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Emergency department visits for mild traumatic brain injury in early childhood

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ABSTRACT

Background: Brain injury during early childhood may disrupt key periods of neurodevelopment. Most research regarding mild traumatic brain injury (mTBI) has focused on school-age children. We sought to characterize the incidence and healthcare utilization for mTBI in young children presenting to U.S. emergency departments (ED).

Methods: The Nationwide Emergency Department Sample was queried for children age 0–6 years with mTBI from 2016 to 2019. Patients were excluded for focal or diffuse TBI, drowning or abuse mechanism, death in the ED or hospital, Injury Severity Score > 15, neurosurgical intervention, intubation, or blood product transfusion.

Results: National estimates included 1,372,291 patient visits: 63.5% were two years or younger, 57.5% were male, and 69.4% were injured in falls. The most common head injury diagnosis was "unspecified injury of head" (83%); this diagnosis decreased in frequency as age increased, in favor of a concussion diagnosis. Most patients were seen at low pediatric volume EDs (64.5%) and non-children's hospital EDs (86.2%), and 64.9% were seen at a non-teaching hospital. Over 98% were treated in the ED and discharged home. Computed tomography of the head and cervical spine were performed in 18.7% and 1.6% of patients, respectively, less often at children's hospitals (OR = 0.55, 95%CI = 0.41–0.76 for head and OR = 0.19, 95%CI = 0.11–0.34 for cervical spine). ED charges resulted in $540–681 million annually, and more than half of patients utilized Medicaid.

Conclusions: Early childhood mTBI is prevalent and results in high financial burden in the U.S. There is wide variation in diagnostic coding and computed tomography scanning amongst EDs. More focused research is needed to identify optimal diagnostic tools and management strategies.

1. Introduction

Mild traumatic brain injury (mTBI), or concussion, is a leading public health issue, with an estimated 1.1–1.9 million sports and recreation-related head injuries in children annually in the United States [1]. Mild TBI can occur through various mechanisms, and only half of children with mTBI presenting to the Emergency Department (ED) are due to sports injuries [2]. In children age 0–4 years, approximately 70% of mTBIs are caused by falls, and <20% are sports-related [3].

Brain injury during early childhood is of particular concern due to the rapid development and changing morphology of the brain. Eighty percent of maximum gray matter and white matter volumes are reached by about 1 year and 6–8 years, respectively [4], and radiographic myelination of the white matter occurs largely in the first 2 years of life [5]. Brain development in early childhood drives the rapid acquisition of motor, cognitive, and social skills, and injury during this period can affect long-term outcomes. Although moderate-severe injuries often lead to significant sequelae [6,7], mTBI can result in persistent manifestations including social and behavioral difficulties [8-10].

Abbreviations: CDC, Centers for Disease Control and Prevention; CPT, current procedural terminology; CT, computed tomography; ED, emergency department; ISS, injury severity score; mTBI, mild traumatic brain injury.

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Most existing research on mTBI has focused on school-age children, especially those playing sports. However, infants, toddlers and preschoolers are at highest risk for all-severity TBI, and the reported rate of TBI in this age group has increased over time [11]. Due to the limited self-report of symptoms, mTBI can be difficult to diagnose in early childhood. Young children may experience somatic, sleep, emotional, or visual-vestibular symptoms typically seen in older children, but they may also experience symptoms not included on concussion symptom checklists such as behavioral difficulties, decreased participation in activities, clinginess, and change in appetite [12,13]. Until recently [14], symptom checklists were only validated down to 5 years of age [15,16]. Due to these diagnostic challenges, little is known about the incidence of mTBI in children prior to entering elementary school. Understanding the incidence and public health burden of ED visits for mTBI in this age group will help inform future research initiatives and public policy. We sought to describe mTBI in children age 0–6 years from a national sample of ED visits in the United States.

