**Patterns of Pediatric Mandible Fractures in the United States**

James A. Owusu, MD; Emily Bellile, MS; Jeffrey S. Moyer, MD; James D. Sidman, MD

**IMPORTANCE** The mandible is arguably the most frequently fractured facial bone in children. However, facial fractures are rare in children compared with adults, resulting in few large studies on patterns of pediatric facial fractures.

**OBJECTIVE** To report the patterns, demographics, and cause of pediatric mandible fractures across the United States.

**DESIGN, SETTING, AND PARTICIPANTS** A retrospective analysis was conducted of the Healthcare Cost and Utilization Project’s National Emergency Department Sample from January 1 to December 31, 2012, using the International Classification of Disease, Ninth Revision, codes for mandible fractures (802.20-802.39) among patients 18 years and younger who presented to emergency departments. Demographics, fracture site, and fracture mechanism were analyzed to identify factors associated with fractures. Analysis was conducted from July 9 to July 28, 2015.

**RESULTS** There were 1984 records, representing a weighted estimate of 8848 cases of pediatric mandible fracture. The mean patient age was 14.0 years (95% CI, 13.6-14.3). The male to female ratio was 4:1 and females were comparatively younger, with a mean age of 12.5 years (95% CI, 11.8-13.1; P < .001). The most frequently fractured sites were the condyle, in 1288 patients (14.6% [95% CI, 12.6%-16.5%]), and the angle, in 1252 patients (14.1% [12.4%-15.9%]). Associated intracranial injuries occurred in 756 patients (8.5% [7.1%-10.0%]), and cervical spine fractures occurred in 393 (4.4% [3.5%-5.4%]). The fracture site and mechanism of injury varied with age and sex. For patients 12 years and younger, the most frequent fracture site was the condyle, accounting for 636 fractures (27.9% [24.2%-31.6%]), and the most frequent cause was falls, accounting for 692 fractures (30.3% [25.9%-34.8%]). In teenaged patients (13-18 years), the angle was the most frequent fracture site, accounting for 1157 fractures (17.6% [15.6%-19.6%]), and the most frequent cause was assault, accounting for 2619 fractures (39.9% [36.4%-43.3%]). For male patients, the angle was the predominant site, accounting for 1053 fractures (15.0% [13.1%-16.8%]), and the leading cause was assault, accounting for 2360 fractures (33.5% [30.2%-36.9%]). For female patients, the condyle was the most frequent site, accounting for 369 fractures (20.3% [16.0%-24.6%]), and the leading cause was falls, accounting for 422 fractures (23.2% [18.6%-28.0%]).

**CONCLUSIONS AND RELEVANCE** In this study, age and sex disparities among pediatric mandible fractures were identified. Younger patients and female patients tend to have condyle fractures caused more commonly by falls while older patients and male patients tend to have angle fractures caused by assault.

**LEVEL OF EVIDENCE** NA.

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Facial fractures are a rare occurrence in children compared with adults. However, traumatic injuries account for significant morbidity and mortality in children. Recent data from the Centers for Disease Control and Prevention report trauma as the leading cause of pediatric mortality in the United States. Anatomical differences between the craniofacial skeleton of adults and children contribute to the differences in the rate of facial fractures. In young children, the cranium accounts for a higher proportion of the craniofacial skeleton than in adults and the cranium protects the facial skeleton from trauma. The cranium to face ratio is 8:1 at birth and decreases to 2.5:1 in adulthood. Thus, the risk of facial fractures increases with age owing to the increasing proportion of the facial skeleton. In addition, children in general are less likely to be involved in activities associated with traumatic injuries seen commonly in adults.

The mandible is the most commonly fractured facial bone in children. In an analysis of the National Trauma Data Bank by Imahara et al, the mandible accounted for 32.7% of all facial fractures in children. Given the rarity of pediatric facial fractures, most studies on this subject have been limited to single institutional experiences. A broader understanding of the cause and epidemiological characteristics of facial fractures in children will help improve prevention and management strategies.

Sponsored by the Agency for Healthcare Research and Quality, the Healthcare Cost and Utilization Project (HCUP) has gathered the largest collection of longitudinal hospital care data in the United States, to our knowledge. These data have enabled studies on conditions that could not previously be easily studied at the national level. The purpose of this study was to examine the cause and epidemiological characteristics of pediatric mandible fractures using the 2012 HCUP Nationwide Emergency Department Sample (NEDS). The 2012 NEDS contains 31 million records from a 20% stratified sample of hospital-based emergency departments (EDs). Weights are provided in the database to allow calculation of national estimates. The NEDS does not contain any identifiable patient information.

