TRENDS IN MEDICALLY ATTENDED INJURIES AMONG CZECH ADOLESCENTS BETWEEN 2002 AND 2022

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SUMMARY

Objectives: Adolescence is widely recognized as a critical developmental period marked by increased independence and risk-taking behaviours, which often result in medically attended injuries. The aim of the study is to present the trends analyses of self-reported HBSC data on medically attended injuries in Czech adolescents between the years 2002 and 2022 and complement other sources of injuries data in Czech adolescents. Additional objective is to outline the possible use of the above-mentioned data for research purposes by public health professionals and researchers so they can be used for injury prevention purposes.

Methods: The overall sample of 44,817 adolescents aged 11, 13 and 15 years (50.3% girls) from the last six cycles of the Health Behaviour in School-aged Children study data collections between 2002 and 2022 was analysed.

Results: An adjusted residual analysis of nationally representative data from 2002 to 2022 revealed a significant shift in the pattern of medically attended injuries among Czech adolescents. Across both sexes and all surveyed age groups, there was a notable increase in the prevalence of multiple (2 or more) injuries. Simultaneously, the proportion of adolescents reporting no injuries decreased significantly, particularly among girls, whose injury-free rate dropped from 61.2% in 2002 to 48.2% in 2022. While the rate of single injuries remained relatively stable – without significant change in many groups – the overall injury burden has shifted toward more frequent and potentially severe injury experiences. Logistic regression analysis revealed that the likelihood of reporting at least one injury was highest in 2022, after controlling for gender, age, and family affluence. Boys, 13-year-olds, and children from higher-income families were at increased risk.

Conclusions: Medically attended injuries have increased in both frequency and complexity over the last two decades among Czech adolescents. The shifting patterns underscore the urgent need for context-sensitive, age-appropriate, and equity-focused prevention strategies.

Key words: wounds, traumas, youth, schoolchildren, epidemiology

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INTRODUCTION

Adolescence is widely recognized as a critical developmental period marked by increased independence and risk-taking behaviours, which often result in medically attended injuries (1, 2). Even though the burden of injuries in children and adolescents showed a decreasing trend from 1990 to 2019 at the worldwide level, injuries remain the leading cause of morbidity and mortality in this age group (3–5). At the same time, the economic cost of injuries in children and adolescents is substantial, encompassing direct medical expenses, lost productivity, and broader societal impacts when the financial burden is not only borne by healthcare systems but also affects families and society at large (6–8).

In Czechia, the official data about the number of injuries treated under public health insurance in the age group 10–19 years shows that there was a slight decrease in treated injuries between the years 2010 and 2013 (422,982 and 369,014 cases, respectively) but the cases re-increased between the years 2014 and 2022 (377,076 and 420,590 cases, respectively) (9). In 2010 and 2022 the injuries of adolescents ended up to account for similar proportion of treated injuries within all age groups (15.9%, 15.2%, respectively).

Another self-reported data from the Health Behaviour in School-aged Children (HBSC) study in Czechia shows that there was an increase in medically attended injuries in Czech adolescents between the years 2002 and 2006 (43.4% and 48.2%, respectively) followed by the decrease in 2010 and 2014 (47.5% and 40.7%, respectively) (10).

Similar trends observed in both official data about the injuries treated under public health insurance and self-reported HBSC data between the years 2010 and 2013/4 (HBSC are one-year retrospective) suggest that, despite the fact that self-reported data are subject to recall bias and may not always align with medical records and serve as reliable proxies for actual injury outcomes, they can be considered as complementary to other more reliable data sources (11–13). Furthermore, the HBSC self-reported data on medically attended injuries provides the opportunity for research of injury correlates by focusing on the outcomes that might not be captured through medical records alone (14–16).

The aim of the study is therefore twofold: firstly, to present the trends analyses of self-reported HBSC data on medically attended injuries in Czech adolescents between the years 2002 and 2022 and complement other sources of injuries data in Czech adolescents; and secondly, to outline the possible use of the above-mentioned data for research purposes by public health professionals and researchers so they can be used for injury prevention purposes as effectively as possible.