2. Methods

2.1. Data source

We conducted a cross-sectional study of a national administrative limited dataset. This study was exempt from review by the institutional review board at our institution. We examined ED visits using the Nationwide Emergency Department Sample (NEDS), generated for the Healthcare Cost and Utilization Project (HCUP) and sponsored by the Agency for Healthcare Research and Quality [17]. NEDS is the largest database of ED visits in the United States, including data from 37 states, over 950 EDs, and 32–35 million ED visits each year representing all ages and all payers. NEDS sample weights allow for the generation of national estimates of approximately 144 million ED visits per year. The 10th revision of the International Statistical Classification of Diseases and Related Health Problems, clinical modification, (ICD-10-CM) was adopted in October 2015 and impacted head injury diagnoses, so we chose to examine data from 2016 to 2019. ICD-10-CM codes and Current Procedural Terminology (CPT) codes were used in this study. NEDS data from 2019 was the most current year available at the time of data analysis.

2.2. Data elements

Patient and hospital characteristics were obtained from the NEDS database. The database includes both adult and pediatric EDs. To classify hospitals, we defined a high pediatric volume ED as one seeing at least 20,000 patients <18 years per year. We also defined children's hospitals by median patient age. The median age for children's hospitals was <10 years, and the median age for non-children's hospitals was >20 years. No hospitals in the NEDS dataset had a median patient age between 10 and 20 years. Injury severity score (ISS), mechanism of injury groupings, and intent were generated using the "icdpicr" injury categorization package version 1.0.0 for R [18]. The ISS assesses trauma severity, with higher scores generated based on the severity of injury to each body region or trauma to multiple body regions. An ISS cutoff of 15 (out of 75 total) has previously been used to distinguish mild from severe brain injury [19]. The Clinical Classifications Software Refined (CCSR), included in the HCUP datasets (version 2020.1), was used to identify groups of CPT codes for exclusionary purposes. The 100 most frequently used CPT codes during the ED encounter for each year of age and the 25 most frequently used CPT codes for each head injury diagnosis were described. Rates of computed tomography (CT) of the head and cervical spine were obtained for the included patients.

2.3. Inclusion and exclusion

We included ED visits for patients age 0–6 years with a head injury diagnosis listed as one of the first 15 diagnoses for the patient visit. To protect the confidentiality of patients, HCUP requires that cell sizes with fewer than 10 patients be excluded or grouped to form larger cell sizes. Therefore, after initial review of the dataset, we grouped the head injury diagnoses into five categories (Table 1). We considered inclusion of patients with focal TBI and diffuse TBI diagnostic codes (S06301A, S062X0A, and S062X1A). However, these codes were consistently associated with higher ISS, suggesting that these codes are commonly used for patients with moderate to severe TBI; therefore, these codes were excluded from the analysis. Patients were also excluded for the following reasons: abuse diagnosis code, death in the ED or death during the associated hospital admission, ISS >15, or a drowning/submersion mechanism of injury. Finally, patients were excluded if they had procedures indicative of moderate to severe TBI in the following CPT code groups: Group 1 (incision and excision of central nervous system), Group 2 (insertion, replacement, or removal of extracranial ventricular shunt), Group 216 (respiratory intubation and mechanical ventilation), or Group 222 (blood and blood product transfusion).

2.4. Data analysis

Descriptive statistics were calculated for patient visit characteristics and hospital characteristics. If a patient visit contained more than one eligible mTBI diagnostic code, the visit was included in analyses for each of the relevant mTBI groups, but only counted once in the total visit count. Two-tailed Rao-Scott chi-square tests were used to assess injury diagnoses between children's hospitals and non-children's hospitals. To analyze the weighted data and obtain *p*-values and 95% confidence intervals for the Rao-Scott chi-square tests, we used the "proc surveyfreq" function. The "proc surveylogistic" function was used to conduct a logistic regression to assess head and cervical spine CT usage between children's hospitals and non-children's hospitals, controlling for age, primary payer, and median household income. Statistical analysis was performed using SAS Enterprise Guide version 8.1.

