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Epidemiology of Isolated vs. Non-Isolated Mild Traumatic Brain Injury Treated in Emergency Departments in the United States, 2006–2012: Sociodemographic Characteristics

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Abstract

Objectives—To describe the frequencies and rates of MTBI ED visits, and analyze the trend across the years; and to compare sociodemographic characteristics of visits by MTBI type (i.e., MTBI as the only injury, or present along with other injuries).

Design—Population-based descriptive study using data from the Nationwide Emergency Department Sample (NEDS, 2006–2012).

Methods—Joinpoint regression was used to calculate the average annual percent changes (AAPCs) of MTBI incidence rates. Characteristics between isolated and non-isolated visits were compared, and the odds ratios were reported.

Results—The rate per 100,000 population of MTBI ED visits in the U.S. increased significantly from 569.4 in 2006 to 807.9 in 2012. The highest rates were observed in 0–4 year olds, followed by 15–24 year old males, and ≥65 year old females; the lowest rates were among 45–64 year olds. The majority (70%) of all visits were non-isolated, and occurred more frequently in residents of metropolitan areas. Falls were the leading external cause. Most visits were privately insured or covered by Medicare/Medicaid, and the injury occurred on weekdays in predominantly metropolitan hospitals in the South region.

Disclaimer

The findings and conclusions in this research are those of the authors alone and do not necessarily represent the official views or policies of the Centers for Disease Control and Prevention (CDC) or any agency of the U.S. government. Inclusion of individuals, programs, or organizations in this article does not constitute endorsement by the U.S. government.

Conflicts of Interest and Source of Funding

For all authors none were declared.

Conclusions—The burden of MTBI in U.S. EDs is high. Most MTBI ED visits present with other injuries. Awareness of sociodemographic factors associated with non-isolated MTBI may help improve diagnosis in U.S. EDs. This information has implications for resource planning and MTBI screening in EDs.

Keywords

brain injuries; brain concussion; emergency service; hospital; epidemiology

Introduction

Mild traumatic brain injury (MTBI) and concussion are interchangeable terms representing a reportedly mild, non-penetrating traumatic injury associated with a brief alteration in brain function.[1] MTBI is one of the most common neurological conditions in the world,[2] and is a serious public health problem in the U.S.[3] In 2010, a combined total of 2.5 million TBI-related emergency department visits, hospitalizations and deaths were reported. These TBIs were either an isolated injury, with TBI as the only injury, or present along with other injuries.[4] It is estimated that MTBI accounts for 80–90% of all cases of TBI in both civilian[5] and military populations.[6] MTBI is most often treated in emergency departments (EDs) or in non-hospital medical settings, or it is not treated at all.[3] While most adults and children recover within days to months, recent studies have shown that 15%–25% of these patients continue to report physical, cognitive, emotional, or behavioral symptoms up to one year post-injury.[7–11] Some people with MTBI have difficulty returning to routine daily activities and may be unable to return to work for weeks or months,[12] costing the U.S. economy an estimated $17 billion per year in 1995.[3]

To our knowledge, no nationally representative data have been used to describe the epidemiology of MTBI treated in EDs in the U.S. with the specific purpose of comparing isolated MTBIs and non-isolated MTBIs (i.e., those presenting with concurrent injuries or co-morbidities). Understanding the epidemiology and trends of MTBI treated in EDs may help design prevention and management strategies by targeting those at higher risk This information could be useful for health care resource planning and may help to improve patient outcomes. The purpose of this population-based descriptive study is to describe the frequencies and rates of MTBI ED visits, and analyze the trend across the years; and to compare sociodemographic characteristics of visits by MTBI type (i.e., MTBI as the only injury, or present along with other injuries).

Methods

Data Source

The Nationwide Emergency Department Sample (NEDS),[13] part of the Healthcare Cost and Utilization Project (HCUP), managed by the U.S. Agency for Healthcare Research and Quality,[1] was analyzed using data from January 1, 2006 through December 31, 2012. The NEDS tracks information about ED visits across the U.S. and is the largest all-payer ED database available in the country with data available beginning in 2006. Information includes geographic and patient characteristics, and the nature of visits (e.g. reasons for ED visits, acute and chronic conditions, and injuries). The NEDS was constructed using the HCUP State Emergency Department Databases (SEDD) and the State Inpatient Databases (SID). The SEDD captures discharge information on ED visits that do not result in an admission (i.e., treat-and-release visits and transfers to another hospital). The SID contain information on patients initially seen in the ED and then admitted to the same hospital. The NEDS is nationally representative consisting of 25 million to 31 million visits from more than 950 hospitals each year, representing a 20% stratified sample of EDs.

