



Published in final edited form as:

J Adolesc Health. 2025 March ; 76(3): 441–447. doi:10.1016/j.jadohealth.2024.10.018.

Concordance of Traumatic Brain Injury Symptoms, Evaluation, and Diagnosis Between Teens and Parents: Data from the National Health Interview Survey-Teen

Lindsey I. Black, MPH¹, Amanda E. Ng, PhD MPH¹, Benjamin Zablotsky, PhD¹, Alexis Peterson, PhD², Jill Daugherty, PhD², Dana Waltzman, PhD², Jonaki Bose, MSc¹

¹Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), Division of Health Interview Statistics

²Centers for Disease Control and Prevention (CDC), National Center for Injury Prevention and Control (NCIPC), Division of Injury Prevention

Abstract

Purpose: To investigate differences in teen-reported and parent-reported lifetime prevalence estimates of traumatic brain injury (TBI) symptoms, TBI evaluation, and TBI diagnosis among a nationally representative sample of teenagers aged 12–17 years old and their parents.

Methods: Parent-reported data from the 2021–2022 National Health Interview Survey linked with teen-reported data from the National Health Interview Survey-Teen July 2021–December 2022 (n=1,153) were analyzed. Lifetime prevalence estimates for TBI symptoms (e.g., selected symptoms as a result of a blow or jolt to the head), history of evaluation by health professional for TBI (i.e., TBI evaluation) and TBI diagnosis stratified by sociodemographic characteristics and reporter type were produced, and z-tests were conducted to test for differences. Concordance measures were calculated to assess agreement between teen and parent survey responses to TBI measures.

Results: Lifetime prevalence of TBI symptoms varied by reporter type across all sociodemographic characteristics with teen-report consistently producing higher estimates. Estimates of TBI evaluation varied by reporter type only among older teens, non-Hispanic teens, and teens who participated in sports; there was no difference for TBI diagnosis. Percent agreement between the two reporters ranged from 73%–95%, prevalence-adjusted bias-adjusted kappa ranged from 0.45–0.90 and Cohen’s kappa ranged from 0.22–0.63.

Conclusions: There was general agreement for observable outcomes TBI evaluation and TBI diagnosis, but discordance existed in reports of TBI symptoms. These findings suggest that youth self-report of TBI symptoms may enhance surveillance efforts.

Corresponding Author: Lindsey Black, Address: 3311 Toledo Rd, Hyattsville, MD 20782, lblack1@cdc.gov.

Disclosure of potential conflicts, real and perceived, for all named authors: The authors have no conflicts of interest for this article.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC).

Keywords

Adolescents; head injuries; concussions; surveys; surveillance; National Health Interview Survey-Teen; National Health Interview Survey

Introduction

Traumatic brain injuries (TBI) are injuries caused by a bump, blow, or jolt to the head, or penetration of an object that disrupts the normal function of the brain (1). Mild TBIs, commonly referred to as concussions, and TBIs of all severities have gained public health attention in recent years because of advances in the understanding of the impact of TBIs on future health outcomes. Although many TBI symptoms resolve over time and most individuals have a complete recovery, TBI is associated with long-term impairment for various health and social outcomes (2–4). According to the Centers for Disease Control and Prevention (CDC), there were over 214,000 TBI-related hospitalizations in 2020 (5). The highest rates of TBIs are among children, adolescents, and adults 75 years and older (6). Among children, motor vehicle crashes and unintentional falls are the leading causes of nonfatal TBI-related hospitalizations (7).

In the United States, national public health surveillance systems for TBI are lacking and existing data sources have inherent limitations. Administrative sources like hospital discharge data may underestimate TBI prevalence and incidence as they only capture those who receive healthcare. Data suggest that a significant portion, potentially up to half, of adults with suspected TBI do not seek medical attention for their injury (8). In addition, children and youth can receive care in a variety of settings that are not typically captured in administrative data such as from pediatrician offices, urgent care, or evaluation during organized recreational activities by trained medical professionals (9, 10).

Nationally representative population-based surveys are an additional data source used to monitor the prevalence of TBI among youth and adults. Unlike administrative data, surveys can capture injuries of varying severity and are not dependent on whether an individual used healthcare services. Further, as in the case of the National Health Interview Survey (NHIS), multiple survey questions can be used and measure experiences like TBI symptoms in conjunction with medical evaluation and subsequent diagnoses. Surveys are also useful as they can simultaneously collect a wealth of other health and demographic measures, which can be used to evaluate risk and protective factors at the population level. However, surveys face challenges due to the lack of standardized methodology for measuring TBI. Estimates vary depending on factors like questionnaire wording and context (11). Accurately estimating the prevalence of TBI helps to assess the need for services, treatments, and interventions. Monitoring prevalence over time may be useful for researchers interested in exploring the impact of prevention programs.

Prevalence estimates of TBI using survey data have been shown to vary by reporter type (e.g., parent-report or self-report) (12). Previous work comparing survey data from different sources has found that youth self-reported estimates of concussions are 2–3 times higher than that of parent-report, suggesting the value of incorporating self-reported data

(12). Among youth with a history of diagnosed concussion, agreement between youth and parent dyads varied considerably according to symptomology, with high concordance among externalizing symptoms (e.g., behavioral problems) and poorest concordance among internalizing symptoms (e.g., anxiety, depression) (13–15).

