

Trends in injuries over 20 years: a cross-national study of 954 298 adolescents from 31 European countries

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Abstract

Injuries are a leading public health priority within adolescent populations; however, few cross-national studies have examined their epidemiology over time. We described time trends in adolescent self-reported medically treated injury across 31 mainly European countries over 20 years, then explored whether observed temporal trends varied according to the prevalence of known behavioral risk factors. The data source included six cycles of the Health Behavior in School-aged Children study (2002–22; weighted $n = 954\,298$, participants aged 11–15 years). Outcomes included self-reports of any and multiple medically treated injuries. Measures of behavioral risks included indicators of violence, substance use, and physical activity. Within countries reporting increases in injuries, variations in reported engagement in known behavioral risk factors were examined. Nearly half of adolescents reported at least one medically treated injury (47%–53% of boys; 38%–44% of girls) and nearly one quarter reported multiple injuries (23%–30% of boys; 16%–22% of girls). In the pooled analysis, temporal trends included increases in any medically treated injury for girls (all age groups) and boys (11 years only) and multiple injuries (boys and girls, all age groups). At the country-level, we observed more temporal increases than decreases. Increases in physical activity were observed coincident with observed injury trends. In one of the largest European analyses of its kind, we demonstrated the ongoing burden of adolescent injury. Persistently high rates of adolescent injuries are concerning, and the origins of temporal increases require an initial focus on sport and physical activity.

Introduction

Injury is a major cause of death and disability in countries from around the world [1–10]. Adolescent injuries have been identified as one of the most important public health priorities facing children of all ages, as identified by organizations as diverse as UNICEF [11], the World Health Organization [12], and the Organization for Economic Cooperation and Development [13], as well as North American bodies that include the US Centers for Disease Control [14] and the Canadian Pediatric Society [15]. The ongoing need for contemporary evidence into the epidemiology of adolescent injury remains, and novel opportunities for the surveillance of this issue over time, geography and socio-demographic contexts are of great contemporary importance.

Despite its establishment as a public health priority, it is unclear whether health burdens associated with adolescent injury have declined, remained the same, or increased over time. Data from population-based studies can inform this issue, and cross-national studies that have employed the same methodology and questionnaire

items over multiple time periods are particularly informative. The latter includes the Global Burden of Disease Study, which has quantified health loss from unintentional and intentional injuries since 1990 in general populations [16], as well as the WHO-affiliated Global School-based Student Health Survey (GSHS) [17] conducted since 2003 with a focus on the experiences of children from low- and middle-income countries. The Health Behaviour in School-aged Children (HBSC) study provides a third example that has a unique focus on adolescent health experiences in Europe [18, 19]. Initiated in 1983 and conducted every 4 years, HBSC has documented the experiences of children aged 11–15 years over 10 survey cycles via robust cross-national samples (most recently in 2022, >50 mainly European countries) [20]. Thirty-one countries have compiled injury data using standard indicators and survey methodologies in each of six survey cycles since 2002, making it one of the richest—albeit potentially underutilized—injury surveillance initiatives in existence. Beyond its monitoring function, HBSC also provides opportunity for the exploration of common risk behaviors, with available indicators of

violence [21, 22], substance use [23, 24], and physical activity [25] that may contribute to temporal patterns of injury. As a surveillance initiative, the cross-national HBSC provides an efficient opportunity to generate foundational evidence in support of international injury research and prevention efforts and has the potential to identify hypotheses that inform more in-depth etiological enquiry.

In this study, we aimed to: (i) describe age and gender specific time trends in self-reported medically treated injury across the 31 HBSC countries over 20 years, and (ii) explore whether any observed temporal injury patterns corresponded with trends over time in available standard indicators describing behavioral risk factors. Our hope was to explore how this leading public health priority has evolved over time in Europe and Canada, in an analysis that spanned 20 years and is one of the largest epidemiological studies of its kind.

Methods

Study population and procedures

Since 1982, the HBSC study has compiled nationally representative samples of children aged 11–15 years on a 4-year cycle, most recently in the 2022–23 (2022) academic year [18–20]. Countries sampled children from schools representing at least 95% of this target population in their national sampling frames, and where countries oversampled subpopulations (e.g. by geography and ethnicity), standardized weights were applied to ensure representativeness. Schools formed the basic sampling unit, with variations in sampling criteria adapted to country-level circumstances. Data were collected in classrooms using an anonymous self-administered questionnaire following the common HBSC survey protocol [18]. Since the HBSC study network has expanded from 19 to 51 participating countries between 1994 and 2022, we drew upon records from 31 countries that collected data over six cycles (2002–22), to optimize both the breadth and temporal depth of our sample.