Unit of Analysis

Because the NEDS data do not contain individual identifiers, it is possible that multiple visits per patient (possibly for the same or different injury events) may be included in NEDS and counted more than once. There are not sufficient identifying data to ensure only one visit per patient. Therefore, the unit of analysis is the ED visit, not a person or patient. The numerator for the rates is the number of ED visits. Denominator data for rates were based on U.S. bridged-race population estimates of the resident population released and maintained by the Centers for Disease Control and Prevention (CDC) for individual years.[14]

Variables

Sociodemographic variables included:[15] *sex* (male, female or unknown); *age* categories (0–4, 5–14, 15–24, 25–44, 45–64, ≥65 or unknown); *external cause of injury* (motor vehicle traffic (MVT), falls, assault, struck by/against an object, other or unknown). MVT includes external cause of the injury for the occupant, motorcyclist, pedal cyclist, pedestrian, or other and unspecified person involved in a MVT incident. Up to 4 external cause of injury codes (E-codes) could be recorded per ED visit in the NEDS. The first-listed valid E-code was used to classify the external cause of injury; however, the first-listed E-code is not necessarily the principle cause of injury. *Residence* was categorized as metropolitan statistical area (MSA), non-metropolitan statistical area (non-MSA) or unknown. MSA included both large (≥1 million residents) and small metropolitan (<1 million residents) areas. Non-MSA referred to micropolitan (at least 10,000 residents) and non-urban residual areas. *Community-level income quartiles* were (1) $1-$40,999; (2) $41,000-$50,999; (3) $51,000-$66,999; (4) $67,000 or more; or unknown. *Primary payers* were Medicare/Medicaid, private, self-pay, no charge/other or unknown. Other included Worker's Compensation, Tricare (formerly known as the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS)), Civilian Health and Medical Program of Veteran Affairs (CHAMPVA), Title V, and other government programs. *ED admission day* was categorized as weekend (Saturday-Sunday), weekday (Monday-Friday) or unknown. *Teaching status* of the hospital was categorized as metropolitan non-teaching, metropolitan teaching, and non-metropolitan hospital. Non-metropolitan hospitals were not split according to teaching status, because rural teaching hospitals are rare. Finally, *hospital region* was defined as Northeast, Midwest, South, or West.

Case Identification

MTBI ED visits were identified using CDC-recommended ICD-9-CM based definition for MTBI.[3,16,17] These codes included 800.0, 800.5, 801.0, 801.5, 803.0, 803.5, 804.0, 804.5 (skull fracture), 850.0, 850.1, 850.5, 850.9 (concussion), 854.0 (intracranial injury, unspecified), and 959.01 (head injury, unspecified). Records with both mild TBI and severe (not mild) TBI diagnoses were excluded. MTBI ED visits comprised all isolated and non-isolated MTBI ED visits, defined as the following:

1. *Isolated MTBI:* records containing ≥1 MTBI ICD-9-CM codes in any of the NEDS' diagnosis fields.[16] Excluded were records containing non-MTBI injury or comorbidity-related ICD-9-CM codes (e.g., diabetes mellitus).[18]

2. *Non-isolated MTBI:* records containing ≥1 ICD-9-CM codes indicative of MTBI, comorbidities, and/or any other concurrent non-TBI injury treated during the same ED visit in any of the NEDS' diagnosis fields. This included, for example, a record containing a MTBI, and a concurrent leg fracture and/or diabetes mellitus.

Statistical Analysis

For the first objective, frequencies and rates with 95% confidence intervals (CI) were used to describe the occurrence of MTBI by year, sex, and age group. The HCUP discharge weight variable was used to produce nationwide visits-level statistics. Joinpoint regression software[19] was used to calculate the average annual percent changes (AAPCs) of MTBI incidence rates by selected characteristics during 2006–2012. AAPCs were considered significantly different from zero for p values <0.05. For the second objective, counts and percentages (95% CI) were used to describe the sociodemographic characteristics of MTBI ED visits. The chi-square test was used to compare the frequencies of these characteristics between isolated and non-isolated MTBI ED visits, and the odds ratios (OR) and 95% CIs were reported. Statistical significance was set at alpha < 0.05. All statistical analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, U.S.).

Results

The overall rate per 100,000 population of MTBI ED visits in the U.S. significantly increased from 569.4 (N=1,699,204) in 2006 to 807.9 (N=2,535,877) in 2012, with an AAPC of 7.0% (95% CI, 5.0–9.0; p=0.0002) (Table 1). Significant average annual increases were observed for both males (AAPC, 5.6%; 95% CI, 4.1–7.2; p=0.0002) and females (AAPC, 8.7%; 95% CI, 6.1–11.4; p=0.0003) (Table 1, Figure 1). Between 2006 and 2012, the AAPC significantly increased in every age group (all p<0.02). The age groups with the highest average annual rates of MTBI ED visits were 0–4 year olds (1417.7, 95% CI, 1331.0–1504.4) and 15–24 year olds (966.2, 95% CI, 924.6–1007.9); in contrast, 45–64 year olds had the lowest average annual rate (417.2, 95% CI, 398.9–435.5) (Table 1, Figure 2). Taking into account both age group and sex, the highest average annual rates of MTBI ED visits were observed in male 0–4 year olds (1592.8, 95% CI, 1494.7–1690.8), female 0–4 year olds (1234.8, 95% CI, 1159.6–1309.9), male 15–24 year olds (1127.4, 95% CI, 1079.6–1175.2), and females ≥ 65 years old (1005.0, 95% CI, 958.5–1051.6).

