], New Zealand [101] or Thailand [102]. Within this review, the lack of Czech studies focusing on health-related time-use patterns and covering all daily behaviours in children and adolescent populations has been recognized.

Consistent, understandable assessments of prevalence and trends in PA (ideally relative to other behaviours) are necessary to guide the development of policies and programs to increase activity levels and to reduce the burden of non-communicable diseases associated with physical inactivity and elevated

SB. In this review, 37 studies investigating the percentage of Czech children or adolescents who achieved PA or SB recommendations were cross-sectional with 62% not having a representative sample.

This review also identified several studies that examined trends in PA or SB or meeting recommendations for these behaviours. Such studies with randomly selected samples suggested the negative trends which were found in other countries [5], such as increased sedentary time, decreasing percentage of children and adolescents meeting PA guidelines, and using AT. However, these studies employed self-reported assessments of PA and SB that could be prone to both inaccurate reporting and reporting bias [103]. Moreover, accelerometers were found more accurate in the characterization of the entire activity pattern in school-aged children [104]. On the other hand, the domain and type-specific differences in PA and SB (e.g., AT, ST) advocate the importance of assessing movement behaviours using the combination of self-reported and device-based methods. Furthermore, the variety of tools used to assess PA and SB, the way how were the data processed (especially in accelerometers) as well as the different definition of sufficient level of PA and SB in the studies may explain the inconsistency of findings related to sex-specific PA and SB or prevalence of sufficient PA.

Strengths and limitations of the study

This is the first comprehensive study systematically reviewing available evidence related to PA and SB in Czech children and youth. Moreover, within this review, we provide suggestions for future directions of the national surveillance system on these behaviours.

Several limitations have to be mentioned. Firstly, the search strategy does not cover "grey literature". This could lead to publication bias as we might miss some valuable data published in conference proceedings, Master or Doctoral thesis, or reports. On the other hand, our search strategy ensured that all studies found for this review underwent a peer-review process and demonstrate at least satisfactory methodological quality standards. Last and not least, within this scoping review we described the study designs, samples, and methods of PA and SB assessments and the main findings of the selected studies. However, an assessment of methodological quality which could help in comparison of outcomes of the studies was not carried out.

Conclusion And Recommendations

This scoping review identified 79 studies related to PA and SB in Czech children and adolescents and revealed the increasing trend in a number of studies being published during the past two decades. The results of studies suggested an increase of the unhealthy sedentary time or its proxy-indicators and decreasing percentage of Czech children and adolescents meeting a sufficient amount of PA. Based on this review, organized PA including PE lessons as well as OLTA, increasing of weekend PA, family inclusion, and movement supporting environment might contribute to decrement of unhealthy time-use in Czech children and adolescents.

Although we reviewed 79 studies, the unified national surveillance was not recognized. This review identified limitations including the large proportion of cross-sectional studies, the limited sample size in longitudinal studies, the lack of studies using a mix of device-based and self-reported methods, and focusing on health-related 24-h time-use patterns.

In agreement with global calls [11, 105], the result of this review advocates the necessity of the governmental-supported development of a national surveillance system that would incorporate a combination of standardized device-based measures, such as those derived from accelerometers, and self-reported domain and type-specific assessments. Such a national surveillance system on movement behaviours which would allow to systematically assess the recommended amount of these behaviours is needed to reduce decreasing of sufficient PA and hence, improve health or reduce the risk of different non-communicable diseases in Czech children and adolescents.

With respect to the "WHO Global action plan on physical activity 2018–2030" call [11] and based on this review of the best available evidence, we identified several issues which might serve as a recommendation for future directions in Czech research and policy and were inspiring for other Central European countries lacking a national surveillance system:

- We advocate the development of a national surveillance system on 24-h movement behaviours that would incorporate both device-based measures and self-reported domain and type-specific assessments.
- The national surveillance system should systematically monitor the prevalence of sufficient PA and 24-h time use of PA, SB, and sleep and their associations with health outcomes.
- Further evidence is needed to support national recommendations on PA, SB, and sleep and to enforce them in state and school policy and practice. Furthermore, longitudinally designed device-based studies employing randomly selected samples of Czech children and adolescents are needed.

Abbreviations

PA: physical activity

SB: sedentary behaviour

METs: metabolic equivalents

WHO: World Health Organization

OLTA: organized leisure-time physical activity

PE: physical education

AT: active transport

ST: screen time

MVPA: moderate-to-vigorous physical activity

LPA: light-intensity physical activity

Declarations

Acknowledgments

We are thankful to the Palacký University Olomouc for providing us with essential resources to complete this review.

Authors' contributions

EM, JP and AG conceptualized the study. EM and JP wrote the manuscript. EM, JP and AG contributed to the abstract and full-text screening. AG creates the search strategy. AG and KF critically reviewed the manuscript and made revisions. All the authors approved the final draft.

Funding

The study was funded by the internal Palacký University Olomouc grant IGA_FTK_2018_007.

Availability of the data and materials

The data supporting the conclusion of this paper are available through the detailed reference list. No original datasets are presented since this was a review of previously existing literature. Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

Ethics approval and consent to participate

This study is a systematic scoping review that relied solely on existing literature. Hence, ethical approval was not required since there were no human participants.

Consent for publication

Not applicable.

Competing interests

The authors declared no competing interests.

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Figures

Figure 1

The flow of information through the different phases of the review.

Figure 2

The overview of included studies considering their year of publication and primary outcomes. Note. PA = Physical activity; SB = Sedentary behaviour.

Figure 3

The overview of included studies considering their year of publication and the assessment tools.

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