MATERIALS AND METHODS

Participants

In the springs of 2002, 2006, 2010, 2014, 2018, and 2022, randomized selection of schools from all 14 regions of Czechia was used to create representative samples of 11-, 13- and 15-year-old adolescents. The school response rates were 93.5%, 95.6%, 94.5%, 99.5%, 89.2%, and 87.0% in the respective years. Using the international Health Behaviour in School-aged Children study protocol, only one class from one grade per school was selected randomly to fulfil the necessary quota for a national representative sample. Pupils in that selected class used up one class period, lasting 45 minutes, and completed the HBSC survey with a teacher or trained researcher present (when the teacher was absent). Pupils that were absent during that period did not complete the survey; therefore, the overall students' response rates were 88.8%, 88.5%, 87%, 89.2%, 86.6%, and 83.3% in the respective years. For the purposes of this study, the overall sample of 44,817 adolescents was analysed (50.3% girls) (Table 1).

The Institutional Ethics Committee for Research of the Faculty of Physical Culture of Palacký University Olomouc approved the design of the cross-sectional study, the course of preparation and implementation of the research and the opt-out method of collecting parental consent and data processing for HBSC data collections in 2014, 2018 and 2022 (numbers of approvals: 17/2013, 9/2016, 65/2020).

Variables

Medically Attended Injuries

The HBSC item measuring the frequency of medically attended injuries originates from the 1988 Child Health Supplement to the United States National Health Interview Survey, with the same item being regularly used in the Youth Risk Behavior Surveillance System (YRBS) (16, 17). It has been used in the HBSC survey since 1993/94 and is considered the standard item for studying injuries, having been substantially validated as part of the YRBS study and used in Canada (17, 18). The item and its response categories are as follows:

"How many times during the past 12 months have you been injured so that you have been treated by a doctor or a nurse? (I have not been injured over the last 12 months; once; twice; three times; four or more times.)"

The responses were dichotomized between the following: have not been injured (none) and at least one medically attended injury (once, twice, three, four or more) for binomial logistic regression analysis (10).

Family Affluence

Family affluence was measured by the Family Affluence Scale (FAS versions II and III) developed by the HBSC study as an alternative tool to parental occupational social class to increase the thoroughness and detail of research into social inequalities in health, and because many children, especially younger ones, have difficulty describing parental occupation. The validity of the FAS has been addressed by several studies (19). The FAS III used in Czechia consists of 6 items based on joint assessment and validation from the HBSC FAS development project (20). The questions include new and refined items from previous FAS versions – bedrooms (FAS II), computers (FAS II), cars (FAS II), holidays abroad (refined), dishwasher (new), bathroom (new) – as defined by the HBSC 2013/2014 survey protocol (21). The items and their response categories are as follows:

"Does your family own a car or another motorized vehicle?" (no = 0; yes, one = 1; yes, two = 2).

"Do you have your own bedroom?" (no = 0; yes = 1).

"How many computers (including laptops and tablets, not including game consoles and smartphones) does your family own?" (none = 0; one = 1; two = 2; more than two = 3).

"How many bathrooms (room with a bath/shower or both) are there in your home?" (none = 0; one = 1; two = 2; more than two = 3).

"Does your family have a dishwasher?" (no = 0; yes = 1).

"How many times did you and your family travel out of the Czechia for holiday/vacation last year?" (never = 0; once = 1; twice = 2; more than twice = 3).

The responses to the items were calculated as an aggregated FAS index ranging from 0 to 13. The index scores were then used to identify groups of adolescents in the lowest 20% (low affluence), middle 60% (medium affluence), and highest 20% (high affluence).

Statistical Analyses

Differences in the prevalence of medically attended injuries between the years 2002 and 2022 were determined using adjusted residual analysis, available in IBM SPSS, which is primarily used for the analysis of contingency tables (e.g., in crosstabs). Adjusted residuals indicate where statistically significant differences occur between observed and expected frequencies in the table. They help identify which specific cells contribute to the overall statistical significance (for instance, to the result of the χ^2 test). This analysis allows a more detailed examination of differences between categories of the analysed variables. If the absolute value of the adjusted residual exceeds 1.96, the difference between the observed and expected frequencies is considered statistically significant at the 0.05 level ($\alpha = 0.05$).

Logistic regression was used to evaluate the model in which the chance of having an injury in the last 12 months was analysed within the context of the following factors: year of data collection, gender, age category/grade, and FAS (low, middle, high).

Analyses were conducted using statistical program IBM SPSS version 25.0 (IBM, New York, NY, USA).