Overall, males had a significantly higher rate of MTBI ED visits than females (760.9, 95% CI, 729.4–792.5 vs. 622.6, 95% CI, 596.6–648.5; p<0.0001). This pattern was observed in all age groups except among those aged ≥ 65 years where females had a significantly higher rate than males (1005.0, 95% CI, 958.5–1051.6 vs. 712.3, 95% CI, 679.5–745.1; p<0.0001).

In total, during 2006 to 2012, the majority of MTBI ED visits were comprised of non-isolated MTBI (n=1,474,413; 69.6%). The aggregated annual average frequencies and percentages of MTBI ED visits, by MTBI type, and selected sociodemographic characteristics are reported in Table 2. *Sex*

Compared to females, males had a 4.0% lower odds of an ED visit for an isolated vs. non-isolated MTBI (OR, 0.960; 95% CI, 0.950–0.971; p<0.0001).

Age

Compared to 45–64 year-olds, all younger age groups had significantly higher odds of an ED visit for an isolated vs. non-isolated MTBI (all p<0.0001). The younger the age, the higher the odds of having an isolated MTBI ED visit; for example, 0–4 year olds had a nearly 7-fold increased odds of an isolated vs. non-isolated MTBI ED visit compared to 45–64 year olds (OR, 6.766; 95% CI, 6.479–7.067). In contrast, persons aged ≥ 65 years had a 44.8% lower odds of having an isolated vs. non-isolated MTBI ED visit compared to 45–64 year olds (OR, 0.552; 95% CI, 0.538–0.566).

External Cause of Injury

Falls were the most common external cause of injury for all MTBI ED visits (44.2%). Compared to MTBI by assault as a reference, those injured by other external mechanisms had a significantly higher odds of sustaining an isolated vs. non-isolated MTBI ED visit. These mechanisms include struck by/against (OR, 4.182; 95% CI, 4.064–4.304; p<0.0001), and falls (OR, 2.096; 95% CI, 2.03–2.164; p<0.0001).

Income

The frequency of MTBI ED visits was similar in all community-level income quartiles. However, persons in the lowest quartiles were significantly less likely to have an isolated vs. non-isolated MTBI ED visit (all p<0.0001). For example, compared to those in the highest income quartile, those in the lowest quartile had a significantly 21.7% lower odds of sustaining an isolated vs. non-isolated MTBI ED visit (OR, 0.783; 95% CI, 0.741–0.827).

Primary Payer

The majority of MTBI ED visits were privately insured (41.3%). Compared to those with private insurance, those with other types of insurance or no insurance had a significantly lower odds of having isolated vs. non-isolated MTBI ED visits (all p<0.001) For instance, those with Medicare or Medicaid had a 39.1% lower odds of sustaining an isolated vs. non-isolated MTBI ED visit (OR, 0.609; 95% CI, 0.590–0.629).

Non-isolated MTBI ED visits were also associated with: living in non-metropolitan areas (vs. metropolitan), injury on weekend days (vs. week days), presentation to non-teaching hospitals (vs. teaching hospitals), and presentation to hospitals in the South region.

Discussion

On average, we found that the MTBI ED visit rates in the U.S. increased significantly from 2006 to 2012 for both males and females in all age groups. The highest average annual rates of MTBI ED visits were observed in 0–4 year old males and females, followed by 15–24 year old males, and ≥ 65 year old females.

We also found that approximately 70% of all MTBI ED visits were non-isolated. Associated sociodemographic factors were: male sex; older patients (≥ 65 years); those injured by assault; non-metropolitan residence; low community-level income; non-private insurance; weekend ED admission day; and presentation to a non-teaching hospital, and to a hospital located in the South region.

Our findings agree with Marin et al who found that the rate of all TBI ED visits in the U.S. increased significantly from 2006 and 2010, with the rate being higher for males compared to females.[20] We used narrower age categories and also broke down each age category by sex, finding that females had a higher rate in the ≥ 65 year age group. One possible explanation from the literature is that fall-related injuries disproportionately affect the health and quality of life of older women.[21] Other studies suggest this could be due to lower physical activity and reduced lower body strength in older women compared to older men[22] as well as reduced bone mass in older women.[21,23]

Marin et al found that children younger than 3 years and adults older than 60 years had the largest increase in TBI rates. Our results differed somewhat and are likely due to our use of narrower age categories in combination with sex. We observed the highest average annual rates of MTBI ED visits among 0–4 year old males and females, followed by 15–24 year old males, and ≥ 65 year old females. While we found that falls are the most common external cause of MTBI ED visits for all age groups, particularly in 0–4 and ≥ 65 year olds, the literature suggests that 15–24 year olds are also commonly afflicted by assault and MVT.[24] This is especially the case for males who are presumably engaged in more risk-taking behavior than females.[25] We found that 70% of MTBI ED visits were non-isolated (i.e., occurred with other injury or co-morbidity). Similarly, Marin et al[20] found that 40% of TBI visits had at least one other injury, including wounds of the head, neck, or trunk; sprains and strains; and fractures.