Understandably among older youth, parents may underreport due to a lack of awareness about the event and the youth not communicating injuries to their parents. This may be particularly of concern among youth athletes where there may be internal and external pressures to not disclose (e.g., to continue participating in their sport), and therefore they may choose to not share this information with others (16). Less is known about injuries sustained outside of sports. Previous work comparing population-level prevalence estimates using surveys has been limited in its ability to fully understand differences by reporting source, as surveys have considerable variation in methodology, question phrasing, and participant eligibility (e.g., including youth ages >18 vs <18) (12). Since many surveys rely on parent-report, it is critical to understand if the estimates obtained via these methods are accurate.

There is limited research available to determine whether proxy reporting accurately reflects youths' TBI experiences within a general population-based health survey. In particular, there is a need to understand how responses from youth and their parents compare when using similar survey methodology and identical questions. For this reason, we aimed to expand on this body of literature by examining nationally representative data from parent-report paired with youth-reported data to understand the concordance of TBI symptoms, TBI evaluation, and TBI diagnosis of teens aged 12–17 years old. Prevalence estimates for TBI outcomes by sociodemographic characteristics and experiences (e.g., participation in sports) are presented by reporter type (self-report vs. parent-report). Additionally, agreement between teen and parent survey responses for each TBI outcome was examined.

Methods

Data source

Data used in this study come from two nationally representative sources: NHIS and National Health Interview Survey – Teen (NHIS-Teen) collected between July 2021 and December 2022.

NHIS is the principal source of information on the health of the civilian noninstitutionalized population of the United States and one of the major data collection programs of the National Center for Health Statistics (NCHS), a part of the CDC. NHIS is a nationally representative cross-sectional household interview that has been conducted annually since 1957. It is designed to be conducted via a computer assisted personal interview by trained field representatives from the United States Census Bureau at an in-person visit or over the telephone. Interviewers are trained to conduct visits in either English or Spanish, interpreters may be available for other languages (<1% conducted in languages other than English or Spanish). For each sampled household, basic demographics of the household members are collected and then one adult (the “Sample Adult”) and one child aged 0–17 (the “Sample Child”) are randomly selected for the collection of more detailed information about

their health. The Sample Adult answers on their own behalf, and a knowledgeable adult responsible for the Sample Child completes the Sample Child interview. Most respondents for the Sample Child interview are parents (approximately 94%), so all Sample Child respondents are herein referenced as parents.

NHIS-Teen is a follow-back survey of the NHIS that was designed to collect self-reported health information from teens themselves. Teens invited to participate in NHIS-Teen are those aged 12–17 years whose parents have completed the Sample Child component of the NHIS and have given permission for their teen to participate in NHIS-Teen. Teens with parental permission receive an invitation to participate in the survey; non-responders received multiple mailings, text messages or emails as reminders to participate. NHIS-Teen is a self-administered online survey that takes about 15-minutes to complete. It covers many of the same topics as the NHIS parent interview such as sleep behaviors, physical activity, injuries, mental health, social and emotional supports, and experiences with bullying. The NHIS-Teen survey was available only in English. The survey and data collection procedures were approved by the NCHS Ethics Review Board. More detailed information about NHIS-Teen has been previously published (17).

Teens aged 12–17 years who participated in NHIS-Teen with valid responses to all the main outcomes of interest (TBI symptoms, evaluation, and diagnosis) were included in the analysis (n=1,153). The teen participation rate for the sample was 46% (17). Sampling weights, which were designed to account for parent permission, teen nonresponse, and post-stratification adjustment to sociodemographic population subgroups, were used to allow for the calculation of nationally representative estimates (18), unless otherwise noted. Data used in this analysis are not publicly available but may be requested via the NCHS Research Data Center (<https://www.cdc.gov/rdc/index.htm>).

Variables

The primary outcomes were lifetime experiences of TBI symptoms, TBI evaluation, and TBI diagnosis. Lifetime TBI symptoms were assessed using a composite of three survey questions: 1) “As a result of a blow or jolt to the head, have (you/Child’s name) ever been knocked out or lost consciousness?” 2) “As a result of a blow or jolt to the head, have (you/Child’s name) ever been dazed or had a gap in your memory?” 3) “As a result of a blow or jolt to the head, have (you/Child’s name) had headaches, vomiting, blurred vision, or changes in mood or behavior?” Respondents answering “Yes” to the first question were considered to have TBI symptoms, and therefore additional questions on symptoms were not asked. Otherwise, an affirmative response to any of the three symptoms questions indicated that the child had experienced TBI symptoms in their lifetime. Lifetime evaluation for TBI was assessed using the question: “Have (you/Child’s name) ever been checked for a concussion or brain injury by a doctor, nurse, athletic trainer, or other health care professional?”. This question was asked of all respondents, regardless of whether TBI symptoms were reported. Lifetime TBI diagnosis was assessed using the question: “Did a doctor, nurse, athletic trainer, or other health care professional ever say that (you/Child’s name) had a concussion or brain injury?”, this question was only asked among those that had ever been evaluated for a concussion or brain injury and therefore respondents who had

not been evaluated were categorized as never receiving a TBI diagnosis. TBI measures were identical on parent and teen surveys.