3. Results

A total of 326,704 (national estimate 1,391,730) head injury ED visits in children 0–6 years were identified in the four-year study period. After exclusionary criteria were applied, 322,235 (national estimate 1,372,291) were included (Fig. 1). Characteristics of the included patient

Table 1
Head injury diagnoses included.

Grouping	Diagnostic Codes
Unspecified injury of head	Unspecified injury of head (S0990XA)
Other specified injury of head	Other specified injuries of head (S098XXA)
Concussion group	concussion without loss of consciousness, initial encounter (S060X0A) concussion with loss of consciousness of 30 min or less, initial encounter (S060X1A) concussion with loss of consciousness of unspecified duration, initial encounter (S060X9A)
Post-traumatic headache group	acute post-traumatic headache, intractable (G44311) acute post-traumatic headache, not intractable (G44319) post-traumatic headache, unspecified, intractable (G44301) post-traumatic headache, unspecified, not intractable (G44309)
Other head injury group	other biomechanical lesions of head region (M9980) unspecified intracranial injury without loss of consciousness, initial encounter (S069X0A) unspecified intracranial injury with loss of consciousness of 30 min or less, initial encounter (S069X1A) unspecified intracranial injury with loss of consciousness of unspecified duration, initial encounter (S069X9A) encounter for screening for traumatic brain injury (Z13850)

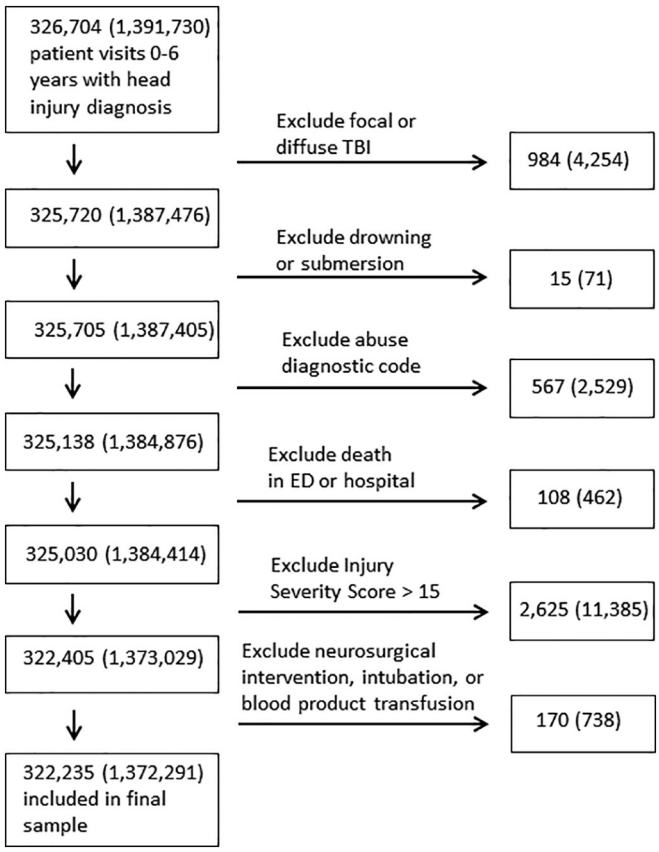

Fig. 1. Emergency department visits for patients age 0–6 years presenting with a head injury diagnosis after applying inclusion and exclusion criteria (sampled visits, US national estimates).

visits and hospitals are shown in Table 2 (national estimates) and Supplementary Table 3 (sampled visits). Unspecified injury of head, initial encounter (S0990XA) was the most commonly used diagnosis, representing 83% of all visits. Mean, median, and total charges for ED care and inpatient care are included in Table 2.

