



# Volleyball-related Adult Maxillofacial Trauma Injuries: A NEISS Database Study

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**Introduction:** Craniofacial trauma among athletes of various sports has been well detailed and described. Despite this research, there is a dearth of literature describing the nature of facial trauma secondary to volleyball, despite its global popularity.

**Methods:** A cross-sectional analysis of volleyball-related facial trauma was conducted using the National Electronic Injury Surveillance System (NEISS) database from 2009 to 2018. Patient demographics (age, sex, and race), medical injury information (injury type and location), and disposition (observed and discharged, admitted, deceased) were collected and analyzed.  $\chi^2$  testing was performed to compare categorical variables.

**Results:** A total of 235 volleyball-related facial traumas were recorded with an estimated 10,424 visits occurring nationally. The majority of injuries were among young adults aged 20 to 29 years (52.3%) and was evenly distributed for men and women. Lacerations were the most frequent injury type (37.9%), whereas the face was the most common site of injury (41.7%). The majority of fractures involved the nose (71.4%) and among individuals aged 20 through 49 (90.5%). Males had significantly more lacerations than females (75.3% vs 24.7%), whereas females had significantly more contusions/abrasions (64.5% vs 35.5%) and concussions (72.9% vs 27.1%).

**Conclusions:** Volleyball-related craniofacial injuries can vary depending on patient demographics. This information can help with the development of safety and preventative measures for individuals participating in the sport.

**Key Words:** Craniofacial trauma, maxillofacial trauma, NEISS, sports injuries, volleyball

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Facial trauma among athletes in major sports has been well-documented in the United States. Participation in sports has been attributed to 3% to 29% of all facial traumas and between 10% and 42% of all facial fractures each year.<sup>1</sup> Among baseball, soccer, and hockey players, facial injuries described as lacerations, contusions, and fractures were the most common presentations.<sup>2–4</sup> Despite the well-documented incidence of sports-related facial trauma, volleyball trauma has little comparable studies while an estimated 500 million people play volleyball globally.<sup>5</sup>

Volleyball is one of the most popular sports among adolescents and young adults in the United States. In high school participants, volleyball is the second most popular sport for women with 452,808 players.<sup>6</sup> Volleyball also ranks as the fifth most common sport among female athletes in the National Collegiate Athletic Association (NCAA), with 17,780 players, behind outdoor and indoor track, soccer, and softball (Student-athlete participation). Although men's volleyball has low participation relative to other NCAA sports, the sport has doubled in active athletes since the 2000/2001 season.<sup>7</sup> With the popularity of women's volleyball and the rapid growth of men's volleyball, the prevalence of volleyball-related injuries is likely to rise.

Despite volleyball rules that limit player contact, concussions are still common.<sup>8,9</sup> This is largely due to ball-contact related injuries that account for approximately 10% of volleyball-related injuries and 31% of ball-contact injuries were located on the head or face.<sup>10</sup> Head and facial traumas make up a low proportion of overall volleyball-related injuries.<sup>11,12</sup>

Several studies have investigated volleyball-associated injuries; however, most studies are designed toward subpopulations such as pediatric,<sup>13,14</sup> NCAA athletes,<sup>8,15</sup> or professional athlete<sup>16</sup> populations. Furthermore, these studies often focus on nonfacial injuries, such as upper<sup>17</sup> and lower<sup>18</sup> extremities or back.<sup>19</sup> There has not been a comprehensive study analyzing volleyball-associated craniofacial traumatic injuries in the general adult population. This study aims to describe volleyball-associated craniofacial traumatic injuries presenting to emergency departments (EDs) in the United States by patient demographics, type, anatomical location, and disposition.

## METHODS

An analysis of volleyball-related trauma was conducted using the National Electronic Injury Surveillance System (NEISS). The NEISS database collects information from approximately 100 EDs under the United States Consumer Product Safety Commission and provides data extrapolated to a nationally representative sample. NEISS data consist of demographics (age, sex, and race), medical injury information (diagnosis and injury location), and a description of the event. The NEISS database was queried for

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volleyball-related head and facial injuries from years 2009 to 2018 based upon the methods of previous studies.<sup>6,15,20</sup>

Data for each event were collected in Excel (Microsoft, Washington) by age (further stratified into age groups: 20–29, 30–39, 40–49, 50–59, and ≥60 years of age), injury type (concussion, contusion/abrasion, dental injury, fracture, and laceration), and injury location (head, eyeball/globe, face [eyelid, eye area and nose], neck, mouth [lips, tongue, and teeth], and ear). Injuries confined to a single anatomical location (ie, concussion and dental injury) were excluded from corresponding analyses.