Injury measures

The core indicator was a validated item [26] describing self-reported medically treated injuries: “Many young people get hurt or injured from activities such as playing sports or fighting with others at different places such as the street or home. Injuries can include being poisoned or burned. Injuries do not include illnesses such as chicken pox or the flu.” Each participant was then asked: “During the past 12 months, how many times were you injured and had to be treated by a doctor or nurse?”, with response options of “I was not injured in the past 12 months,” “1 time,” “2 times,” “3 times,” or “4 times or more.” Two indicators were considered: (i) “any medically treated injury” vs. “not injured,” and (ii) “multiple (2 or more) injuries” vs. “not injured or 1 injury”; each expressed in binary formats. Multiple injuries were considered as an outcome due to the higher impact that they might have on the victims, their families, and the medical care system that serves them. Items describing more specific causes of injury were asked in an optional survey package, but only one country included them throughout all six cycles.

Stratification variables

These included gender identity (“boy” vs. “girl”; gender diverse identities were unavailable pre-2022), age group (11, 13, and 15 years), survey cycle, and country.

Risk behaviors

Violence

Participants reported the number of physical fights that they had engaged in during the past 12 months (5 categories, “none” through “4 or more times”), with the item dichotomized to capture recidivist (“3 or more times”) behavior [21, 22]. They also reported on perpetration of bullying in the last couple of months (5 categories, “never”

through “several times a week”). This item was similarly dichotomized for analysis (“2 or more times” vs. all others) [22].

Substance use

Participant drunkenness was assessed over their lifetime (5 categories, “never” through “10 or more times”), with the item dichotomized (“2 or more times” vs. all others) as per precedent [23]. Lifetime cannabis use was available for 15-year-old participants only (7 categories, “never” through “40 times or more” in 3 cycles, and “never” through “30 days or more” in 3 cycles). Due to this disparity in how the item was asked between cycles, it was dichotomized (“ever” vs. “never”) for analysis [24].

Physical activity

Moderate to vigorous physical activity was assessed using a standard indicator [25, 27] that asked each student how often that they had engaged in such activities during the last 7 days for at least 60 minutes per day (0 through 7 days), with the item averaged for the purposes of analysis.

Analysis

All analyses were performed in SAS 9.4 (SAS Institute, Cary, NC, United States) and weighted to ensure national representativeness.

Using the pooled overall sample, we estimated the prevalence of the two injury indicators within groups stratified by age (11, 13, 15 years), gender (boys, girls), and year of survey cycle (2002, 2006, 2010, 2014, 2018, 2022). The 95% confidence intervals (CIs) were estimated with adjustment for clustering by country/region. Log-binomial regression models that included the HBSC survey cycle as an independent continuous variable and each injury indicator as the dependent variable were used to test for temporal trends. Models accounted for clustering by country using generalized estimating equations.

At the country-level, we estimated the absolute change in prevalence of each injury indicator (and associated 95% CI, adjusted for school-level clustering) within each age/gender strata across the six cycles. Based upon whether the adjusted 95% CI included 0 and the direction of effects, the number of countries that demonstrated a decrease, increase, or no change in injury prevalence were identified, and summarized within each age/gender strata. Within these same strata, graphical analyses at the country level were used to summarize the absolute difference in prevalence levels between the initial (2002) and final (2022) survey cycle to highlight the consistency of any potential trends across the 31 countries. Statistically significant ($P < .05$) changes in prevalence (increases, decreases observed within countries) were based on whether the 95% CI for the absolute change in prevalence included the value of zero.

Finally, to explore whether absolute increases in the prevalence of self-reported injury between 2002 and 2022 could potentially be explained by changes in known risk behaviors, we used a descriptive approach to compare mean levels (physical activity) and prevalence levels [drunkenness, physical fighting, bullying, cannabis use (15-year olds only)] between the earliest and latest cycles. Analyses were stratified by age and gender and restricted to the countries that reported statistically significant increases in the multiple injury outcome within the age/gender strata. Absolute differences were adjusted for clustering at the country level. Differences in multiple injuries were reported first without and then with adjustment for the five behavioral risk factors.

Human subjects

Each participating country obtained approval to survey each of the cycles from the ethics review board or equivalent regulatory body associated with the lead HBSC institution. Participation was voluntary, and consent (explicit or implicit) was sought from school

administrators, parents, and children as per national human subject requirements.

Results

Sample

The median and range (minimum, maximum) of country-level counts of participating adolescents are described in [Supplementary Table S1](#), as is the distribution of the overall sample by gender/age group. The sample involved a weighted total of 954 298 adolescents [49.0% ($n = 468\,082$) boys, 51.0% ($n = 486\,216$) girls], ranging from 140 428 in 2002 to 188 203 in 2022. This was a robust sample: illustratively, country-level participants ranged from a minimum of 736 (Greenland) in 2002, to a maximum of 30 616 (Wales) in 2022.

Overall injury trends

Increases in the prevalence of self-reported medically treated injury varied according to the injury outcome and gender/age group ([Table 1](#)). Across all cycles, nearly half of adolescents reported at least one medically treated injury (47% to 53% of boys; 38% to 44% of girls) and nearly a quarter reported multiple injuries (23% to 30% of boys; 16% to 22% of girls). For the “any injury” outcome, among boys, modest yet statistically significant increases in prevalence were observed over time among 11-year olds, with no significant trends observed among 13- and 15-year olds. Among girls, modest yet statistically significant increases in prevalence were observed in all age groups. For the “multiple injuries” outcome, statistically significant increases were observed in all age groups among both boys and girls.