The use of each head injury diagnosis category varied by age (Fig. 2). With increasing age, the unspecified injury of head diagnosis decreased while concussion diagnoses increased. Similarly, post-traumatic headache diagnoses increased with age, although remained uncommon (0.0% of patients <1 year and 1.3% of patients 6 years old). As shown in Table 3, children's hospitals used the unspecified injury of head diagnosis at a similar rate as non-children's hospitals (85.1% vs 82.7%, respectively, $p = 0.09$). Children's hospitals also used a concussion diagnosis at a similar rate as non-children's hospitals (9.5% vs 9.6%, respectively, $p = 0.94$). Head CT was obtained in 18.7% of patients, while cervical spine CT was obtained in 1.6% of patients. Patients treated at children's hospitals were less likely to receive a head CT (OR = 0.55, 95%CI = 0.41–0.76) or a cervical spine CT (OR = 0.19, 95%CI = 0.11–0.34).

For each year of age, the rate of CPT code usage for level of medical complexity, repair of superficial wounds, imaging, medication administration, venipuncture, labs, and other interventions are summarized in Supplementary Table 1. ED visits were mostly of low or moderate medical complexity: 32% low complexity (CPT codes 99281 and 99282), 65% moderate complexity (CPT codes 99283 and 99284), and 3% high complexity (CPT code 99285). The rate of CPT code usage for each head injury diagnosis is shown in Supplementary Table 2.

4. Discussion

Most research on pediatric mTBI has focused on school-age children and athletes, leaving a gap in knowledge regarding the epidemiology, diagnosis, management, and consequences of these injuries in young children. Our study showed that mTBI is highly prevalent in children 6 years or younger, with approximately 343,000 ED visits annually in the U.S.

To our knowledge, this is the first study to identify mTBI specifically in young children from a nationally representative sample. The Centers for Disease Control and Prevention's (CDC) 2021 report on the incidence of all-severity TBI used ICD codes for skull fracture, facial fracture, crushing injury of skull, injury of the optic nerves or specific brain regions, intracranial injury, and shaken infant syndrome [20]. Given that the majority of TBIs are known to be mild in nature, we included only diagnostic codes that suggest concussion or mild TBI. We did not include codes for fractures or specific intracranial injuries because these indicate a more focal or severe brain injury.

To meet the unique challenge of identifying young children with mTBI, we included the "unspecified injury of head" diagnosis. A study of all-severity pediatric head trauma using NEDS data from 2006 to 2010 included the "head injury, unspecified" diagnosis but did not distinguish its incidence from other head injury diagnoses [21]. Others have excluded this diagnosis from surveillance data based on the assumption that it does not reflect clinical TBI [20]. Two studies evaluated the characteristics of adults and children diagnosed with "unspecified injury of head" in the ED. Peterson and colleagues found that almost half of patients had moderate to high clinical evidence of TBI, based on traumatic neuroimaging findings or classic signs and symptoms of mTBI [22]. Bazarian and colleagues found that 25% of patients met their clinical definition of mTBI, which required loss of consciousness, amnesia, or mental status change [23]. However, these previous studies included older children and adults, and the criteria they used may have underestimated the number of children age 0–6 years with mTBI, who are unable to report amnesia, have difficulty reporting most symptoms, and often have negative neuroimaging studies.

Over 80% of the children in our sample were diagnosed with "unspecified injury of head". The use of this diagnosis was similar between children's hospitals and non-children's hospitals. We saw a prominent decline in the use of this diagnosis as age increases, in favor of a concussion diagnosis, suggesting that health care professionals are more comfortable with the concussion diagnosis at older ages. This is not surprising due to the common association of the term "concussion" with sport-related injuries found more commonly in older children. Limited resources are available to guide clinicians in the diagnosis and management of mTBI in early childhood.