RESULTS

An adjusted residual analysis of nationally representative data from 2002 to 2022 revealed a significant shift in the pattern of

Table 1. *Trends in medically attended injuries between 2002 and 2022 by gender and age group/grade*

	Survey year	2002	2006	2010	2014	2018	2022	2002 vs. 2022 p-value
Boys	n	1,832	2,400	2,388	2,091	6,966	6,581	
	No injury (%)	51.6	48.1	49.4	56.8	50.6	44.9	**< 0.05**
	1 injury (%)	29.8	31.0	29.5	24.5	25.0	26.6	**< 0.05**
	≥ 2 injuries (%)	18.6	20.9	21.1	18.6	24.4	28.5	**< 0.05**
Girls	n	1,858	2,592	2,353	2,240	7,133	6,383	
	No injury (%)	61.2	55.5	55.4	61.8	57.0	48.2	**< 0.05**
	1 injury (%)	26.1	27.4	27.0	22.4	23.1	24.3	NS
	≥ 2 injuries (%)	12.7	17.2	17.6	15.9	19.9	27.5	**< 0.05**
11 years 5th grade	n	1,684	1,493	1,420	4,492	4,154	4,268	
	No injury (%)	60.5	58.7	54.3	55.6	63.2	55.0	**< 0.05**
	1 injury (%)	24.6	26.8	28.2	26.1	22.1	23.8	NS
	≥ 2 injuries (%)	14.9	14.5	17.5	18.2	14.7	21.3	**< 0.05**
13 years 7th grade	n	1,657	1,601	1,453	4,853	4,540	4,710	
	No injury (%)	59.2	54.7	50.4	50.8	56.7	51.4	**< 0.05**
	1 injury (%)	24.6	29.6	29.5	28.5	24.8	25.1	**< 0.05**
	≥ 2 injuries (%)	16.2	15.8	20.0	20.7	18.5	23.5	**< 0.05**
15 years 9th grade	n	1,651	1,647	1,458	4,754	4,270	5,448	
	No injury (%)	62.1	56.3	50.8	51.2	58.3	55.1	**< 0.05**
	1 injury (%)	23.5	27.3	29.8	29.8	23.3	23.2	**< 0.05**
	≥ 2 injuries (%)	14.4	16.4	19.4	18.9	18.3	21.7	**< 0.05**

P-value – statistical significance based on adjusted residual analysis; NS – not significant; numbers in bold indicate statistically significant values.

medically attended injuries among Czech adolescents. Across both sexes and all surveyed age groups (11-, 13- and 15-year-old), there was a notable increase in the prevalence of multiple (2 or more) injuries. Simultaneously, the proportion of adolescents reporting no injuries decreased significantly, particularly among girls, whose injury-free rate dropped from 61.2% in 2002 to 48.2% in 2022. While the rate of single injuries remained relatively stable – without significant change in many groups – the overall injury burden has shifted toward more frequent and potentially severe injury experiences (Table 1, Fig. 1).

Logistic regression analysis revealed that the likelihood of reporting at least one injury in the past 12 months was highest in

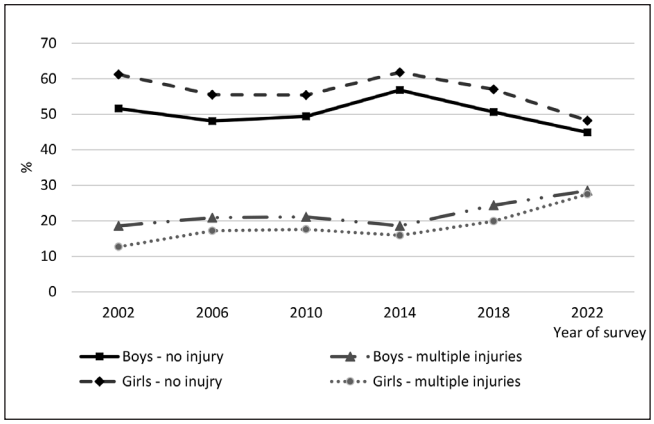

Fig. 1. *Trends over time in the proportion of boys and girls with no injury and with multiple medically attended injuries.*