Country-level trends

Illustrative summaries of country-level trends over time in the occurrence of the self-reported medically treated injury outcome are provided in [Fig. 1](#) (boys) and [Fig. 2](#) (girls). Among boys, while substantial proportions of countries reported no change in the prevalence of the “any injury” outcome, the number of countries reporting increases over the study period varied from 14/31 (45%) in 11-year olds to 5/31 (16%) in 15-year olds. Among girls, while countries reporting no change in prevalence too were common, the number of countries

reporting increases ranged from 16/31 in 11-year olds (52%) to 11/31 (36%) in 15-year olds. Patterns for “multiple injuries” were more striking, with country-level increases between 2002 and 2022 reported in 16/31 (52%) of 11-year-old and 7/31 (23%) of 15-year-old boys ([Supplementary Fig. S1](#)) and 19/31 (61%) of 11-year-old girls and 16/31 (52%) of 15-year-old girls ([Supplementary Fig. S2](#)). Across both outcomes and all age/gender strata, more countries reported increases than decreases in the prevalence of injury. Increases in both injury outcomes tended to be most commonly reported in Eastern Europe and Scandinavia, while (with the exception of adolescents from French-speaking Belgium) decreases were more heavily concentrated in the British Isles and Southern and Western European countries.

A final analysis examined absolute differences between 2022 and 2002 in the prevalence of the self-reported “multiple injury” outcome, as well as reported levels of the five available behavioral risk factors. These analyses were stratified by age/gender and restricted to the countries that reported temporal increases in the “multiple injury” outcome. While the size of these absolute differences varied between groups, one general pattern emerged: reported levels of four behavioral risk factors (lifetime drunkenness, physical fighting, bullying perpetration, and lifetime cannabis use) consistently declined, while mean levels of physical activity consistently increased. An illustration of this general pattern is provided in [Table 2](#) for “multiple injuries” reported by boys and girls aged 11 then 15 years, restricted to countries reporting increases in 2022 relative to 2002. Increases in the prevalence of multiple injury coincided with reported increases in physical activity but declines in the other known behavioral risk factors.

Discussion

In this study of nearly 1 million adolescents surveyed in 31 countries over two decades, it was concerning to find that half of all boys and almost 40% of girls consistently reported seeking medical treatment for an injury in the past year. Furthermore, roughly half of those injured (boys and girls) were injured on multiple occasions. Our study findings therefore provide contemporary evidence that adds to a historical body of literature [1–10] that demonstrates a substantial, persisting burden of adolescent injury to populations and health care systems. Injury remains an important health priority that crosses countries, genders, culture and time. This fact cannot be forgotten,

Table 1. The prevalence of self-reported, medically treated injuries (any then multiple) in the past 12 months among adolescents in 31 countries across six HBSC survey cycles (2002–22), pooled analysis by gender and age group ($n = 952\,803$; weighted $n = 954\,298$)^a

	HBSC survey cycle (year)												<i>P</i> -trend ^b
	2002		2006		2010		2014		2018		2022		
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	(95% CI)	
Any injury													
Boys													
11 years	51.5	(47.7–55.3)	49.1	(46.0–52.3)	49.1	(46.0–52.3)	49.6	(45.9–53.3)	52.2	(49.7–54.6)	52.9	(49.2–56.7)	.03
13 years	53.1	(49.5–56.6)	50.8	(47.7–54.0)	50.3	(47.2–53.4)	50.9	(47.7–54.0)	52.3	(49.7–54.9)	52.3	(48.7–56.0)	.73
15 years	51.3	(47.8–54.7)	48.8	(45.7–51.8)	48.4	(45.4–51.3)	47.4	(44.2–50.6)	49.2	(46.4–52.0)	48.3	(45.5–51.1)	.18
Girls													
11 years	40.5	(37.2–43.7)	39.0	(35.3–42.8)	39.1	(36.3–41.8)	39.9	(36.2–43.6)	42.2	(39.3–45.1)	44.3	(40.1–48.5)	.0003
13 years	40.2	(36.9–43.5)	38.9	(35.9–41.9)	40.3	(37.5–43.2)	41.6	(38.3–45.0)	44.4	(41.8–47.0)	43.4	(39.8–47.1)	.0003
15 years	38.4	(35.1–41.7)	37.5	(34.8–40.2)	38.8	(36.0–41.6)	38.5	(35.3–41.7)	41.9	(39.0–44.7)	40.4	(36.8–44.1)	.003
Multiple injury													
Boys													
11 years	25.5	(22.4–28.6)	23.6	(20.9–26.3)	24.2	(21.6–26.7)	25.9	(22.8–28.9)	27.1	(25.1–29.0)	29.8	(26.6–33.0)	<.0001
13 years	25.9	(22.9–28.8)	24.4	(22.0–26.8)	23.7	(21.2–26.3)	25.7	(23.2–28.2)	27.4	(25.3–29.4)	28.5	(26.1–31.0)	.003
15 years	24.6	(22.0–27.3)	22.8	(20.6–24.8)	23.1	(20.9–25.3)	23.4	(20.9–25.9)	25.0	(22.9–27.0)	25.4	(23.5–27.4)	.047
Girls													
11 years	17.0	(14.8–19.1)	15.8	(13.4–18.3)	15.6	(13.8–17.4)	17.8	(15.3–20.2)	19.3	(17.5–21.2)	22.2	(19.3–25.2)	<.0001
13 years	16.3	(14.1–18.4)	15.7	(13.6–17.8)	16.9	(14.9–18.9)	19.4	(17.0–21.7)	21.6	(19.9–23.2)	22.4	(20.0–24.7)	<.0001
15 years	16.0	(13.7–18.3)	16.0	(14.1–18.0)	17.0	(15.1–19.0)	18.7	(16.3–21.0)	20.4	(18.3–22.5)	20.4	(18.2–22.6)	<.0001