Subgroup categories included in the analysis were informed by data availability and previous literature indicating associations with TBI (7, 12, 19, 20). Variables included demographic characteristics, which were based on parent-report. Demographic characteristics included: age group, sex, family income, Hispanic origin (categorized as: Hispanic or non-Hispanic), race (categorized as: White or all other races which includes persons who are Black/African American, American Indian, Alaska Native, Native Hawaiian, Other Pacific Islander, Asian, or some other race), and current health insurance coverage (dichotomized as private, public). Other race groups and insurance types, including uninsured, are not shown as disaggregated due to small sample size and reliability issues, however are included in totals. Teens with more than one type of health insurance were assigned to the first appropriate category in the following hierarchy: private, public (which included Medicaid or other public). Family income, measured as the percentage of the federal poverty level (FPL), was categorized as: <200% FPL, 200%–<400% FPL, ≥400% FPL, and imputed income files were used (21, 22). Participation in sports during the past 12 months was dichotomized as yes/no and based on teen self-report. Variables with missing observations (<1%) were excluded from subgroup analysis, however included in the total.

Statistical Analysis

Prevalence estimates and corresponding 95% confidence intervals (CIs) for each TBI outcome by reporter type (parent- or teen self-report) were calculated. Z-tests were conducted to assess significant differences by reporter type. CIs were calculated using the Korn-Graubard method for complex sample surveys (23). All estimates shown meet NCHS data presentation standards for proportions (24).

Parent-teen concordance was examined using percent agreement, weighted Cohen's kappa and prevalence-adjusted bias-adjusted kappa (PABAK) statistics to provide a more comprehensive assessment of concordance (25). A low prevalence of the condition and bias in the distribution of responses can make it challenging to interpret Cohen's Kappa. Additionally, Cohen's Kappa assumes that the raters are independent, meaning their ratings are not influenced by each other. If raters are influenced by each other's ratings, the agreement estimates will be inflated. This limitation highlights the need for presenting multiple statistics to enhance interpretation (25, 26). Kappa values for Cohen's Kappa and PABAK were evaluated as follows: ≤0 = no agreement; 0.01–0.20 = no to slight agreement; 0.21–0.40 = fair agreement; 0.41–0.60 = moderate agreement; 0.61–0.80 = substantial agreement; and 0.81–1.00 = close to perfect agreement (27). Last, the percentage who reported receipt of TBI evaluation was calculated among those who ever had TBI symptoms based on teen self-report or parent report, respectively. Weighted estimates used the NHIS Sample Child weight (28, 29) for parent-reported data and NHIS-Teen weight for teen-reported data (18). All analyses were conducted using SAS-callable SUDAAN version 11.0.1 software (30).

Results

Sample characteristics

Table 1 describes unweighted characteristics of the sample with sample sizes as well as weighted estimates that are generalizable to US teens aged 12–17 years old. Of the 1,153 teens, 54.5% were aged 15–17 years; 51.3% were female; teen ethnicity was 77.6% non-Hispanic; teen race was 67.0% White; 68.2% had private health insurance; 48.2% resided in families with an income $\geq 400\%$ FPL; and 61.0% participated in sports in the past 12 months.

Prevalence of TBI outcomes by reporter type

Table 2 shows prevalence of TBI outcomes by reporter type and demographic characteristics. Based on parent-report, the lifetime prevalence of TBI symptoms was 10.4% (95% CI: 8.3–12.8), while the estimate based on teen self-report was nearly three times that at 29.9% (95% CI: 26.7–33.3). Parent and teen self-reported estimates for evaluation for TBI were similar to each other, with parent-report at 14.6% (95% CI: 12.4–17.1) and teen self-report at 18.4% (95% CI: 15.8–21.2). Likewise, prevalence of TBI diagnosis was similar for both parents and teens, at 7.0%, respectively.

The prevalence of TBI symptoms was consistently significantly higher for all demographic subgroups when the teens reported for themselves compared with parent reports. The largest differences were for teens aged 12–14 years (teen self-reported, 32.3%, 95% CI: 27.1–37.9 vs. parent-reported, 7.5%, 95% CI: 5.0–10.7), Hispanic teens (teen self-reported, 28.1%, 95% CI: 21.2–35.9 vs. parent-reported, 7.6%, 95% CI: 4.1–12.6), and teens with public insurance (teen self-reported, 28.7%, 95% CI: 22.7–35.3 vs. parent-reported, 8.4, 95% CI: 4.5–14.0).

For TBI evaluation, the prevalence based on teen and parent report varied; prevalence was only statistically significantly different for teens aged 15–17 (teen self-reported, 21.8%, 95% CI: 17.7–26.2 vs. parent-reported, 16.2%, 95% CI: 12.8–20.1), non-Hispanic teens (teen self-reported, 20.9%, 95% CI: 17.7–24.4 vs. parent-reported, 15.9%, 95% CI: 13.1–18.9), and teens who participated in sports (teen self-reported, 23.3%, 95% CI: 19.6–27.3 vs. parent-reported, 18.1%, 95% CI: 14.7–21.9).

Prevalence of TBI diagnosis was similar based on teen or parent report and there were no statistically significant differences when stratified by demographic characteristics.

Parent-teen concordance of TBI outcomes

Table 3 shows the differences between parent-reported and teen self-reported TBI outcomes. Cohen's Kappa was strongest for TBI diagnosis ($k=0.63$; substantial agreement); followed by TBI evaluation ($k=0.47$; moderate agreement); and poorest agreement for TBI symptoms ($k=0.22$; fair agreement). Agreement strength using PABAK was higher for each outcome compared to Cohen's Kappa: Close to perfect agreement for TBI diagnosis ($k=0.90$), substantial agreement for TBI evaluation ($k=0.68$), and moderate agreement for TBI symptoms ($k=0.45$).