Table 2. *Logistic regression analysis of the likelihood of reporting at least one injury in the past 12 months*

	n	OR	p-value	95% CI
Survey year				
2022	14,155	Ref.		
2018	12,673	0.74	**< 0.001**	0.71–0.78
2014	13,715	0.58	**< 0.001**	0.55–0.60
2010	4,246	0.79	**< 0.001**	0.73–0.84
2006	4,673	0.80	**< 0.001**	0.75–0.86
2002	4,916	0.65	**< 0.001**	0.61–0.70
Gender				
Boys	27,085	Ref.		
Girls	27,293	0.81	**< 0.001**	0.78–0.83
Age category/grade				
11 years /5th	17,006	Ref.		
13 years /7th	18,383	1.16	**< 0.001**	1.12–1.21
15 years /9th	18,989	1.04	0.056	0.99–1.09
Family affluence status				
Low	9,040	Ref.		
Middle	35,036	1.18	**< 0.001**	1.12–1.24
High	10,302	1.58	**< 0.001**	1.49–1.67

Logistic regression analysis – enter method; OR – odds ratio to have at least 1 injury in last 12 months; CI – confidence interval; Ref. – reference group; numbers in bold indicate statistically significant values.

2022, after controlling for gender, age, and family affluence. Boys, 13-year-olds, and children from higher-income families were at increased risk. These findings suggest the need for targeted injury prevention programmes, particularly in more affluent contexts and during early adolescence, where risk appears elevated (Table 2).

DISCUSSION

This study presents compelling evidence of a substantial shift in medically attended injuries patterns among Czech adolescents between 2002 and 2022. The adjusted residual analysis revealed a marked increase in the prevalence of multiple medically attended injuries across all age groups and both sexes.

This trend is similar to the official data about the increased number of injuries treated under public health insurance in the age group 10–19 years old between the years 2014 and 2022 (9). Together with the above-mentioned similarity of the trends within previous data collections, this finding supports the suggestion that self-reported HBSC data may serve as complementary to other more reliable data sources about the adolescents' injuries.

Concurrently, there was a significant decline in the proportion of adolescents reporting no injuries, most notably among girls. These findings suggest that the overall burden of injuries among adolescents has intensified, with a shift toward more frequent and potentially recurrent or severe injury episodes.

Interestingly, while the prevalence of single injuries remained largely stable across groups, the rise in multiple injuries points to systemic or environmental changes that may have increased exposure to risk or decreased the effectiveness of existing prevention strategies. The pronounced decline in injury-free status among girls may reflect evolving participation in activities with higher physical or social risk – an important consideration for gender-responsive health interventions. As reported in our previous study (16), similar trend was observed in Slovakia with decline in gender differences in medically attended injuries between 2010, 2014 and 2018 (8.3%, 6.6% and 4.6%, respectively), but with increasing prevalence in girls (26%, 30.7% and 46.4%, respectively). Referring to the results of the study of de Looze et al. (22) we hypothesized that one of the explanatory factors of gender differences in medically attended injuries may be the societal gender inequality, which the above-mentioned authors positively associated with sex differences in adolescent injuries, physical fighting, and physical activity. According to them, in all studied countries, boys reported more physical fighting, physical activity, and injuries than girls, but the magnitude of these sex differences varied greatly between countries. In more gender-unequal countries, boys reported higher levels of fighting and physical activity compared with boys in more gender equal countries. In girls, scores were consistently low for these outcomes; however, injury was more common in countries with less gender inequality. This could be a partial explanation for Czechia as well since the Czechia's gender inequality index (23) declined between the years 2010, 2014, 2018, and 2022 (0.139, 0.146, 0.129, and 0.113, respectively).

The logistic regression analysis reinforced these findings, showing that the likelihood of reporting at least one injury was significantly higher in 2022 than in all previous survey years, even after adjusting for gender, age, and family affluence. This suggests that the observed trends are not solely attributable to demographic shifts but may stem from broader societal, behavioural, or environmental factors. Subgroup analyses further identified boys, 13-year-olds, and adolescents from higher-affluence households as particularly at risk. The elevated injury rates among boys align with existing literature on sex differences in physical risk-taking behaviours. The peak risk at age 13 is consistent with developmental research indicating increased autonomy, social influence, and impulsivity during early adolescence (24, 25).