a: All values are weighted; 95% confidence intervals are adjusted for clustering by country.

b: *P* values for linear trend across years (HBSC survey cycles).

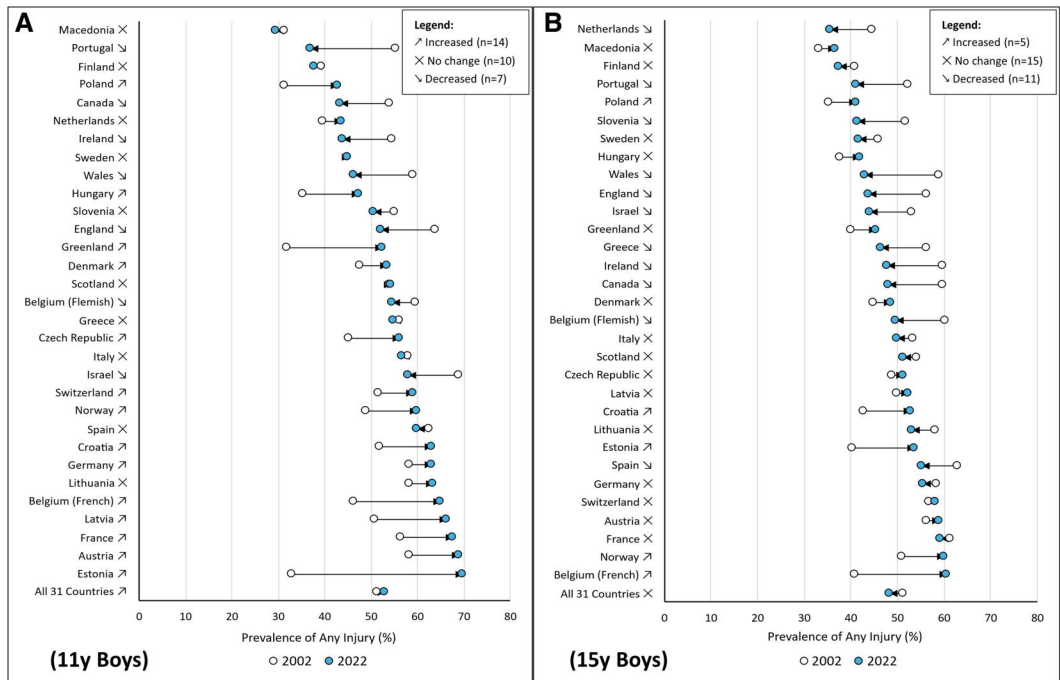


Figure 1. Changes in prevalence of any self-reported, medically treated injury from 2002 to 2022 among boys aged 11 years old (A) and 15 years old (B), by country.