Figure 1 shows the percentage of teens with TBI symptoms that had ever had an evaluation for TBI by reporter type. Based on teen self-report, 34.8% of those with TBI symptoms were ever evaluated for TBI. This was significantly lower than parent-report, wherein 53.8% of teens with TBI symptoms were ever evaluated for TBI.

Discussion

Using pairs of teens and their parents, our findings indicated that the prevalence of TBI symptoms is nearly three times higher when using teen self-report rather than parent-report. Further, our findings revealed poor to moderate concordance between parent-reported and teen self-reported TBI symptoms. Conversely, lifetime prevalence of TBI evaluation and TBI diagnosis produced similar estimates and had substantial agreement when comparing parent and teen self-report.

There is the potential for discordance in injury and symptom reporting between parent-report and youth self-report because youths may sustain injuries and experience symptoms of which their parents are not aware. Past research on youth-parent agreement of concussion symptoms among those who sustained injuries during sport play have found moderate to substantial agreement (31, 32). Since our sample was not limited to sports participants, but represents experiences of injuries in any setting and the recall period was lifetime, this may explain why symptom agreement was not as strong as in previous work (31). Higher concordance among samples of sports participants may be the result of increased knowledge of concussion due to past experience with the condition and thus being able to recognize symptoms as part of the injury. Athletes and their parents often have access to coaches or trainers that may provide concussion guidance information and therefore may be better reporters than the general population of youth (33).

Other research has also demonstrated that agreement between parent and youth report of severity of post-concussive symptoms (due to any cause including sports) were modest (13) with youth reporting higher mean levels of symptoms severity than parents (15). Findings from the current study underscore the utility for collection of teen self-report of TBI symptoms for understanding patterns in youth if possible. For more observable and objective measures of health, parent-report yields similar prevalence estimates. In particular, our results have wider utility as they are nationally representative of teens, and better inform the nature of parent-reported indicators of their child's injuries.

It is challenging to compare concordance findings across studies due to a wide variation of questions used to assess undiagnosed TBI experiences. Concordance assessments may be based on a single question, series of questions, or instruments (e.g., Sports Concussion Assessment Tool Version 2), and this may also contribute to observed differences between studies (34). Additionally, variations in study populations, such as age groups or specific populations (e.g., athletes), can further complicate the comparison of concordance results across studies. A lack of standardized methodologic approaches for measuring TBI using surveys may lead to inconsistent measurement across settings and populations (11). The current study's use of a survey of a national population sample to quantify the burden of TBI in the United States underscores the role reporter type may also play in producing significant

differences for the prevalence of TBI symptoms, but not reports of healthcare utilization or diagnosis.

Results from this study represent injuries that occurred across the lifetime.

Time since injury also could have impacted agreement observed, suggesting over time, parents may be unable to recall symptoms while teens may have greater self-awareness of their symptoms (31). Among young children (aged <6 years), parent recall of injuries in general has been shown to decrease with time (35). Given that the recall period in this study was lifetime, it is possible that a shorter recall period may have revealed better agreement between reporters.

Despite poor concordance on TBI symptoms, and higher estimates of TBI symptoms from teens compared with parents, parent-report of evaluation and diagnosis produced similar prevalence estimates to that of teen self-report, with a few exceptions. Analysis revealed significant differences in the reported prevalences for TBI evaluation among some subgroups. Still, in these instances, teens reported a higher prevalence of having an evaluation compared with parents. Previous research on youth athletes has shown underreporting of concussions due to reasons like not wanting to upset parents (36, 37). It is possible that these evaluations are happening when the parent is not present, and the results of the evaluation did not warrant sharing the information with the parent. Post-hoc analysis found that around 80% of discordant teens (those where the teen reported being evaluated but the parent reported no evaluation) later reported not being diagnosed with TBI. Variations in reporting evaluation may also be attributed to differences in the underlying population participating in sports, which is more likely to be teens who are non-Hispanic White and have high family income (38). Regardless, evaluation and diagnosis are more objective measures than symptoms of TBI, measuring interactions with healthcare professionals and subsequent diagnosis that parents are likely involved in. Teens experiencing head injuries are likely unable to access healthcare settings on their own. For athletes, best practices for concussion response plans outlined for athletic trainers includes engaging parents (39). Parent perspectives may provide accurate information regarding healthcare utilization patterns and subsequent diagnosis for TBI. Further research may be helpful to understand the underlying reasons for the variations among teens and parents, especially in subgroups with significant discordance. NHIS-Teen is a nationally representative sample of teens living in the United States. Strengths of the data include linkage to parent-reported measures of health, healthcare utilization, and detailed demographics (e.g., health insurance type, family income) to understand population health by detailed subgroups. TBI outcomes examined in this study utilized identical survey questions that were reported by parents and their teens. This study highlights that estimates can vary depending on the reporter, even when using the same questions.