### Results

The 2012 NEDS estimates 8848 pediatric ED visits for mandible fractures from an unweighted frequency of 1984 records in a complex survey sample. This number represents 0.03% of the 6,848,951 records of pediatric ED visits in the NEDS. Table 1 summarizes the characteristics of children in the 2012 NEDS with mandible fractures. The mean age at the time of presentation was 14.0 years (95% CI, 13.6-14.3). Most fractures (6570 [74.3%]) occurred in children between the ages of 13 and 18 years. Fractures were most common in males, with a male to female ratio of 4:1. The mean age in females (12.5 years [95% CI, 11.8-13.1]) was significantly lower than in males (14.3 years [95% CI, 14.0-14.7]) (P < .001). Most patients (2864 [32.4%]) fall within the lowest household income group.

The leading etiologies of mandible fractures included assault (2663 [30.1%]), falls (1519 [17.2%]), and MVC (1141 [12.9%]). The cause of injury varied with age and sex (Table 2). Falls caused 691 fractures (30.3%) in the younger age group (<12 years), followed by MVC (368 [16.1%]). Assault was the leading cause of fractures in the older age group (13-18 years), accounting for 2619 fractures (39.9%). The leading causes of fractures in females were falls (422 [23.2%]) and MVC (400 [22.0%]). In males, the leading cause of fractures was assault (2360 [33.5%]).

The most common anatomic sites of fractures were the condyle, in 1288 patients (14.6% [95% CI, 12.6%-16.5%]), younger (primary dentition) were combined into 1 group with those aged 7 to 12 years (mixed dentition). The second group consisted of patients aged 13 to 18 years (secondary dentition). The primary and mixed dentition groups were combined to comply with the HCUP data use agreement that prohibits reporting categories with fewer than 10 records. Likewise, owing to their low numbers, coronoid fractures were combined with unspecified fractures to comply with the HCUP data use agreement. Associated cervical spine and intracranial injuries were identified using Clinical Classification Software codes. This software is used by HCUP to conglomerate clinically relevant ICD-9 codes in diagnostic groups. The Clinical Classification Software codes 233 and 231 (ICD-9 codes 805.00-805.18) correspond with intracranial injury and cervical spine fractures, respectively. Analysis was conducted between July 9 and July 28, 2015.

Weighted statistics for national estimates with 95% CIs were calculated using the discharge weights, strata, and cluster elements of the sampling design provided in the database for a domain analysis of the subset of pediatric mandible fractures. Age and sex were compared across fracture type and cause of injury using linear and logistic regression models, respectively, adjusted for the complex survey design (PROC SURVEYREG and SURVEYLOGISTIC procedures in SAS). All statistical analyses were performed using SAS, version 9.4 (SAS Institute).

### Methods

Following approval from the University of Michigan Institutional Review Board, we analyzed mandible fractures recorded in the 2012 NEDS (data from January 1 to December 31, 2012). Records of children 18 years and younger were selected using the International Classification of Diseases, Ninth Revision (ICD-9), codes for mandible fractures (802.20-802.39). The database included the following mechanism of injuries: motor vehicle collision (MVC), assault, and falls. Sports injuries were determined using ICD-9 Ecode (E8494) and other causes of injury were categorized as other. The mechanism of injury and fracture type (anatomical site) were analyzed by age and sex. For age group analysis, patients were stratified into 2 categories based on dentition development. Patients 6 years and
and angle, in 1252 patients (14.1% [95% CI, 12.4%-15.9%]). Fracture site varied with age and sex (Table 2). In the younger age group, the predominant fracture site was the condyle (636 [27.9%]), with a small proportion occurring elsewhere. In the older age group, the most frequent fracture site was the angle (1157 [17.6%]), followed by the condyle (652 [9.9%]) and ramus (623 [9.5%]). Average age varied across fracture sites (Figure). The mean age among patients with condyle and alveolar fractures was significantly lower than that of all other fracture sites. Sex-based analysis showed that the 2 leading fracture sites in both sexes were the condyle and angle. In males, condyle fractures accounted for 13.1% (n = 919) and angle fractures for 15.0% (n = 1053) of all mandible fractures. In females, condyle fractures accounted for 20.3% (n = 369) and angle fractures for 10.9% (n = 199). The proportion of females in the condyle fracture cases (28.6% [95% CI, 23.6%-35.3%]) was significantly higher than the expected 20% observed in the overall mandible fracture subset.