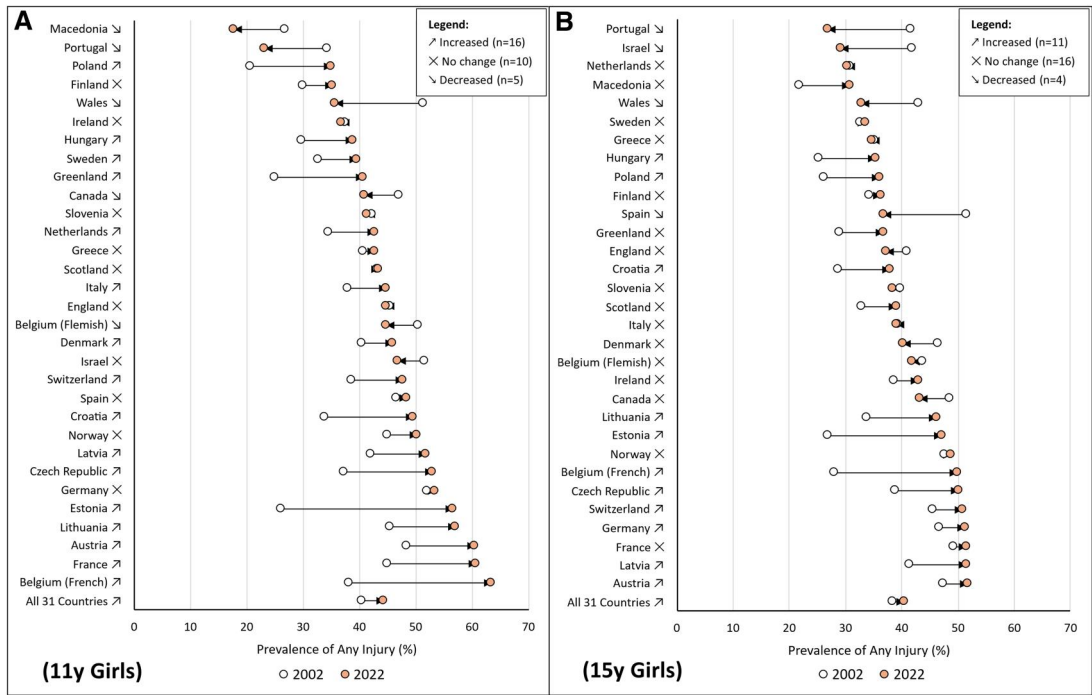


Figure 2. Changes in prevalence of any self-reported medically treated injury from 2002 to 2022 among girls aged 11 years old (A) and 15 years old (B), by country.

even as adolescents face a litany of other emerging health issues, notably obesity, mental health, and social media misuse and addiction [e.g. 28–30]. Longstanding international and national efforts have existed to bring attention to injury and foster prevention [1–10]; however, in contrast to what has been observed globally for major injury [31], the prevalence of self-reported adolescent injuries has not declined, and age and gender-based inequalities in reports of injury are persisting or increasing in many contexts. Adolescent injury remains a matter of international, societal concern.

Beyond its expression of burden, what made this analysis somewhat unique is its robust emphasis on trends, and the identification of

temporal patterns that inform hypothesis formation, resource planning, and monitoring. To illustrate, we observed a gendered pattern in injury reports, with increases most often demonstrated among girls. This suggests a need for enhanced theory about the reporting, behaviors and social norms that might explain such increases. Similar to patterns of adolescent violence [22], specific forms of substance use [23, 24], and historical trends in injury [32], the injury experiences of boys and girls may too be converging in many contexts as gendered roles, experiences and activities become more alike. Such a pattern of convergence is important to gender theory, especially with the emergence of diverse social norms related to masculinity, feminization, and

Table 2. Changes in self-reported behavioral risk factors and self-reported, multiple medically treated injuries in countries where a significant increase in the prevalence of multiple injuries was identified in 2022 vs. 2002, stratified by age and gender^a

	Survey year		2022 vs. 2002		
	2002	2022	Diff.	(95% CI)	Change
Boys					
11 years old (no. of countries: 16; <i>n</i> = 20 842)					
Physical activity (mean; 0–7 days in past week)	4.29	4.58	0.29	(0.24 to 0.35)	↗
Lifetime drunkenness (% 2 or more times)	3.7	1.3	–2.4	(–3.3 to –1.5)	↘
Physical fighting (% 2+ times in past 12 months)	28.5	19.0	–9.5	(–13.8 to –5.1)	↘
Bullying perpetration (% 2+ times in past 12 months)	13.4	8.2	–5.1	(–7.3 to –3.0)	↘
Multiple injury (% past 12 months)	22.6	35.6	13.0	(9.7 to 16.3)	↗
			14.5 ^b	(11.0 to 18.1)	
15 years old (no. of countries: 7; <i>n</i> = 9157)					
Physical activity (mean; 0–7 days in past week)	3.98	4.21	0.23	(0.14 to 0.32)	↗
Lifetime drunkenness (% 2 or more times)	39.9	24.3	–15.5	(–23.0 to –8.1)	↘
Physical fighting (% 2+ times in past 12 months)	20.2	10.9	–9.3	(–11.0 to –7.7)	↘
Bullying perpetration (% 2+ times in past 12 months)	14.4	3.2	–9.1	(–14.4 to –3.9)	↘
Lifetime cannabis use (% ever used)	25.5	16.2	–9.4	(–14.9 to –3.8)	↘
Multiple injury (% past 12 months)	21.6	31.3	9.7	(7.7 to 11.7)	↗
			11.2 ^b	(9.8 to 12.6)	
Girls					
11 years old (no. of countries: 19; <i>n</i> = 24 462)					
Physical activity (mean; 0–7 days in past week)	3.83	4.17	0.34	(0.29 to 0.39)	↗
Lifetime drunkenness (% 2 or more times)	1.1	1.0	–0.1	(–0.5 to 0.3)	×
Physical fighting (% 2+ times in past 12 months)	6.8	8.4	1.6	(0.4 to 2.8)	↗
Bullying perpetration (% 2+ times in past 12 months)	5.8	4.3	–1.5	(–2.9 to –0.2)	↘
Multiple injury (% past 12 months)	16.4	27.8	11.4	(8.8 to 14.0)	↗
			10.8 ^b	(8.3 to 13.2)	
15 years old (no. of countries: 16; <i>n</i> = 24 035)					
Physical activity (mean; 0–7 days in past week)	3.22	3.53	0.32	(0.27, 0.37)	↗
Lifetime drunkenness (% 2 or more times)	29.3	24.8	–4.5	(–8.5 to –0.5)	↘
Physical fighting (% 2+ times in past 12 months)	6.3	4.7	–1.6	(–3.1 to –0.1)	↘
Bullying perpetration (% 2+ times in past 12 months)	7.0	2.4	–4.6	(–8.5 to –0.7)	↘
Lifetime cannabis use (% ever used)	16.5	14.1	–2.4	(–6.2 to 1.4)	×
Multiple injury (% past 12 months)	14.2	22.2	8.0	(6.2 to 9.8)	↗
			7.9 ^b	(6.0 to 9.7)	