Due to the absence of symptom reporting and limited observable signs of mTBI, health care professionals lack validated and reliable methods to diagnose mTBI in children age 0–6 years. Most mTBI assessment tools are validated only in school-age children and adults, making the diagnosis of mTBI in early childhood particularly challenging. For example, the Child SCAT-5 and Post-Concussion Symptom Inventory use self- and parent-reported symptoms checklists and are only validated down to age 5 years [15,16]. The assessment of young children suspected of having a mTBI may require a more developmentally-appropriate tool based on signs and symptoms, such as the recently proposed Report of Early Childhood Traumatic Injury Observations & Symptoms (REACTIONS), developed for children age 0–8 years [14]. The diagnostic and prognostic accuracy of this assessment tool needs to be further studied.

Head and spine imaging are not recommended for the routine diagnosis of children with mTBI [24]. The Pediatric Emergency Care Applied Research Network (PECARN) prediction rules to identify children at higher risk for clinically important TBI were published in 2009 [25]. This tool aids the clinician in determining if head imaging is indicated after head trauma. We found that 18.7% of children age 0–6 years received a head CT. Adoption of these prediction rules may have contributed to the lower imaging rates seen in this study, as compared with that seen in 2011, when 37.4% of patients age 0–11 diagnosed with mTBI received a head CT in the ED [26]. In our sample, head CT and

Table 2
Characteristics of emergency department patient visits from 2016 to 2019, national estimates.