$\chi^2$  testing was performed to compare categorical variables, with a Bonferroni correction applied in post-hoc analysis, using IBM SPSS 25<sup>th</sup> version software (Armonk, NY). Statistical significance for *P* values was considered <0.05 (*P* < 0.05).

NEISS qualifies as a nonhuman research source of public, anonymized data. Philadelphia College of Osteopathic Medicine’s (Philadelphia, Pennsylvania) institutional review board (IRB) policy considers this research exempt from IRB review.

### RESULTS

From 2009 to 2018, two hundred and thirty-five (n = 235) volleyball-related facial trauma ED visits were recorded in the NEISS database with an estimated 10,424 (95% confidence interval: 6158–14,690) visits occurring nationally. ED visits tended to decrease annually across the 10-year period, with 488 being the lowest reported visits in 2013 (Fig. 1A).

The majority of injuries were among young adults 20 to 29 years of age, encompassing 52.3% of the sample. Conversely, older adults aged ≥60 years comprised the lowest (6%) volume of ED visits. The demographic makeup of the study population was evenly male and female (49.4% and 50.6%, respectively). White patients were the majority of participants (51.9%); however, race was not

reported in 30.6% of patients. Among injury types, lacerations were the most frequent (37.9%), with contusions/abrasions and concussions also being common (26.4% and 25.1%, respectively). The face was the most common site of injury (41.7%), followed by the head (35.7%). “Other” injury locations (neck and ear injuries) were the least frequent (3.8%). The majority (97.6%) of patients evaluated in the ED and subsequently released (Table S1, <http://links.lww.com/SCS/B779>).

Injury type appeared to be related to injury location. In regards to lacerations, the face was the most commonly affected site (67.4%). Lacerations were significantly less likely to involve the globe (2.2%) and mouth (16.9%). Contusions/abrasions commonly involved the globe (35.5%), face (32.3%), and head (27.4%). The vast majority of fractures involved the face (85.7%) (Table S2, <http://links.lww.com/SCS/B779>). Further stratifying of fractures by location was performed; however, statistical analysis was not conducted due to the small sample size (n = 21). The majority of fractures involved the nose (71.4%) and were among individuals aged 20 through 49 (90.5%). Fractures involving the midface (9.5%), cervical spine (9.5%), mandible (4.8%), and skull (4.8%) were far less common (Fig. 1B).

Although age did not significantly influence injury type or location (data not shown), these patterns were affected by sex. Males had significantly more lacerations than females (75.3% vs 24.7%), whereas females had significantly more contusions/abrasions (64.5% vs 35.5%) and concussions (72.9% vs 27.1%) (Table S3, <http://links.lww.com/SCS/B779>). Males were more likely to sustain injuries to the face (60.2% vs 39.8%), whereas females were more likely to sustain injuries to the head (67.9% vs 32.1%). This was largely driven by the higher frequency of concussions in females (Table S4, <http://links.lww.com/SCS/B779>).