a: All values are weighted, absolute differences are adjusted for clustering by country, and Diff. represents the absolute difference in means (physical activity) or proportions comparing 2022 to 2002.

b: Absolute difference in self-reported multiple injuries after adjusting for the risk behaviors. For “change” column, increases are represented by “↗,” decreases are represented by “↘,” and no change is represented by “×.”

diverse expressions of gender [33]. How these relate to experiences of injury remains relatively unexplored in international populations, but the injury experiences of girls appear to be an emergent health priority, and those of gender diverse populations have not been studied.

From a geographic perspective, isolating the countries where declines were reported over time too is helpful (e.g. those reported by boys in the British Isles and Southern Europe), especially if contrasted against those contexts where increases were more typically reported (e.g. those in Eastern Europe and Scandinavia). The analysis provides a starting place for novel hypotheses about potential causes. Perhaps geographic contexts where self-reported injury was in decline were exposed to policies and countermeasures that make them unique from those reporting increases, or perhaps they experienced substantial changes in activities, behaviors or social norms that rendered these populations at differential risk. To that end, our study opportunity provided a unique opportunity to explore whether emergent trends in injury correlate with reported levels of known behavioral risk factors, as an initial step in understanding the deeper etiologies of these temporal patterns.

Our findings showed that within countries where increases in the prevalence of self-reported injury were experienced, the only explanatory risk factor that consistently increased was engagement in physical activity. This makes intuitive sense, as injury risks are a natural consequence of engagement with what otherwise would be viewed as a positive and health promoting behavior. Other relevant risk factors, including violence and substance use behaviors, either remained static or declined between 2002 and 2022. From a surveillance perspective, this points to the need to consider a more diverse set of indicators that

focus on physical activity injury (e.g. by anatomical site, nature, intent, activity, and mechanism) and engagement in sport, physical recreation and like experiences within population health surveys. More comprehensive models are also required that consider relevant structural and intermediary determinants simultaneously in explaining the observed increases [34], with a primary focus on physical activity contexts. Observed trends could be attributable, for example, to temporal increases in reporting tendencies for medically treated sports injuries as mandatory requirements within educational systems, organized sports and analogous contexts evolve, and as injury management approaches and referral practices similarly change. Medical care systems too evolve, and there is potential that access to medical care too has changed, reducing barriers for injured children to seek care from a doctor or nurse, which is inherent to our study definition. While we have studied this issue ecologically [35], measures of such access to care are required for individual-level analyses. In addition, perhaps socio-cultural factors that contribute to opportunities to be exposed to risk of injury have changed with time, including organized injury prevention campaigns and strategies, such as enhanced safety promotion in youth sports and associated training practices [36]. And beyond our epidemiological approach, comprehensive theory needs to be applied to understand these trends, using different research epistemologies that both quantify trends and their explanations yet go deeper qualitatively into their root causes. These potential explanations provide thought and direction for future theory, surveillance and etiological enquiry.

Limitations and strengths of this study warrant comment. The HBSC survey data are reliant on self-reports, and there have been

no recent validations of the questionnaire-based injury measures which were established almost 30 years ago [20]. Modern conceptualizations of gender were not considered in earlier survey years and in some countries, precluding description of experiences of adolescents who identify outside of cisgender spectrums. Etiologically, indicators of many established risk factors for injury were unavailable within HBSC over the six cycles, and our analysis only provides a rudimentary look at the etiology of emergent injury patterns. As HBSC is a study of children in the formal school system, the study base excludes those who are in alternative educational settings and may have different injury experiences, which may affect generalizability. And finally, as few participating countries consistently asked optional survey items about specific types of injury (e.g. by location, activity or circumstances), our outcomes combined heterogeneous types of injury in composite measures, which may have distorted patterns, trends, and effects.

In terms of study strengths, the analysis was based on one of the few cross-national surveys of adolescents that maintained common injury indicators over multiple cycles, which enhances its utility as a health surveillance tool. The size and breadth of the populations under study make this one of the most robust analyses of its kind. The standardized survey protocol enabled valid and reliable comparisons of findings. And finally, although the analysis did not uncover definitive reasons for the observed temporal trends, the existence of the HBSC data provides a platform to explore and generate hypotheses about potential explanations.

In summary, this cross-national analysis provides compelling evidence that injury is a persisting problem that merits attention as a European public health priority. This problem clearly is evolving over time. Explanations for the observed increases in injury may relate to increased engagement in physical activity within different groups of adolescents, yet these clearly warrant further investigation and monitoring.