Marin et al further indicated that the TBI ED visit rate was 8-fold more than the rate of increase of total ED visits during the same 2006–2010 period.[20] We agree with their proposed explanation - that the increased rate of TBI ED visits may be related to increased TBI exposure, awareness, diagnoses, or a combination. Practice patterns and a lack of alternatives for care may also be contributing to increasing ED visits. For example, people may be unable to easily access primary care at certain times. The fact that more MTBIs are presenting to U.S. EDs[20] underscores the importance of appropriate resource planning and patient management for MTBI in EDs.

The literature suggests many MTBIs are underdiagnosed in U.S. ED settings.[26–28] Thus, our estimates of isolated and non-isolated MTBI ED visits in the U.S. may be lower than the true estimates, especially for non-isolated MTBI, because it may be more likely to be missed when the head injury is not the presenting concern. On the other hand, some MTBI visits may be captured in the ED because it is other injuries that bring them into the ED and not specifically the MTBI. We do not know how undiagnosed MTBI ED visits differ from those that are diagnosed, and there are likely many factors involved (e.g., busy ED nurses and physicians, lack of resources or tools to screen for MTBI, lack of incentive to document MTBI if not relevant for reimbursement, and concurrent presenting injuries or illnesses). Nonetheless, previous studies have stressed the importance of improving the recognition of MTBI in EDs in order to provide timely and appropriate patient management and follow up, and ultimately improve patient outcomes.[2,29] Our findings support this research suggesting that ED physicians should have a higher index of suspicion of MTBI in patients with other injuries.

Certain sociodemographic factors, namely male sex, lower socioeconomic status (i.e., lower community-level income), and older age may be associated with non-isolated MTBI for the following reasons. Other literature suggests that males, especially adolescents and young adults, have higher rates of injury-related visits to EDs in the U.S. than females.[30,31] This may be due in part to presumed increased risk-taking behaviour, participation in contact sports such as American football, and alcohol consumption. Explanations from other studies suggest that alcohol consumption is associated with physical assault, falls, and MVT, and these mechanisms increase the odds of concomitant injuries.[32] Increased alcohol consumption and physical assault may also be more prominent among individuals with lower socioeconomic status. According to other studies, socioeconomic status is an important determinant of injury, e.g., blue-collar workers were found to be at significantly increased odds of nonfatal injury compared to white-collar workers.[33] Finally, other literature suggests that older adults (≥ 65 years) have higher rates of comorbidities, which may lead to falls,[30] and thus multiple injuries including MTBI.

Limitations

This study has at least four limitations. First, we may have overestimated the numbers and rates of MTBI ED visits, due to both coding issues and differences in coding practices, and the unit of analysis being the ED visit. It has been suggested that identifying MTBI cases using the CDC recommended ICD-9-CM codes is relatively inaccurate [sensitivity 45.9% (95% CI 41.3–50.2); specificity 97.8% (95% CI 97.6–97.9)].[34] Specifically, code 959.01 (unspecified head injury), which accounts for approximately 60% of all MTBI ED visit codes,[20] is associated with a high number of false positives. In our study, approximately 68% of MTBI ED visits were coded with 959.01; 67% of visits had this code only. Moreover, those with multiple injuries make up the majority of the patients with false-positive assignment of codes.[34] When we re-calculated our findings without using code 959.01, most of our observed trends remained. The main difference was that the highest average annual rates of MTBI ED visits were found in 15–24 year-old males, followed by 5–14 year-old males, and 15–24 year-old females. This suggests that MTBI may be more difficult to diagnose in the very young and older age groups. An overestimation of ED visits was also possible given that the unit of analysis was the ED visit, thus multiple visits per patient may have been included in the NEDS. Despite these limitations, it is important to note that all of the codes in the CDC definition, including 959.01 contributed to the prediction of MTBI.[34] Moreover, code 959.01 is also associated with a high number of false negatives,[34] the CDC-recommended codes have low sensitivity,[34] and a substantial proportion of MTBIs still do not result in any medical consultation at all.[1] Thus, we used the CDC- recommended codes to identify MTBI because these codes are widely used in the literature. Until future algorithms for identifying MTBI using administrative data are developed, we feel that it was appropriate to use these codes so that our results are comparable with other studies in this area.[16,20,35]