Variable	Subcategory	2016 N	2017 N	2018 N	2019 N	Total N	Total Percentage
Total		370,112	343,292	353,161	305,726	1,372,291	100.0
Head Injury Diagnosis[a]	Unspecified injury of head (S0990XA)	309,092	283,670	293,494	252,799	1,139,056	83.0
	Other specified injuries of head (S098XXA)	21,626	22,860	22,109	18,813	85,407	6.2
	Concussion group[b]	34,995	33,341	33,207	29,749	131,292	9.6
	Post-traumatic headache group[c]	1310	1226	1145	1047	4728	0.3
	Other head injury group[d]	7485	5884	5568	5172	24,110	1.8
Age (years)	<1	79,981	72,615	78,902	69,067	300,565	21.9
	1	76,995	71,664	71,729	61,843	282,230	20.6
	2	81,709	70,355	74,126	61,316	287,506	21.0
	3	39,639	39,440	39,655	34,424	153,158	11.2
	4	33,248	32,407	31,446	28,128	125,229	9.1
	5	29,996	29,316	30,004	26,092	115,408	8.4
	6	28,461	27,448	27,264	24,715	107,888	7.9
Gender	Male	212,855	198,680	202,865	174,166	788,566	57.5
	Female	157,243	144,590	150,260	131,528	583,621	42.5
Patient's Residence	Large central metropolitan	127,064	102,075	110,755	89,900	429,794	31.4
	Small metropolitan	191,737	192,077	194,191	170,635	748,639	54.7
	Micropolitan	32,577	32,434	31,162	28,818	124,990	9.1
	Not metropolitan or micropolitan	17,700	15,828	16,294	15,663	65,484	4.8
Disposition from ED	Patient treated and released	364,546	337,355	348,003	300,863	1,350,767	98.4
	Patient admitted to same hospital	2029	2073	1938	1887	7927	0.6
	Patient transferred to a short-term hospital	3366	3265	2902	2927	12,460	0.9
	Patient not admitted, destination unknown	172	599	318	37	1127	0.1
ED Charges (dollars)	Mean	1727	1836	1959	2244	1940	
	Median	1000	1034	1157	1308	1116	
	Total	539,751,868	548,417,948	598,656,794	681,391,250	2,368,217,860	
Inpatient Charges (dollars)	Mean	32,632	24,529	35,886	29,162	30,464	
	Median	19,050	16,194	21,069	21,318	19,053	
	Total	70,708,551	54,268,394	72,448,363	56,411,314	253,836,623	
Primary Payer	Medicare	2725	1074	1087	1756	6642	0.5
	Medicaid	199,208	187,029	191,580	164,672	742,489	54.2
	Private insurance	134,350	127,305	129,140	110,384	501,178	36.6
	Self-pay	19,587	16,076	18,835	17,603	72,101	5.3
	No charge	187	279	304	466	1235	0.1
	Other	13,771	10,700	11,995	10,301	46,767	3.4
Median Household Income Quartile by Zip Code	0%–25%	107,000	99,157	105,187	87,820	399,165	29.4
	25%–50%	94,693	92,337	93,968	79,130	360,129	26.5
	50%–75%	85,367	81,537	79,312	73,599	319,815	23.5
	75%–100%	79,081	67,043	71,535	62,680	280,339	20.6
Mechanism of Injury	Fall	260,426	240,815	235,596	216,087	952,924	69.4
	Struck by, against	58,137	52,268	50,910	47,992	209,307	15.3
	MVA group[e]	10,187	9229	8886	7908	36,210	2.6
	Pedal cyclist, other	3306	2940	2617	2410	11,271	0.8
	Pedestrian, other	400	365	314	275	1354	0.1
	Natural/environmental	855	881	980	859	3575	0.3
	Cut/pierce	584	609	535	607	2334	0.2
	Miscellaneous group[f]	132	174	174	164	643	0.0
	Other group[g]	36,086	36,013	53,150	29,424	154,672	11.3
Intent	Unintentional	340,266	312,804	304,744	280,683	1,238,497	90.3
	Assault	735	635	724	728	2821	0.2
	Self-inflicted	22	22	19	38	101	0.0
	Undetermined	310	256	275	160	1000	0.1
	NA	28,780	29,576	47,399	24,117	129,872	9.5
Injury Severity Score	0	688	725	684	630	2728	0.2
	1–3	270,906	251,315	265,534	230,567	1,018,322	74.2
	4–8	89,720	84,633	80,728	68,982	324,063	23.6
	9–15	8798	6620	6214	5547	27,179	2.0
Children's Hospital	Children's hospital	49,353	35,364	66,843	37,339	188,899	13.8
	Non-Children's hospital	320,760	307,928	286,318	268,387	1,183,393	86.2
Teaching Hospital	Teaching hospital	230,472	217,078	242,035	200,481	482,226	35.1
	Non-teaching hospital group[h]	139,641	126,214	111,126	105,245	890,065	64.9
Hospital Region	Northeast	67,077	59,912	60,741	54,645	242,374	17.7
	Midwest	79,339	87,798	90,377	69,277	326,791	23.8
	South	132,762	112,656	131,921	112,248	489,586	35.7
	West	90,934	82,927	70,122	69,557	313,540	22.8
Number of Patients < 18 Treated at Hospital Annually	1–1799	11,634	12,924	12,557	14,115	51,230	3.7
	1800–4999	55,715	52,523	54,328	52,466	215,031	15.7
	5000–9999	75,452	84,745	74,270	75,573	310,041	22.6

(continued on next page)

Table 2 (*continued*)

Variable	Subcategory	2016 N	2017 N	2018 N	2019 N	Total N	Percentage
	10,000–19,999	85,347	76,018	71,656	75,141	310,041	22.5
	20,000–49,999	79,654	65,309	63,669	57,650	266,283	19.4
	≥ 50,000	62,310	51,773	76,680	30,781	221,545	16.1