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Author contributions

All authors conceived the present manuscript. W.P., N.K., and V.F.P. conducted the literature review, conducted the analysis, drafted the manuscript and performed the final editing. P.D.D. and M.M. contributed to the writing and final editing. Y.H.-F., S.D.W., K.N.,

M.M.-C., D.E.V., and G.Q. reviewed and edited the manuscript and provided critical direction and feedback. All authors contributed to the article and approved the submitted version.

Supplementary data

Supplementary data are available at *EURPUB* online.

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Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

Key points

- Adolescent injuries are a leading public health priority globally
- This article describes the burden of self-reported adolescent injury over 20 years in a robust international analysis
- Persistently high rates of adolescent injuries are concerning
- More positively, one explanation for the observed increases is increased engagement in physical activity

References

- 1 Krug EG, Sharma GK, Lozano R. The global burden of injuries. *Am J Public Health* 2000;**90**:523–6. <https://doi.org/10.2105/ajph.90.4.523>
- 2 Peden M, McGee K, Krug E (eds). *Injury: A Leading Cause of the Global Burden of Disease, 2000*. Geneva: World Health Organization, 2002.
- 3 Institute of Medicine (US) and National Research Council (US) Committee on Trauma Research. *Injury in America: A Continuing Public Health Problem*. Washington (DC): National Academies Press, 1985.
- 4 Haagsma JA, Graetz N, Bolliger I *et al*. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the global burden of disease study 2013. *Inj Prev* 2016;**22**:3–18. <https://doi.org/10.1136/injuryprev-2015-041616>
- 5 Miller TR, Romano EO, Spicer RS. The cost of childhood unintentional injuries and the value of prevention. *Future Child* 2000;**10**:137–63. <https://doi.org/10.2307/1602828>
- 6 Peterson C, Miller GF, Barnett SB *et al*. Economic cost of injury—United States, 2019. *MMWR Morb Mortal Wkly Rep* 2021;**70**:1655–9. <https://doi.org/10.15585/mmwr.mm7048a1>
- 7 Overpeck MD, Kotch JB. The effect of US children's access to care on medical attention for injuries. *Am J Public Health* 1995;**85**:402–4. <https://doi.org/10.2105/AJPH.85.3.402>
- 8 Ma VY, Chan L, Carruthers KJ. Incidence, prevalence, costs, and impact on disability of common conditions requiring rehabilitation in the United States: stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, osteoarthritis, rheumatoid arthritis, limb loss, and back pain. *Arch Phys Med Rehabil* 2014;**95**:986–95.e1. <https://doi.org/10.1016/j.apmr.2013.10.032>
- 9 Ardolino A, Sleat G, Willett K. Outcome measurements in major trauma—results of a consensus meeting. *Injury* 2012;**43**:1662–6. <https://doi.org/10.1016/j.injury.2012.05.008>