The location of the fracture was related to the cause. Angle fractures were most frequently caused by assault (633 [50.6%; 95% CI, 43.5%-57.8%]), whereas condyle fractures were commonly caused by falls (401 [31.1%; 95% CI, 25.2%-31.7%]).

Associated cervical spine and intracranial injuries were seen in 1149 of the patients (13.0%). The most predominant was intracranial injury, which was associated with 756 fractures (8.5% [95% CI, 7.1%-10.0%]); cervical spine fractures were seen in 393 patients (4.4% [95% CI, 3.5%-5.4%]). Most intracranial injuries occurred in the children with condyle (147 [19.5%; 95% CI, 12.6%-26.4%]) or angle (81 [10.7%; 95% CI, 5.9%-15.5%]) fractures.

**Discussion**

Prior studies on pediatric facial fractures have been limited to single institutional experiences.4,6-8 Our study presents a

### Table 1. Characteristics of Children With Pediatric Mandible Fractures

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Male</th>
<th>Female</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, weighted No. (% [95% CI])</td>
<td>7035 (79.5 [77.5-81.5])</td>
<td>1813 (20.5[18.5-22.5])</td>
<td></td>
</tr>
<tr>
<td>Age, mean (95% CI), y</td>
<td>14.3 (14.0-14.7)</td>
<td>12.5 (11.8-13.1)</td>
<td></td>
</tr>
<tr>
<td>Annual household income, US $, weighted No. (% [95% CI])&lt;sup&gt;6&lt;/sup&gt;</td>
<td>145 (1.6 [1.0-2.3])</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>1-38 999</td>
<td>2864 (32.4 [29.4-35.4])</td>
<td></td>
</tr>
<tr>
<td>39 000-47 999</td>
<td>2157 (24.4 [22.1-26.7])</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 000-62 999</td>
<td>2078 (23.5 [21.1-25.9])</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥63 000</td>
<td>1605 (18.1 [15.3-20.9])</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> P < .001.

<sup>b</sup> These numbers do not total 8848 owing to rounding.

### Table 2. Frequencies of Fracture Sites and Causes of Injuries

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Weighted No. (% [95% CI])</th>
<th><strong>Male</strong></th>
<th><strong>Female</strong></th>
<th><strong>Age ≤12 Years</strong></th>
<th><strong>Age 13-18 Years</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fracture Site</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condyle</td>
<td>919 (13.1 [11.1-15.0])</td>
<td>369 (20.3 [16.0-24.6])</td>
<td>636 (27.9 [24.1-31.6])</td>
<td>652 (9.9 [8.2-11.6])</td>
<td></td>
</tr>
<tr>
<td>Subcondyle</td>
<td>400 (5.7 [4.4-6.9])</td>
<td>93 (5.1 [2.9-7.3])</td>
<td>172 (7.5 [5.0-10.1])</td>
<td>182 (8.0 [5.7-10.3])</td>
<td></td>
</tr>
<tr>
<td>Ramus</td>
<td>667 (9.5 [7.9-11.0])</td>
<td>138 (7.6 [4.9-10.4])</td>
<td>182 (8.0 [5.7-10.3])</td>
<td>623 (9.5 [7.8-11.1])</td>
<td></td>
</tr>
<tr>
<td>Angle</td>
<td>1053 (15.0 [13.1-16.8])</td>
<td>199 (11.0 [7.9-14.0])</td>
<td>95 (4.2 [2.4-5.9])</td>
<td>1157 (17.6 [15.6-19.6])</td>
<td></td>
</tr>
<tr>
<td>Symphysis</td>
<td>220 (3.1 [2.1-4.1])</td>
<td>66 (3.6 [1.8-5.5])</td>
<td>61 (2.7 [1.2-4.1])</td>
<td>225 (3.4 [2.4-4.4])</td>
<td></td>
</tr>
<tr>
<td>Alveolar</td>
<td>257 (3.6 [2.5-4.8])</td>
<td>101 (5.6 [3.1-8.0])</td>
<td>176 (7.7 [4.3-11.1])</td>
<td>182 (2.8 [1.9-3.6])</td>
<td></td>
</tr>
<tr>
<td>Body</td>
<td>416 (5.9 [4.5-7.3])</td>
<td>82 (4.5 [2.5-6.7])</td>
<td>68 (3.0 [1.4-4.5])</td>
<td>430 (6.5 [5.2-8.0])</td>
<td></td>
</tr>
<tr>
<td>Multiple sites</td>
<td>550 (7.8 [6.1-9.5])</td>
<td>129 (7.1 [4.8-9.5])</td>
<td>146 (6.4 [4.1-8.7])</td>
<td>533 (8.1 [6.3-9.9])</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>2553 (36.3 [33.5-39.0])</td>
<td>635 (35.0 [29.5-40.5])</td>
<td>742 (32.6 [27.7-37.4])</td>
<td>2447 (37.2 [34.3-40.2])</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7035 (100)</td>
<td>1813 (100)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2278 (100)</td>
<td>6570 (100)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