Despite these strengths, this study is not without limitations. The period of assessment for TBI outcomes was lifelong, whereas many sociodemographic indicators (e.g., health insurance and FPL), as well as sports participation were based on the past 12 months. All data are self-reported, or parent-reported, and therefore may be subject to recall bias. Additionally, parent-reported data are collected in the presence of an interviewer,

and respondents may be reluctant to mention an injury to an interviewer. These reports are subject to social desirability bias, particularly if the circumstances where the injury implicates the parent (e.g., physical abuse) which could contribute to underestimating the prevalence of TBI. In contrast, teen surveys were self-administered via the web in the absence of an interviewer and may be less likely to be influenced by social desirability. Furthermore, the questions used in the current study have not been evaluated for psychometric properties nor compared with external sources (e.g., medical records) to assess validity. Measures were based on self-report (or parent-report) and therefore are based on the judgement and interpretation of the individual. NHIS-Teen sample size limited the ability to produce stable estimates among detailed race and ethnicity subgroups. Last, because NHIS-Teen is a general health survey, data are lacking on explanatory covariates like injury severity, mechanism of injury, and intrapersonal characteristics between parent and teen (e.g. attachment style). This limits the assessment of recall or concordance.

Conclusion

Parent-report for youth TBI symptoms is discordant with youths' experiences. However, measures of TBI evaluation and diagnosis showed substantial agreement between youth and parent-report. Obtaining accurate prevalence estimates of TBI are important to inform programs designed to prevent and decrease TBI at the population level. These findings suggest that teen report of TBI symptoms may enhance surveillance.

Acknowledgements:

The authors would like to thank Dr. Jessica Jones for her review of the manuscript.

List of abbreviations:

TBI	Traumatic brain injury
CDC	Centers for Disease Control and Prevention
NHIS	National Health Interview Survey
NHIS	Teen- National Health Interview Survey- Teen
NCHS	National Center for Health Statistics
CI	Confidence interval
PABAK	prevalence-adjusted bias-adjusted kappa
FPL	federal poverty level
NR	not reliable

References

- [1]. Centers for Disease Control and Prevention. Get the facts about TBI. Available at: https://www.cdc.gov/traumaticbraininjury/get_the_facts.html Accessed October 17, 2023 2023.

- [2]. Sariaslan A, Sharp DJ, D’Onofrio BM, et al. Long-term outcomes associated with traumatic brain injury in childhood and adolescence: a nationwide Swedish cohort study of a wide range of medical and social outcomes. *PLoS medicine* 2016;13:e1002103. [PubMed: 27552147]
- [3]. Cassidy JD, Cancelliere C, Carroll LJ, et al. Systematic Review of Self-Reported Prognosis in Adults After Mild Traumatic Brain Injury: Results of the International Collaboration on Mild Traumatic Brain Injury Prognosis. *Archives of Physical Medicine and Rehabilitation* 2014;95:S132–S151. [PubMed: 24581902]
- [4]. McMahon PJ, Hricik A, Yue JK, et al. Symptomatology and Functional Outcome in Mild Traumatic Brain Injury: Results from the Prospective TRACK-TBI Study. *Journal of Neurotrauma* 2013;31:26–33. [PubMed: 23952719]
- [5]. Centers for Disease Control and Prevention. Traumatic Brain Injury & Concussion. Available at: <https://www.cdc.gov/traumaticbraininjury/index.html> Accessed October 17, 2023 2023.
- [6]. Taylor CA, Bell JM, Breiding MJ, Xu L. Traumatic Brain Injury-Related Emergency Department Visits, Hospitalizations, and Deaths - United States, 2007 and 2013. *MMWR Morb Mortal Wkly Rep* 2017;66:1–16. [PubMed: 28081055]
- [7]. Peterson AB, Thomas KE. Incidence of Nonfatal Traumatic Brain Injury-Related Hospitalizations - United States, 2018. *MMWR Morb Mortal Wkly Rep* 2021;70:1664–1668. [PubMed: 34855719]
- [8]. Womack LS, Breiding MJ, Daugherty J. Concussion Evaluation Patterns Among US Adults. *J Head Trauma Rehabil* 2022;37:303–310. [PubMed: 35125431]
- [9]. Arbogast KB, Curry AE, Pfeiffer MR, et al. Point of health care entry for youth with concussion within a large pediatric care network. *JAMA pediatrics* 2016;170:e160294–e160294. [PubMed: 27244368]
- [10]. Sullivan L, Newton A, Shi J, et al. Concussion-Related Health Care Utilization Among Medicaid Insured Children in Ohio: Rural and Urban Differences. *J Rural Health* 2021;37:479–486. [PubMed: 32744752]
- [11]. Daugherty J, Peterson A, Black L, Waltzman D. Summary of the Centers for Disease Control and Prevention’s Self-reported Traumatic Brain Injury Survey Efforts. *The Journal of Head Trauma Rehabilitation* 2024;10.1097/HTR.0000000000000975.
- [12]. Haarbauer-Krupa J, Lebrun-Harris LA, Black LI, et al. Comparing prevalence estimates of concussion/head injury in U.S. children and adolescents in national surveys. *Ann Epidemiol* 2021;54:11–20. [PubMed: 33227432]
- [13]. Liu R, Hicks SD. Discrepancies in child and parent reporting of concussion symptoms. *Brain Inj* 2021;35:675–681. [PubMed: 33646888]
- [14]. Jones KM, Starkey NJ, Theadom A, et al. Parent and child ratings of child behaviour following mild traumatic brain injury. *Brain Inj* 2018;32:1397–1404. [PubMed: 29985672]
- [15]. Hajek CA, Yeates KO, Taylor HG, et al. Agreement between parents and children on ratings of post-concussive symptoms following mild traumatic brain injury. *Child Neuropsychol* 2011;17:17–33. [PubMed: 20680882]
- [16]. Kroshus E, Garnett B, Hawrilenko M, et al. Concussion under-reporting and pressure from coaches, teammates, fans, and parents. *Soc Sci Med* 2015;134:66–75. [PubMed: 25917137]
- [17]. Zablotsky B, Black LI, Ng AE, et al. Methodology Report for the 2021–2022 National Health Interview Survey – Teen 18-month File; 2023.
- [18]. Bramlett MD, Black LI, Zablotsky B, Dahlhamer JM. Weighting procedures and bias assessment for the 2021–2022 National Health Interview Survey- Teen 18-month file; 2023.
- [19]. Black LI, Zablotsky B. Concussions and Brain Injuries in Children: United States, 2020. *NCHS Data Brief* 2021;1–8.
- [20]. Veliz P, McCabe SE, Eckner JT, Schulenberg JE. Prevalence of Concussion Among US Adolescents and Correlated Factors. *JAMA* 2017;318:1180–1182. [PubMed: 28973604]
- [21]. National Center for Health Statistics. Multiple Imputation of Family Income in 2021 National Health Interview Survey: Methods. Available at: https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2021/NHIS2021-imputation-techdoc-508.pdf.