- 10 Strong KL, Pedersen J, Johansson EW *et al*. Patterns and trends in causes of child and adolescent mortality 2000–2016: setting the scene for child health redesign. *BMJ Glob Health* 2021;**6**:e004760. <https://doi.org/10.1136/bmjgh-2020-004760>
- 11 Diers J. Why the world needs to get serious about adolescents: a view from UNICEF. *J Res Adolesc* 2013;**23**:214–22. <https://doi.org/10.1111/jora.12042>
- 12 Sminkey L. World report on child injury prevention. *Inj Prev* 2008;**14**:69. <https://doi.org/10.1136/ip.2007.018143>
- 13 Thakrar AP, Forrest AD, Maltenfort MG *et al*. Child mortality in the US and 19 OECD comparator nations: a 50-year time-trend analysis. *Health Aff* 2018;**37**:140–9. <https://doi.org/10.1377/hlthaff.2017.0767>
- 14 Waxweiler RJ, Harel Y, O'Carroll PW. Measuring adolescent behaviors related to unintentional injuries. *Public Health Rep* 1993;**108**:11–4.
- 15 Yanchar NL, Warda LJ, Fuselli P. Child and youth injury prevention: a public health approach. *Paediatr Child Health* 2012;**17**:511–2. <https://doi.org/10.1093/pch/17.9.511>
- 16 Vos T, Lim SS, Abbafati C *et al*. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. *Lancet* 2020;**396**:1204–22. [https://doi.org/10.1016/S0140-6736\(20\)30925-9](https://doi.org/10.1016/S0140-6736(20)30925-9)
- 17 Han L, You D, Gao X *et al*. Unintentional injuries and violence among adolescents aged 12–15 years in 68 low-income and middle-income countries: a secondary analysis of data from the global School-Based student health survey. *Lancet Child Adolesc Health* 2019;**3**:616–26. [https://doi.org/10.1016/S2352-4642\(19\)30195-6](https://doi.org/10.1016/S2352-4642(19)30195-6)
- 18 Inchley J, Currie D, Budisavljevic S *et al*. *Spotlight on Adolescent Health and Wellbeing: Findings from the 2017/2018 Health Behaviour in School-Aged Children (HBSC) Survey in Europe and Canada. International Report. Vol. 1: Key Findings*. Copenhagen: WHO Regional Office for Europe, 2020.
- 19 King A, Wold B, Tudor-Smith C *et al*. *The Health of Youth: A cross-national survey*. Copenhagen, Denmark: WHO Regional Publications, European Series No. 69. 1996.
- 20 Samdal O, Kelly C, Craig W *et al*. Four decades of advancing research on adolescent health and informing health policies: the health behaviour in school-aged children study. *Int J Public Health* 2025;**70**:1608136. <https://doi.org/10.3389/ijph.2025.1608136>
- 21 Pickett W, Molcho M, Elgar FJ *et al*. Trends and socioeconomic correlates of adolescent physical fighting in 30 countries. *Pediatrics* 2013;**131**:e18–e26. <https://doi.org/10.1542/peds.2012-1614>
- 22 Cosma A, Molcho M, Pickett W. *A Focus on Adolescent Peer Violence and Bullying in Europe, Central Asia and Canada. Health Behaviour in School-Aged Children International Report from the 2021/2022 Survey. Vol. 2*. Copenhagen: WHO Regional Office for Europe, 2024.
- 23 de Looze M, Raaijmakers Q, Bogt TT *et al*. Decreases in adolescent weekly alcohol use in Europe and North America: evidence from 28 countries from 2002 to 2010. *Eur J Public Health* 2015;**25**:69–72. <https://doi.org/10.1093/eurpub/ckv031>
- 24 ter Bogt TF, de Looze M, Molcho M *et al*. Do societal wealth, family affluence and gender account for trends in adolescent cannabis use? A 30 country cross-national study. *Addiction* 2014;**109**:273–83. <https://doi.org/10.1111/add.12373>
- 25 Sigmundová D, Sigmund E, Hamrik Z *et al*. Trends of overweight and obesity, physical activity and sedentary behaviour in Czech schoolchildren: HBSC study. *Eur J Public Health* 2014;**24**:210–5. <https://doi.org/10.1093/eurpub/ckt085>
- 26 Harel Y, Overpeck MD, Jones DH *et al*. The effects of recall on estimating annual nonfatal injury rates for children and adolescents. *Am J Public Health* 1994;**84**:599–605. <https://doi.org/10.2105/ajph.84.4.599>
- 27 Prochaska JJ, Sallis JF, Long B. A physical activity screening measure for use with adolescents in primary care. *Arch Pediatr Adolesc Med* 2001;**155**:554–9. <https://doi.org/10.1001/archpedi.155.5.554>
- 28 Tsao SF, Chen H, Tisseverasinghe T *et al*. What social media told us in the time of COVID-19: a scoping review. *Lancet Digit Health* 2021;**3**:e175–e194. [https://doi.org/10.1016/S2589-7500\(20\)30315-0](https://doi.org/10.1016/S2589-7500(20)30315-0)
- 29 Baird S, Choonara S, Azzopardi PS *et al*. A call to action: the second lancet commission on adolescent health and wellbeing. *Lancet* 2025;**405**:1945–2022. [https://doi.org/10.1016/S0140-6736\(25\)00503-3](https://doi.org/10.1016/S0140-6736(25)00503-3)
- 30 Patton GC, Sawyer SM, Santelli JS *et al*. Our future: a lancet commission on adolescent health and wellbeing. *Lancet* 2016;**387**:2423–78. [https://doi.org/10.1016/S0140-6736\(16\)00579-1](https://doi.org/10.1016/S0140-6736(16)00579-1)
- 31 Li C, Jiao J, Hua G *et al*. Global burden of all cause-specific injuries among children and adolescents from 1990 to 2019: a prospective cohort study. *Int J Surg* 2024;**110**:2092–103. <https://doi.org/10.1097/J99.0000000000001131>
- 32 Molcho M, Walsh S, Donnelly P *et al*. Trend in injury-related mortality and morbidity among adolescents across 30 countries from 2002 to 2010. *Eur J Public Health* 2015;**25**:33–6. <https://doi.org/10.1093/eurpub/ckv026>
- 33 King K, Rice S, Schlichthorst M *et al*. Gender norms and the wellbeing of girls and boys. *Lancet Glob Health* 2021;**9**:e398. [https://doi.org/10.1016/S2214-109X\(20\)30551-9](https://doi.org/10.1016/S2214-109X(20)30551-9)
- 34 Commission on Social Determinants of Health. *Closing the Gap in a Generation: health Equity through Action on the Social Determinants of Health. Final Report of the Commission on Social Determinants of Health*. Geneva: World Health Organization, 2008.
- 35 Pagnotta VF, King N, Donnelly PD *et al*. Access to medical care and its association with physical injury in adolescents: a cross-national analysis. *Inj Prev* 2023;**29**:42–9. <https://doi.org/10.1136/ip-2022-044701>
- 36 Toivo K, Bakalár P, Leppänen M *et al*. Frequency of physical activity-related injuries among adolescents: an umbrella review. *Public Health Rev* 2025;**46**:1606767. <https://doi.org/10.3389/phrs.2025.1606767>