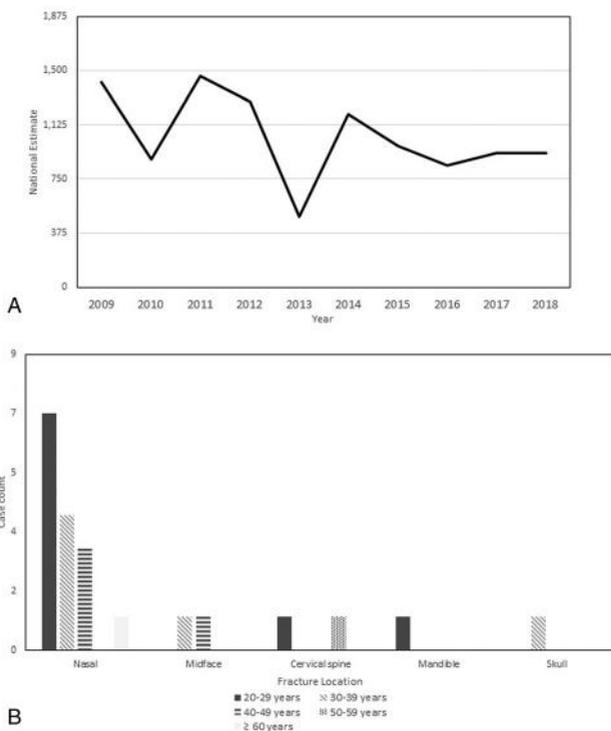
### DISCUSSION

The increasing popularity of volleyball demands a greater understanding of facial trauma incurred while playing this sport. Among NCAA athletes, facial protection is not required and thus not commonly used by participants,<sup>20,21</sup> despite efforts to improve player safety with protective facial shields.<sup>22</sup>

The incidence of ED visits due to volleyball-related facial traumas occurred mostly in the 20 to 29 years of age group. This may be expected due to the high volume of college-aged individuals and college graduates participating in the sport.<sup>23</sup> A majority of lacerations occurred on the face, supporting the practicality of protective facial shields. Preventive equipment (ie, facial shields) is appropriate for volleyball, as well as other sports, given the frequency of lacerations observed in basketball, soccer, baseball, and hockey.<sup>2,4,24,25</sup> Men incurred significantly more lacerations than women; however, the reason for this remains unknown. One could propose that men engage in more violent, aggressive behavior while playing sports.<sup>31</sup>

Contusions and abrasions occurred in similar proportions to the face, head, and globe. Given the high demand for hand-eye coordination in volleyball, ocular damage may increase the time for return to play, but does not often lead to long-term complications.<sup>26,27</sup> Contusions and abrasions occurred more frequently in women than men in the cohort, but men and women received overall injury to the globe at the same frequency.

Fractures most often occurred to the face, more specifically the nose. Among all sports-related facial fractures, the nose, mandible, and orbit have been documented as being the most common.<sup>28</sup> Such fractures require immediate evaluation and management from a sideline physician. Nasal fractures may lead to gross deformity and airway obstruction.<sup>29</sup> Although most athletes are capable of returning to play within 3 weeks, complex fractures may warrant



**FIGURE 1.** (A) National estimates of annual volleyball-related head and neck injuries (2009–2018). (B) Distribution of head and neck fractures by fracture location and age group.

prolonged recovery time.<sup>30</sup> Further research into sports-related facial fractures is needed to evaluate recovery time.

This study is the first of its kind to evaluate maxillofacial trauma in the setting volleyball injuries. As such, providers can utilize patient-specific patterns to better build comprehensive profiles and management plans for patients presenting with various types of injuries following volleyball participation. We found that young adults aged 20 to 29 years were the most likely to be injured playing volleyball, with an equal sex distribution. Lacerations were the most frequent injury type; however, sex distributions varied on the most common type of injury. Males had significantly more lacerations than females, whereas females had significantly more contusions/abrasions and concussions (72.9% vs. 27.1%). Nasal fracture was by far the common type of fracture.

The authors acknowledge several limitations; NEISS does not provide information that may enhance the conclusions of this study. Aspects of the injury setting (competitive game, practice, or recreational) or use of safety equipment are unknown. Certain outcomes, such as lacerations, contusions, or mild concussions, may be unreported as the injury may not have warranted an emergency department visit for treatment. Fractures, however, are likely to be seen by a health care worker, but may present at a primary care provider instead of the emergency department. Additionally, the database reports facial injuries as involving the head, face (including the eyelid, eye area and nose), eyeball/globe, mouth (including the lips, tongue, and teeth), neck, and ear. There is significant cross-over with these structures which potentially impacted the analyses of the study. The specific nature and context of the injuries may increase or decrease presentation at the emergency department.<sup>31</sup> Thus, our results likely underreport volleyball-related facial trauma.

## CONCLUSIONS

The growing popularity of volleyball warrants further analysis of sports-related injuries. This study describes such injuries to the craniofacial region presenting to emergency departments. The most common type of injury were lacerations and most injuries involved the face. As safety precautions and equipment are considered for use in volleyball, physicians must understand how to provide sideline and emergency care to those sustaining facial trauma injuries. Facial trauma experts, such as otolaryngologists or plastic surgeons, can assist in the design and implementation of protective equipment.

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