- [22]. National Center for Health Statistics. Multiple Imputation of Family Income in 2022 National Health Interview Survey: Methods. Available at: https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2022/NHIS2022-imputation-techdoc-508.pdf.
- [23]. Korn EL, Graubard BI. Confidence intervals for proportions with small expected number of positive counts estimated from survey data. *Survey Methodology* 1998;24:193–201.
- [24]. Parker JD, Talih M, Malec DJ, et al. National Center for Health Statistics Data Presentation Standards for Proportions. *Vital Health Stat* 2 2017;1–22.
- [25]. Byrt T, Bishop J, Carlin JB. Bias, prevalence and kappa. *J Clin Epidemiol* 1993;46:423–429. [PubMed: 8501467]
- [26]. Chen G, Faris P, Hemmelgarn B, et al. Measuring agreement of administrative data with chart data using prevalence unadjusted and adjusted kappa. *BMC Med Res Methodol* 2009;9:5. [PubMed: 19159474]
- [27]. Warrens M Five ways to look at Cohen's Kappa. *Journal of Psychology & Psychotherapy* 2015;5.
- [28]. National Center for Health Statistics. National Health Interview Survey, 2022. Public-use data file and documentation.; 2023.
- [29]. National Center for Health Statistics. National Health Interview Survey, 2021. Public-use data file and documentation.; 2022.
- [30]. SUDAAN. 11.0.0 edition: RTI International, 2012.
- [31]. Rowhani-Rahbar A, Chrisman SPD, Drescher S, et al. Agreement between high school athletes and their parents on reporting athletic events and concussion symptoms. *J Neurotrauma* 2016;784–791. [PubMed: 26414288]
- [32]. Bretzin AC, Anderson M, Schmitt AJ, Beidler E. Agreement between parent reported and child self-reported sport-related concussion history: A brief report. *Appl Neuropsychol Child* 2023;12:197–201. [PubMed: 35531867]
- [33]. Daugherty J, Waltzman D, Sarmiento K. Provision of Concussion Information From Coaches and the Presence of Athletic Trainers: Findings From the 2021 YouthStyles Survey. *Journal of Athletic Training* 2023;58:611–617. [PubMed: 36645830]
- [34]. Daugherty J, Peterson A, Waltzman D, et al. Rationale for the Development of a Traumatic Brain Injury Case Definition for the Pilot National Concussion Surveillance System. *J Head Trauma Rehabil* 2023.
- [35]. Cummings P, Rivara FP, Thompson RS, Reid RJ. Ability of parents to recall the injuries of their young children. *Inj Prev* 2005;11:43–47. [PubMed: 15691989]
- [36]. Wallace J, Covassin T, Nogle S, et al. Knowledge of Concussion and Reporting Behaviors in High School Athletes With or Without Access to an Athletic Trainer. *Journal of Athletic Training* 2017;52:228–235. [PubMed: 28387561]
- [37]. Register-Mihalik JK, Guskiewicz KM, McLeod TC, et al. Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. *J Athl Train* 2013;48:645–653. [PubMed: 23848520]
- [38]. Black LI, Terlizzi EP, Vahratian A. Organized sports participation among children aged 6–17 ayears: United States, 2020. 2022.
- [39]. Centers for Disease Control and Prevention. CDC Heads Up. Safe Brain. Stronger future Available at: <http://www.cdc.gov/HEADSUP> Accessed 03/22/2024.

Implications and Contribution:

Parents and teens report health measures differently, with discrepancies particularly evident for measures that are less easily observed. Findings suggest that surveillance efforts may be enhanced by using youth self-report.