The association between higher family affluence and injury prevalence may reflect greater engagement in organized sports and structured recreational activities, which, while beneficial, also entail a higher risk of injury (26, 27). As we reported in our survey report focused on the physical activity-related injuries among adolescents in 5 European union member states, 50% of 13-year-old and 42% of 15-year-old Czech adolescents reported participating in sports club activities regularly and actively or occasionally. Of them, 58% of 13-year-olds and 56% of 15-year-olds reported at least one accident or injury related to activities in sports clubs (11). Alternatively, the association between higher family affluence and injury prevalence may indicate better healthcare access and reporting among more affluent groups (28, 29).

Similar patterns have been observed in international HBSC analyses, where adolescents from higher-affluence families consistently reported higher rates of non-fatal injuries. These differences are often interpreted as the combined effect of greater exposure and detection. Youth from affluent families tend to participate more frequently in organized sports and structured leisure activities – contexts that increase the risk of injury but also provide better access to health care and thus greater likelihood of injury reporting (30, 31). Molcho et al. (30) demonstrated that higher family affluence was a significant risk factor of injury across 30 countries, while also noting that access to care may bias self-reported medically attended injuries toward more affluent groups. Similarly, Pagnotta et al. (31) found that adolescents with greater access to medical care were more likely to report injuries, highlighting the role of healthcare accessibility in shaping observed inequalities. Therefore, the higher injury prevalence among more affluent Czech adolescents may partly reflect both increased risk exposure (via sports participation) and reporting sensitivity due to enhanced access to medical care.

Our findings underscore the need for targeted, evidence-based injury prevention strategies since our data suggests that the effectivity of the previous National Action Plan on Child Injury Prevention 2007–2017 of the Czech Government diminished (10). Specifically, efforts should prioritize early adolescence and incorporate both school- and community-level approaches. Interventions should be tailored to address the unique risk profiles of both boys and girls and more affluent youth, including safety education, supervision in sports and physical activities, and digital risk awareness. Beyond national efforts, recent international initiatives emphasize the importance of multi-sectoral, evidence-based injury prevention approaches. The WHO Safety 2024 agenda highlights various interventions proven to reduce injury burden (32). Within Europe, the European Association for Injury Prevention and Safety Promotion (EuroSafe) (33) is working to prevent home and leisure injuries by working in partnership with industry, governments, research institutes, and health and safety practitioners to help reduce the greatest risks. In the physical activity

context, The PARIPRE project (34) provides recommendations for preventing physical activity-related injuries. Together, these initiatives demonstrate a growing international consensus that injury prevention must combine behavioural, environmental and system-level measures – an approach also relevant for the Czech adolescent population.

The study's strengths include a large and longitudinal representative sample of Czech adolescents and the usage of a valid HBSC questionnaire. The usage of the questionnaire allows for various analyses to be conducted with a vast number of variables related to adolescents' health monitored within the HBSC study. At the same time, it allows for comparison of the results with the other countries participating in the HBSC study. Several study limitations need to be mentioned as well. The injuries were self-reported, and data were collected retrospectively, which might cause recall bias. To minimize this recall bias, the time for reporting injuries was limited to within the past 12 months. Additionally, no definition of injury in the questionnaire might misclassify some respondents and bias the results. To minimize such bias, trained administrators were available in person during data collection in the schools to answer and explain any doubts of the participants regarding the injuries.

CONCLUSIONS

Medically attended adolescent injuries have increased in both frequency and complexity over the last two decades in Czechia. The shifting patterns underscore the urgent need for context-sensitive, age-appropriate, and equity-focused prevention strategies. Collaborative action involving schools, families, healthcare providers, and policymakers is essential to reduce injury risk and promote adolescent health and safety.

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Conflicts of Interest

None declared

Adherence to Ethical Standards

The Institutional Ethics Committee for Research of the Faculty of Physical Culture of Palacký University Olomouc approved the design of the HBSC data collections in 2022, 2018 and 2014 (numbers of approvals: 65/2020; 9/2016; 17/2013). Rigorous international research protocol (e.g. ,standardized questionnaire, back-translation of the research items, or provision of a representative sample) was followed by the HBSC study coordinating institutions (CI) in Czechia during previous data collections in 2010 (CI: Faculty of Physical Culture, Palacký University Olomouc), 2006 (CI: National Institute of Public Health in Prague) and 2002 (CI: Prague Psychiatric Centre).

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the main author used SciSpace Co-pilot by Typeset.io in order to conduct literature searches and ChatGPT in order to interpret partial results of the statistical analyses. After using these tools, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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