| **Cause of Fracture** | | | | |
| MVC | 741 (10.5 [8.4-12.6]) | 400 (22.1 [17.7-26.3]) | 368 (16.1 [12.4-20.0]) | 772 (11.7 [9.6-13.9]) |
| Assault | 2360 (33.5 [30.2-36.9]) | 303 (16.7 [12.6-11.0]) | 45 (2.0 [0.6-3.4]) | 2619 (39.9 [36.4-43.3]) |
| Falls | 1097 (15.6 [13.4-17.8]) | 422 (23.3 [18.6-28.0]) | 691 (30.3 [25.8-34.8]) | 827 (12.6 [10.4-14.7]) |
| Sports injuries | 490 (7.0 [5.5-8.4]) | 77 (4.2 [2.2-6.3]) | 106 (4.7 [2.5-6.8]) | 461 (7.0 [5.5-8.5]) |
| Other | 2348 (33.4 [29.7-37.0]) | 610 (33.6 [29.0-38.3]) | 1068 (46.9 [41.4-52.3]) | 1890 (28.8 [25.2-32.4]) |
| Total | 7035 (100)<sup>a</sup> | 1813 (100)<sup>a</sup> | 2278 (100) | 6570 (100)<sup>a</sup> |

Abbreviation: MVC, motor vehicle collision.

<sup>a</sup> These numbers do not sum to the total owing to rounding.
been reported by Hoppe et al.4 occurred at a younger age, a finding that has previously
Our analysis also revealed a predominance in males, which
activities associated with trauma and accidental injuries.10 Younger children are also typically
protected from high-risk activities through close adult
spine injuries; children presenting with mandible fractures
should be carefully assessed for these injuries. National
database analyses, such as those presented in our study,
play an essential role in the creation of diagnostic, treat-
ment, and prevention protocols for rare pediatric injuries.

Conclusions
Significant age and sex disparities exist in the patterns and
cause of pediatric mandible fractures. Fractures predomin-
antly occur in older male children, with assault as the main
mechanism of injury. The main causes of mandible frac-
tures in females and younger children are falls and MVCs. Fractures can be associated with intracranial and cervical
spine injuries; children presenting with mandible fractures
should be carefully assessed for these injuries. National
data base analyses, such as those presented in our study,
play an essential role in the creation of diagnostic, treat-
tment, and prevention protocols for rare pediatric injuries.

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integrity of the data and the accuracy of the data analysis.
Study concept and design: Owusu, Moyer, Sidman.
Acquisition, analysis, or interpretation of data:
Owusu, Bellille, Moyer.
Drafting of the manuscript: Owusu, Sidman.
Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Owusu, Bellille, Sidman.
Administrative, technical, or material support:
Moyer, Sidman.
Study supervision: Moyer, Sidman.

Conflicts of Interest Disclosures: None reported.

REFERENCES
3. Imahara SD, Hopper RA, Wang J, Rivara FP, Klein MB. Patterns and outcomes of pediatric facial
207(5):710-716.
4. Hoppe IC, Kordahi AM, Paik AM, Lee ES, Granick MS. Age and sex-related differences in 431 pediatric
5. Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality. What is the
Nationwide Emergency Department Sample