The second limitation is the potential for the misclassification of isolated and non-isolated MTBI, which is also related to coding issues. For example, it is plausible that some isolated MTBI ED visits identified were simply due to coders "missing" a concurrent injury ICD code. Similarly, more diligent coders or those more familiar with the ICD system may have been inclined to insert additional ICD codes, resulting in non-isolated MTBI ED visits. Additionally, the absence of identifiers in the NEDS precluded us from determining the extent to which a patient enters the ED with an isolated MTBI, and is then readmitted with a non-isolated MTBI, for example. Such identifiers in the data source would have allowed us to eliminate these cases from the isolated MTBI group as co-morbid conditions may readily have been missed during the initial admission. Third, given that that many MTBIs still go undiagnosed in EDs,[36] it is likely that those that are detected are potentially systematically different than those that are not. This may have biased our findings, leading us to over- or underestimate the rates of MTBI ED visits, or distort the associations between sociodemographic factors and non-isolated MTBI. Finally, our study is limited by not having data on visits to federal hospitals or on patients who died prior to arriving at the ED. While our findings should be interpreted with caution, we have used the best available data and methods to capture isolated and non-isolated MTBI ED visits, and we feel that a strength of our study is to highlight the urgent need for better diagnosis and classification of MTBI in U.S. EDs.

Conclusions

The rate of MTBI ED visits in the U.S. increased significantly from 2006 to 2012, and the majority of these visits were for non-isolated MTBI. It is likely that many MTBIs, especially non-isolated, remain largely undiagnosed in U.S. EDs and we presented a number of associated sociodemographic factors that may facilitate their detection. This information has implications for ED resource planning; as well as for MTBI education and screening processes in EDs, especially in non-teaching hospitals located in the South.

This information also has implications for primary prevention. For instance, for the groups with the highest average annual rates of MTBI ED visits (0–4 year olds, 15–25 year old males, and ≥ 65 year old females), increased primary prevention efforts could be directed toward preventing Shaken Baby Syndrome (a form of abusive head trauma and inflicted TBI),[37] falls,[38] comorbidities (e.g., hypertension and diabetes mellitus), and motor vehicle traffic incidents, especially in non-metropolitan residences.

Finally, these data have implications for government-sponsored healthcare programs which cover seniors aged 65 years and older, and certain disabled individuals (i.e., Medicare), and low-income individuals (i.e., Medicaid); all of whom may be more exposed to MTBI, and non-isolated MTBI in particular. Concurrent injuries and illnesses could complicate or delay recovery of MTBI, potentially leading to more costly ED visits and number of ED visits, not to mention higher healthcare system costs altogether.

Our findings highlight the need for future research to develop accurate algorithms for identifying and coding MTBI and comorbid conditions in the ED. Future research should also assess the use of EDs versus other health care settings for MTBI.

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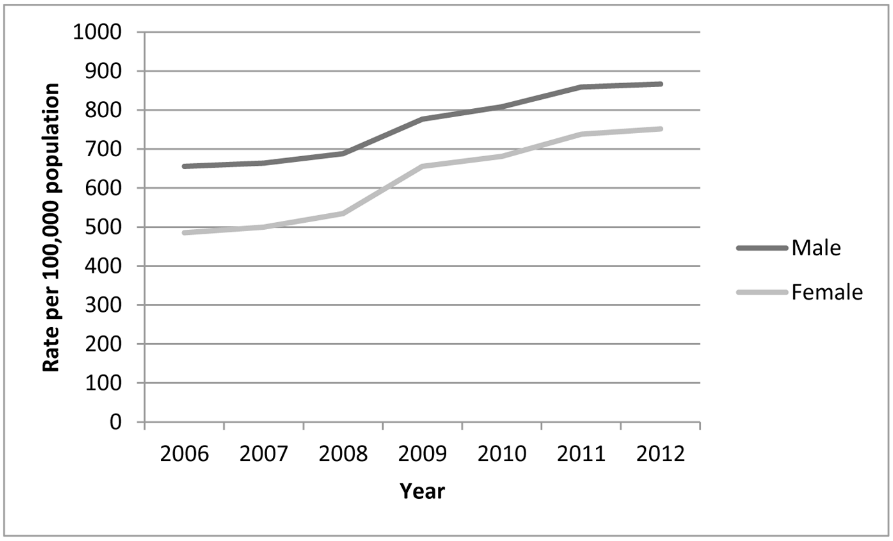

Figure 1.
Rates per 100,000 population for mTBI treated in EDs, by year and sex, U.S., 2006-2012