ED, emergency department; MVA, motor vehicle accident; NA, not applicable.
a: some patient visits may be classified in multiple sub-categories.
b: Concussion group: concussion without loss of consciousness, initial encounter (S060X0A), concussion with loss of consciousness of 30 min or less, initial encounter (S060X1A), concussion with loss of consciousness of unspecified duration, initial encounter (S060X9A).
c: Post-traumatic headache group: acute post-traumatic headache, intractable (G44311), acute post-traumatic headache, not intractable (G44319), post-traumatic headache, unspecified, intractable (G44301), post-traumatic headache, unspecified, not intractable (G44309).
d: Other head injury group: other biomechanical lesions of head region (M9980), unspecified intracranial injury without loss of consciousness, initial encounter (S069X0A), unspecified intracranial injury with loss of consciousness of 30 min or less, initial encounter (S069X1A), unspecified intracranial injury with loss of consciousness of unspecified duration, initial encounter (S069X9A), encounter for screening for traumatic brain injury (Z13850).
e: MVA group: motor vehicle traffic and transport.
f: Miscellaneous group: adverse effects, fire/burn, firearm machinery, overexertion.
g: Other group: other specified classifiable, other specified not elsewhere classifiable, unspecified, NA.
h: Non-teaching hospital group: metropolitan non-teaching and non-metropolitan.

cervical spine CT were used more frequently at non-children's hospitals. Additional education of clinicians regarding evidence-based indications for CT after head injury in young children is warranted and may further reduce the rate of CT usage for mTBI.

Although most of the head injury visits in this sample are of low or moderate medical complexity, they result in significant financial burden, incurring almost 600 million dollars per year for ED care plus 63 million dollars per year for inpatient care. More than half of the visits were covered by Medicaid, indicating a high burden on public payers.

4.1. Limitations

There are several limitations to the current study. First, the NEDS database is based on billing and diagnostic codes, which are limited by the input accuracy of the health care professionals and billing department of the hospital. Second, using the "unspecified injury of head" diagnosis may have resulted in the inclusion of patients with very mild injuries, not meeting the clinical definition of concussion that has been established for older children and adults [27]. However, we believe that this diagnosis should be included in estimates of the incidence of mTBI in young children due to the limited guidelines available to clinicians to make a more specific diagnosis. Third, information regarding race, ethnicity, neuroimaging results, outpatient medications, and past medical history are not available in the NEDS database. Repeat visits to the ED and follow-up outpatient visits are also not available in NEDS, so we were unable to track patients over time to determine recovery. Fourth, many children with mTBI are seen in the outpatient setting or do not seek medical care. However, 87% of young children diagnosed with