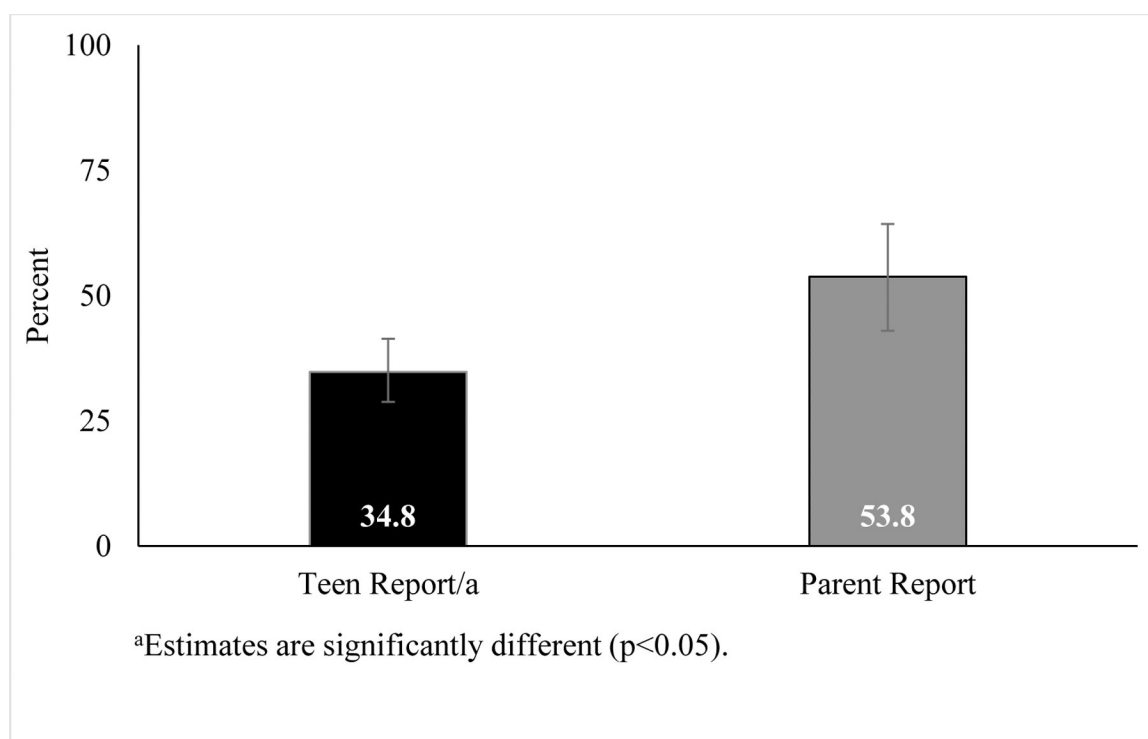


Figure 1.
Percentage of teens with traumatic brain injury symptoms that have ever been evaluated for traumatic brain injury, National Health Interview Survey-Teen July 2021 - December 2022 and National Health Interview Survey 2021–2022

Table 1.

Sample Description, National Health Interview Survey-Teen July 2021 - December 2022

	n^a	Unweighted Percentage	Weighted Percentage
Total	1153	100.0	100.0
Age group			
12–14	525	45.5	49.7
15–17	628	54.5	50.3
Sex			
Male	560	48.6	51.7
Female	592	51.3	48.3
Hispanic ethnicity			
Hispanic	258	22.4	26.6
Non-Hispanic	895	77.6	73.4
Race			
White	772	67.0	73.9
All other races ^b	289	25.1	26.1
Health insurance			
Private	786	68.2	59.8
Public ^c	299	25.9	35.8
Federal poverty level			
<200% FPL	289	25.2	35.8
200–<400% FPL	312	26.6	27.9
≥400% FPL	553	48.2	36.3
Sports participation, past 12 months	703	61.0	58.8

^aUnweighted sample size.^bIncludes persons who are Black/African American, American Indian, Alaska Native, Native Hawaiian, Other Pacific Islander, Asian, or some other race.^cPublic health insurance includes: Medicaid or other public.

Columns may not sum to total due to missing data.

FPL=federal poverty level

Prevalence of Traumatic Brain Injury Outcomes by Sociodemographic Characteristics and Reporter, National Health Interview Survey-Teen July 2021 - December 2022 and National Health Interview Survey 2021–2022

Table 2.