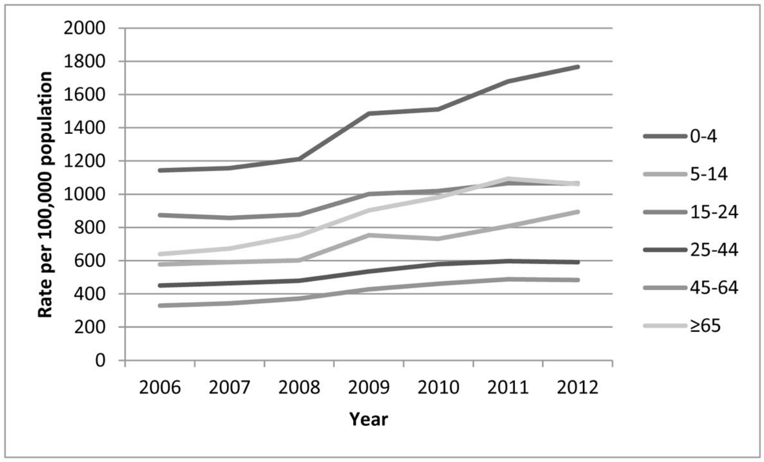

Figure 2.

Rates per 100,000 population for mTBI treated in EDs, by year and age group, U.S., 2006-2012

Table 1

Numbers and rates per 100,000 population for mTBI treated in EDs, by year, sex, and age group, U.S., 2006–2012

		2006		2012		Total (2006–2012)			
Age Group	**Sex[a]**	**No.**	**Rate (95% CI)**	**No.**	**Rate (95% CI)**	**No.**	**Rate (95% CI)**	**AAPC (95% CI)[b]**	**P value**
0–4	**Male**	134,914	1280.5 (1095.6–1465.3)	203,716	1994.9 (1749.7–2240.2)	167,744	1592.8 (1494.7–1690.8)	8.6 (6.1–11.2)	0.0003
	Female	100,668	999.0 (851.5–1146.5)	149,247	1526.4 (1339.0–1713.7)	124,417	1234.8 (1159.6–1309.9)	8.4 (5.7–11.2)	0.0004
	All	235,582	1142.9 (976.7–1309.1)	352,963	1765.7 (1549.2–1982.2)	292,162	1417.7 (1331.0–1504.4)	8.5 (5.9–11.2)	0.0003
5–14	**Male**	155,687	753.0 (666.0–840.0)	243,162	1156.7 (1033.6–1279.7)	191,812	921.5 (874.2–968.8)	7.7 (5.1–10.4)	0.0006
	Female	77,517	393.1 (347.5–438.7)	124,262	617.7 (552.7–682.7)	96,545	485.5 (460.5–510.4)	8.5 (4.9–12.3)	0.0016
	All	233,204	577.3 (510.7–643.9)	367,424	893.1 (798.7–987.5)	288,356	708.5 (672.2–744.8)	8.0 (5.0–11.0)	0.0008
15–24	**Male**	235,449	1065.8 (973.2–1158.4)	267,416	1188.2 (1085.9–1290.6)	251,876	1127.4 (1079.6–1175.2)	2.8 (1.2–4.4)	0.0070
	Female	137,750	668.1 (609.8–726.4)	199,903	932.9 (849.4–1016.5)	167,234	795.1 (759.4–830.8)	6.8 (4.3–9.4)	0.0008
	All	373,198	873.8 (798.3–949.3)	467,319	1063.7 (971.0–1156.4)	419,110	966.2 (924.6–1007.9)	4.3 (2.4–6.3)	0.0020
25–44	**Male**	221,191	530.0 (478.2–581.7)	265,374	639.4 (578.3–700.4)	245,970	591.7 (563.8–619.7)	4.0 (2.4–5.6)	0.0012
	Female	152,159	368.8 (335.8–401.8)	224,291	543.0 (494.2–591.7)	190,473	462.9 (441.6–484.1)	7.8 (5.2–10.5)	0.0005
	All	373,350	449.8 (407.9–491.8)	489,664	591.3 (536.9–645.6)	436,443	527.6 (503.3–552.0)	5.6 (3.8–7.5)	0.0005
45–64	**Male**	132,600	365.2 (330.2–400.3)	201,779	499.4 (454.3–544.4)	169,781	439.3 (419.2–459.3)	6.3 (4.6–8.0)	0.0002
	Female	112,946	295.9 (270.3–321.4)	198,975	468.8 (427.4–510.1)	160,941	396.3 (379.0–413.6)	9.3 (6.2–12.5)	0.0005
	All	245,546	329.7 (300.1–359.2)	400,753	483.7 (441.2–526.2)	330,722	417.2 (398.9–435.5)	7.7 (5.5–10.0)	0.0003
≥65	**Male**	84,464	536.2 (488.6–583.9)	156,788	832.9 (761.2–904.7)	121,887	712.3 (679.5–745.1)	9.1 (6.2–12.1)	0.0004
	Female	153,759	715.7 (651.5–779.9)	300,892	1237.2 (1126.2–1348.2)	228,255	1005.0 (958.5–1051.6)	11.1 (8.0–14.2)	0.0002
	All	238,223	639.8 (583.2–696.4)	457,680	1060.8 (967.5–1154.2)	350,142	879.3 (838.9–919.7)	10.3 (7.3–13.4)	0.0003
Unknown	**Male**	64†		39†		63			
	Female	38†		34†		69†			
	All	101†		73†		131			
All ages	**Male**	**964,368**	**655.6 (597.3–713.9)**	**1,338,274**	**866.3 (790.7–942.0)**	**1,149,133**	**760.9 (729.4–792.5)**	5.6 (4.1–7.2)	0.0002
	Female	**734,836**	**485.6 (444.0–527.1)**	**1,197,602**	**751.3 (686.8–815.8)**	**967,934**	**622.6 (596.6–648.5)**	8.7 (6.1–11.4)	0.0003
	All	**1,699,204**	**569.4 (519.9–618.9)**	**2,535,877**	**807.9 (738.3–877.6)**	**2,117,066**	**690.7 (662.2–719.3)**	7.0 (5.0–9.0)	0.0002