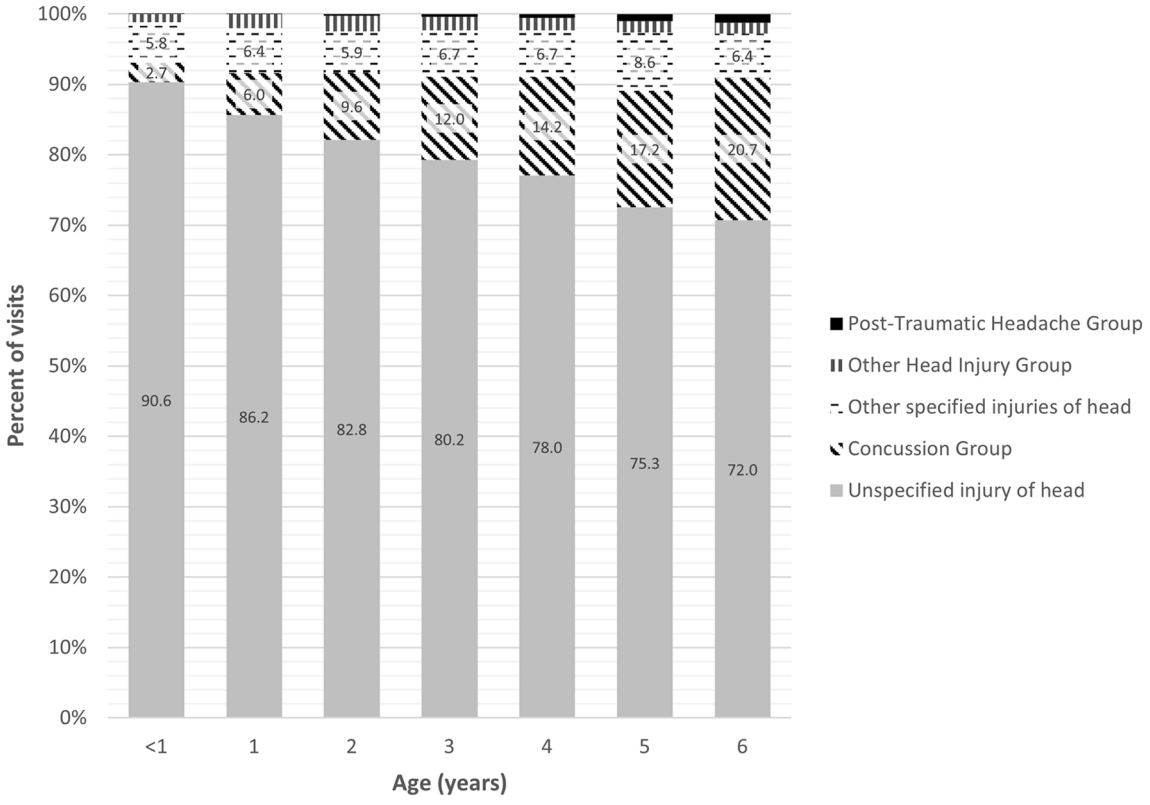

Fig. 2. Percentage of patient visits to the emergency department using each head injury diagnosis category. Percentages for the "other head injury" and "post-traumatic headache" groups were all <2.5%, so exact percentages are not shown for these categories.

Table 3
Injury diagnosis rates by hospital type, national estimates.

	Children's Hospital			Non-Children's Hospital			P-value
Diagnosis	N	Percent	95% CI	N	Percent	95% CI	
Unspecified injury of head (S0990XA)	160,780	85.1	82.5–87.0	978,276	82.7	81.8–83.5	0.09
Other specified injuries of head (S098XXA)	7650	4.1	2.6–5.5	77,758	6.6	5.9–7.2	0.08
Concussion group[a]	17,949	9.5	7.6–11.5	113,343	9.6	9.2–10.0	0.94
Post-traumatic headache group[b]	639	0.3	0.2–0.5	4088	0.4	0.3–0.4	0.92
Other head injury group[c]	2870	1.5	1.1–1.9	21,240	1.8	1.6–2.0	0.26
Total	188,899	100		1,183,393	100		

Comparisons made using two-tailed Rao-Scott Chi-Square tests.
[a] Concussion group: concussion without loss of consciousness, initial encounter (S060X0A), concussion with loss of consciousness of 30 min or less, initial encounter (S060X1A), concussion with loss of consciousness of unspecified duration, initial encounter (S060X9A).
[b] Post-traumatic headache group: acute post-traumatic headache, intractable (G44311), acute post-traumatic headache, not intractable (G44319), post-traumatic headache, unspecified, intractable (G44301), post-traumatic headache, unspecified, not intractable (G44309).
[c] Other head injury group: other biomechanical lesions of head region (M9980), unspecified intracranial injury without loss of consciousness, initial encounter (S069X0A), unspecified intracranial injury with loss of consciousness of 30 min or less, initial encounter (S069X1A), unspecified intracranial injury with loss of consciousness of unspecified duration, initial encounter (S069X9A), encounter for screening for traumatic brain injury (Z13850).

mTBI are seen in the ED or urgent care [12]. Our study assessed the subset of patients presenting to the ED for care.

4.2. Conclusions

Approximately 343,000 children ages 0–6 years present to U.S. EDs each year with concussion or mTBI, incurring over $650 million in ED and inpatient charges. Most are diagnosed with "unspecified injury of head", highlighting the diagnostic uncertainty clinicians face in this age group. There are limited diagnostic tools and no clinical practice guidelines tailored to this young age. Future research should focus on the diagnostic accuracy of mild TBI in early childhood and the development of effective treatments.

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Declaration of Competing Interest

The authors report no conflicts of interest related to this article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajem.2022.12.035.

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