	TBI Symptoms ^d				TBI Evaluation ^b				TBI Diagnosis ^c			
	Teen		Parent		Teen		Parent		Teen		Parent	
	% ^d	CI	% ^d	CI	% ^d	CI	% ^d	CI	% ^d	CI	% ^d	CI
Total	29.9 ^e	26.7–33.3	10.4	8.3–12.8	18.4 ^e	15.8–21.2	14.6	12.4–17.1	7.0	5.3–8.9	7.0	5.2–9.1
Age group												
12–14	32.3 ^e	27.1–37.9	7.5	5.0–10.7	14.9	11.4–19.0	13.0	9.9–16.8	4.8	2.9–7.5	4.9	2.8–7.9
15–17	27.6 ^e	23.4–32.0	13.2	9.9–17.2	21.8 ^e	17.7–26.2	16.2	12.8–20.1	9.1	6.5–12.3	9.0	6.3–12.4
Sex												
Male	30.3 ^e	25.8–35.0	9.5	6.9–12.8	22.8 ^e	18.7–27.3	16.7	13.3–20.6	8.5	6.0–11.5	8.0	5.5–11.2
Female	29.5 ^e	24.9–34.5	11.3	8.1–15.3	13.6	10.4–17.3	12.4	9.3–16.1	5.3	3.3–8.1	5.8	3.5–9.0
Hispanic ethnicity												
Hispanic	28.1 ^e	21.2–35.9	7.6	4.1–12.6	11.3	6.9–17.1	11.2	7.1–16.5	NR		6.5	3.2–11.5
Non-Hispanic	30.6 ^e	26.9–34.4	11.4	8.9–14.3	20.9 ^e	17.7–24.4	15.9	13.1–18.9	7.8	5.9–10.1	7.1	5.1–9.6
Race												
White	30.7 ^e	26.9–34.7	11.1	8.6–13.9	20.9	17.7–24.5	16.6	13.8–19.8	7.8	5.8–10.3	6.9	5.1–9.2
All other races ^f	26.0 ^e	19.7–33.1	9.1	4.8–15.2	14.2	9.3–20.4	9.9	5.7–15.9	NR		NR	
Health insurance												
Private	30.7 ^e	26.9–34.8	11.2	8.9–13.8	20.7	17.3–24.4	16.8	14.0–20.0	7.8	5.8–10.3	6.5	4.7–8.8
Public ^g	28.7 ^e	22.7–35.3	8.4	4.5–14.0	14.7	10.3–20.1	10.5	6.5–15.9	NR		7.0	3.7–11.9
Federal poverty level												
<200% FPL	29.3 ^e	23.3–35.9	10.2	6.1–15.8	16.1	11.6–21.5	13.1	8.6–18.8	6.2	3.4–10.2	7.6	4.2–12.4
200–<400% FPL	27.3 ^e	21.4–33.9	9.5	6.1–13.9	15.0	10.3–20.7	13.7	9.4–19.0	6.2	3.0–11.0	7.0	3.8–11.8
≥400% FPL	32.6 ^e	27.9–37.6	11.2	8.4–14.7	23.2 ^e	19.0–27.7	16.8	13.4–20.8	8.3	6.0–11.1	6.3	4.3–8.9
Sports participation, past 12 months												
Sports participation	32.8 ^e	28.5–37.2	12.5	9.5–16.0	23.3 ^e	19.6–27.3	18.1	14.7–21.9	8.3	6.1–10.9	8.6	6.1–11.8

	TBI Symptoms ^a			TBI Evaluation ^b			TBI Diagnosis ^c					
	Teen		Parent	Teen		Parent	Teen		Parent			
	% ^d	CI	% ^d	CI	% ^d	CI	% ^d	CI	% ^d	CI		
No sports participation	25.9 ^e	20.8–31.5	7.4	4.7–11.1	11.3	8.0–15.4	9.7	6.7–13.5	5.1	2.8–8.4	4.6	26.–7.4

^a A composite measure based on three separate survey questions. Report of one or more lifetime experiences of symptoms of: being knocked out or losing consciousness, been dazed or had a gap in memory, had headaches, vomiting, blurred vision, or changes in mood or behavior as a result of a blow or jolt to the head.

^b Based on report of ever being checked for a concussion or brain injury by a doctor, nurse, athletic trainer, or other health care professional.

^c Based on report of ever being told by a doctor, nurse, athletic trainer, or other health professional that teen had a concussion or brain injury. Teens that never received evaluation for TBI were categorized as never having a TBI diagnosis.

^d Weighted percentage.

^e Indicates estimate is statistically significant from parent-reported estimate (p<.05).

^f Includes persons who are Black/African American, American Indian, Alaska Native, Native Hawaiian, Other Pacific Islander, Asian, or some other race.

^g Public health insurance includes: included Medicaid or other public.

FPL=federal poverty level; NR=not reliable; TBI=traumatic brain injury

Table 3.

Parent and Teen Self-Report of Traumatic Brain Injury Outcomes, National Health Interview Survey-Teen July 2021 - December 2022 and National Health Interview Survey 2021–2022

		Child Report		Percent agreement	Cohen's Kappa	PABAK
		% (n) ^a	% (n) ^a			
TBI Symptoms ^b		Yes	No	73%	0.22	0.45
Parent Report	Yes	6.8 (90)	3.6 (45)			
	No	23.2 (271)	66.4 (747)			
	Total (%)	361 (100%)	792 (100%)			
TBI Evaluation ^c		Yes	No	84%	0.47	0.68
Parent Report	Yes	8.9 (125)	5.7 (76)			
	No	9.4 (110)	76.0 (842)			
	Total (%)	235 (100%)	918 (100%)			
TBI Diagnosis ^d		Yes	No	95%	0.63	0.90
Parent Report	Yes	4.4 (61)	2.6 (27)			
	No	2.6 (32)	90.5 (1033)			
	Total (%)	93 (100%)	1060 (100%)			

^aUnweighted percentage and unweighted n.

^bA composite measure based on three separate survey questions. Report of one or more lifetime experiences of symptoms of: 1) being knocked out or losing consciousness, 2) been dazed or had a gap in memory, 3) had headaches, vomiting, blurred vision, or changes in mood or behavior. Each was in reference to happening as a result of a blow or jolt to the head

^cBased on report of ever being checked for a concussion or brain injury by a doctor, nurse, athletic trainer, or other health care professional.

^dBased on report of ever being told by a doctor, nurse, athletic trainer, or other health professional that teen had a concussion or brain injury. Teens that never received evaluation for TBI were categorized as never having a TBI diagnosis.

PABAK=prevalence-adjusted bias-adjusted kappa; TBI=traumatic brain injury