†The relative standard error was over 30 percent or the standard error = 0, the value of the estimate was reported, but considered unreliable.

[a]Records with missing sex were excluded.

[b]Average annual percent change (AAPC) calculated by using joinpoint regression analysis. Joinpoint analyses allowed for up to 1 joinpoint and are based on rate per 100,000 population.

Data Source: HCUP-NEDS, 2006–2012

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Table 2

Sociodemographic and epidemiological characteristics of visits to EDs for mTBI, by mTBI type, U.S., 2006–2012 (aggregated)[a]

	Isolated mTBI		Non-isolated mTBI		All Isolated and Non-isolated mTBI Total			
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)	OR (95% CI)(Isolated vs. Non-isolated mTBI)	P-value
Sex								
Male	344,343	53.6 (53.3–53.8)	804,790	54.6 (54.3–54.8)	1,149,133	54.3 (54.0–54.5)	0.960 (0.950–0.971)	<.0001
Female	298,310	46.4 (46.2–46.6)	669,623	45.4 (45.1–45.7)	967,934	45.7 (45.5–45.9)	1.0 (reference)	
Unknown	145†	0.0 (0.0–0.0)†	610†	0.0 (0.0–0.1)†	755†	0.0 (0.0–0.1)†		
Age Group (yrs)								
0–4	168,250	26.2 (25.3–27.0)	123,969	8.4 (8.0–8.8)	292,219	13.8 (13.2–14.4)	6.766 (6.479–7.067)	<.0001
5–14	142,031	22.1 (21.7–22.5)	146,407	9.9 (9.6–10.3)	288, 437	13.6 (13.2–14.0)	4.837 (4.688–4.990)	<.0001
15–24	140,346	21.8 (21.4–22.2)	278,939	18.9 (18.7–19.2)	419,284	19.8 (19.5–20.0)	2.508 (2.457–2.561)	<.0001
25–44	101,947	15.9 (15.4–16.3)	334,693	22.7 (22.3–23.1)	436,640	20.6 (20.2–21.0)	1.519 (1.496–1.542)	<.0001
45–64	55,274	8.6 (8.3–8.9)	275,571	18.7 (18.4–18.9)	330,844	15.6 (15.4–15.9)	1.0 (reference)	
65+	34,913	5.4 (5.2–5.7)	315,316	21.4 (20.9–21.9)	350,228	16.5 (16.1–17.0)	0.552 (0.538–0.5660)	<.0001
Unknown	39	0.0 (0.0–0.0)	129	0.0 (0.0–0.0)	168	0.0 (0.0–0.0)		
External cause of injury								
Motor Vehicle - Traffic	60,194	9.4 (9.1–9.7)	272,560	18.5 (17.9–19.1)	332,754	15.7 (15.2–16.2)	1.021 (0.991–1.052)	0.1818
Falls	291,833	45.4 (44.6–46.2)	643,700	43.6 (42.9–44.4)	935,533	44.2 (43.5–44.8)	2.096 (2.030–2.164)	<.0001
Assault	36,378	5.7 (5.4–5.9)	168,166	11.4 (11.1–11.7)	204,544	9.7 (9.4–9.9)	1.0 (reference)	
Struck by/against	167,515	26.1 (25.6–26.6)	185,159	12.6 (12.3–12.8)	352,674	16.7 (16.3–17.0)	4.182 (4.064–4.304)	<.0001
Other	41,295	6.4 (6.2–6.6)	127,826	8.7 (8.4–8.9)	169,121	8.0 (7.8–8.2)	1.493 (1.449–1.539)	<.0001
Unknown	45,583	7.1 (5.8–8.4)	77,613	5.3 (4.2–6.3)	123,196	5.8 (4.8–6.8)		
Residence MSA								
MSA	543,179	84.5 (83.6–85.4)	1,222,452	82.9 (82.0–83.8)	1,765,631	83.4 (82.5–84.2)	1.116 (1.067–1.167)	<.0001
Non-MSA	95,549	14.9 (14.0–15.7)	239,898	16.3 (15.4–17.2)	335,447	15.8 (15.0–16.7)	1.0 (reference)	
Unknown	4,070	0.6 (0.5–0.8)	12,673	0.9 (0.7–1.0)	16,743	0.8 (0.6–0.9)		
Community-level Income Quartile ($)								
1-$40,999	146,356	22.8 (21.6–23.9)	365,931	24.8 (23.7–25.9)	512,286	24.2 (23.1–25.2)	0.783 (0.741–0.827)	<.0001

	Isolated mTBI		Non-isolated mTBI		All Isolated and Non-isolated mTBI Total			
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)	OR (95% CI)(Isolated vs. Non-isolated mTBI)	P-value
$41,000-$50,999	154,108	24.0 (23.0–24.9)	374,991	25.4 (24.5–26.3)	529,099	25.0 (24.1–25.9)	0.804 (0.767–0.843)	<.0001
$51,000-$66,999	157,784	24.5 (23.6–25.4)	360,485	24.4 (23.5–25.4)	518,269	24.5 (23.5–25.4)	0.857 (0.824–0.890)	<.0001
$67,000 or more	172,257	26.8 (25.2–28.4)	337,093	22.9 (21.4–24.3)	509,350	24.1 (22.6–25.5)	1.0 (reference)	
Unknown	12,294	1.9 (1.7–2.1)	36,524	2.5 (2.3–2.6)	48,817	2.3 (2.1–2.5)		
Primary Payer								
Medicare/Medicaid	197,007	30.6 (29.9–31.4)	560,839	38.0 (37.5–38.6)	757,846	35.8 (35.3–36.3)	0.609 (0.590–0.629)	<.0001
Private	319,944	49.8 (48.8–50.7)	554,606	37.6 (37.0–38.2)	874,550	41.3 (40.6–42.0)	1.0 (reference)	
Self-pay	75,838	11.8 (11.3–12.2)	238,348	16.2 (15.7–16.6)	314,186	14.8 (14.4–15.3)	0.552 (0.536–0.568)	<.0001
No charge/Other	47,340	7.4 (7.0–7.7)	114,733	7.8 (7.4–8.1)	162,074	7.7 (7.3–8.0)	0.715 (0.687–0.745)	<.0001
Unknown	2,670	0.4 (0.3–0.5)	6,497	0.4 (0.4–0.5)	9,166	0.4 (0.4–0.5)		
Admission Day								
Monday-Friday	462,282	71.9 (71.8–72.1)	1,009,711	68.5 (68.3–68.6)	1,471,993	69.5 (69.4–69.6)	1.0 (reference)	
Saturday/Sunday	180,325	28.1 (27.9–28.2)	464,806	31.5 (31.4–31.6)	645,131	30.5 (30.3–30.6)	0.847 (0.841–0.854)	<.0001
Unknown	192	0.0 (0.0–0.0)	506	0.0 (0.0–0.0)	697	0.0 (0.0–0.0)		
Hospital Teaching Status								
Metropolitan non-teaching	263,616	41.0 (39.0–43.0)	640,939	43.5 (41.4–45.5)	904,555	42.7 (40.8–44.6)	1.0 (reference)	
Metropolitan teaching	287,367	44.7 (42.4–47.0)	616,116	41.8 (39.4–44.1)	903,483	42.7 (40.5–44.9)	1.134 (1.052–1.223)	0.0012
Non-metropolitan	91,815	14.3 (13.3–15.3)	217,969	14.8 (13.7–15.8)	309,784	14.6 (13.6–15.6)	1.024 (0.973–1.078)	0.3652
Hospital Region								
Northeast	162,457	25.3 (23.2–27.4)	284,639	19.3 (17.7–20.9)	447,096	21.1 (19.4–22.8)	1.0 (reference)	
Midwest	146,177	22.7 (21.1–24.4)	348,660	23.6 (21.9–25.4)	494,838	23.4 (21.7–25.0)	0.735 (0.671–0.804)	<.0001
South	199,955	31.1 (28.9–33.3)	545,139	37.0 (34.7–39.3)	745,094	35.2 (33.0–37.3)	0.643 (0.589–0.701)	<.0001
West	134,210	20.9 (19.4–22.4)	296,584	20.1 (18.7–21.5)	430,794	20.3 (19.0–21.6)	0.793 (0.727–0.865)	<.0001

[†] The relative standard error was over 30 percent or the standard error = 0, the value of the estimate was reported, but considered unreliable.

[a] Weighted estimates and (95% confidence intervals)

Data Source: HCUP-NEDS, 2006–2012

\\cdc\project\NCIPC_DARPI_SPEB_Stats\Help\Victor\mTBI\Report\Table2b.sas