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Incidence of metacarpal fractures in the US population

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Abstract
Background There are scarce data regarding the epidemiology of metacarpal fractures within the US population. The purpose of this study is to report the epidemiology of metacarpal fractures in the USA using the National Electronic Injury Surveillance System Database (NEISS).
Methods The NEISS database represents a national probability sample of approximately 100 hospitals in the USA and its territories. The database was queried for metacarpal fractures during the time period 2002–2006. US census data were used to calculate incidence rate (IR) for various demographic criteria.
Results A total of 4,718 metacarpal fractures were identified, representing approximately 160,790 metacarpal fractures. The calculated IR was 13.6 (95 % CI, 13.6–13.67) per 100,000 person-years. The highest IR occurred in the 10–19 age group (IR 38.8; 95 % CI, 38.6–38.9) followed by those 20–29 years of age (IR 28.4; 95 % CI, 28.3–28.5). Metacarpal fractures were found more commonly in males (IR 23; 95 % CI, 22.9–23.1) than females (IR 4.5; 95 % CI, 4.5–4.5), with an incidence rate ratio of 5.08. The most common mechanisms of injury were contact with a wall or door, and falls. The most common setting was in the home, followed by recreational locations.
Conclusions The estimated incidence of metacarpal fractures presenting for acute hospital care in the USA is 13.6 per 100,000 person-years. Males in the second and third decades of life sustain this injury most commonly. Metacarpal fractures occur frequently in the home or recreational setting, with contact force as the primary mechanism of injury.

Keywords Metacarpal fracture · Epidemiology · Mechanism of injury

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Introduction

Fractures of the metacarpals are some of the most common orthopedic injuries seen in emergency departments. Despite this, there are little published data on the epidemiology of metacarpal fractures. The two most common mechanisms of injury include accidental fall and direct blow [1]. According to data from the 1998 National Hospital Ambulatory Medical Care Survey, metacarpal fractures make up 18 % of all forearm and/or hand fractures occurring in the USA [1]. A prospective study of 1,129 patients with hand fractures found that 12.2 % of all hand fractures involved a metacarpal bone [4]. Another study from Amsterdam retrospectively examined all emergency visits in 1996, finding that 19 % of all fracture visits included hand fractures, with 33 % of these being fractures of metacarpal bones [4]. De Jonge et al. performed a retrospective analysis of 3,858 metacarpal fractures seen over a 23-year period in a Netherlands-based institution, finding that men aged 10–29 had the highest incidence of metacarpal fractures (2.5 %) [2]. They found

that bicycle accidents in particular accounted for the vast majority of metacarpal fractures across all demographic variables in their study, while accidental fall was the mechanism of injury over a bimodal distribution of age groups less than 9 or older than 50 years old.

The purpose of this study was to characterize the epidemiology of metacarpal fractures across the US population, using the National Electronic Injury Surveillance System (NEISS) database, and compare these results to those cited in previous studies. The secondary purpose of the study was to describe specific demographic factors that predispose patients to a heightened risk of metacarpal fractures, such as age, gender, and mechanism of injury.

Materials and Methods

The NEISS database is maintained by the Consumer Product Safety Commission (CPSC), with the primary aim to provide information about injury trends associated with consumer products [9]. This database represents a national probability sample of approximately 100 hospitals in the USA and its territories, where patient information is collected for each presentation to the emergency department with an injury. The hospitals enrolled in the NEISS database were selected based on criteria such as hospital size, number of emergency department visits, and geographical region, in order to provide a balanced demographic and socioeconomic dataset. Each hospital participating in the NEISS reporting process is stratified by the number of emergency room visits per year, and the hospital sample pool includes both adult and children's hospitals, trauma centers, and community hospitals in both rural and urban areas. Each patient visit is assigned a weighted value based on the particular hospital's geography and volume, allowing extrapolation of individual visits to a probability weighted sample within the US population. A standard query of this database reports the following data per patient visit: date, sex, age, race, product (s) involved, locale, body part, diagnosis, and disposition, along with an individual case number, treatment date, and weighted value for each case. The NEISS database has been used extensively to analyze injury epidemiology using US population census data, for which the dataset is specifically configured as well as trends in consumer product-related injuries [3, 5, 11].

We performed a query of the NEISS database using data from 2002 through to 2006 for all hand fractures using the diagnosis code “fracture” and the body part “hand.” The resultant data were then manually searched for metacarpal fractures within the narrative or free-form description of the injury. Inclusion criteria for statistical analysis included any record with a specific diagnosis of “metacarpal” or “boxer's” fracture. We excluded patient records that involved hand fractures other than metacarpal fractures and all records that did not have complete demographic data. The total number of records from the initial query was 15,936 resulting in isolation of 4,770 metacarpal fractures. Of these, the total number of records meeting inclusion criteria was 4,718, representing a weighted value of 160,790 individual metacarpal fractures over the 5-year period of the query.

This study was approved as exempt from institutional review board approval, as no identifiable human subjects were involved.

Results

A total of 4,718 patients meeting inclusion criteria presented with metacarpal fractures during the time period from 2002 through to 2006. Weighted data estimates indicate this represents an estimated 160,790 metacarpal fractures nationwide. According to US Census Bureau data, the estimated US population during this period averaged 1,180,339,726 [8]. This represents an estimated incidence rate (IR) of 13.6 metacarpal fractures per 100,000 person-years (95 % CI, 13.6–13.67) (Table 1). For comparison, there were 15,936 hand fractures reported during this period, resulting in an estimated 604,478 hand fractures. This represents an IR of 29.7 hand fractures per 100,000 person-years (95 % CI 29.7, 29.8). Based on this information, metacarpal fractures made

Table 1 Summary of NEISS metacarpal fracture data

Age		Raw number of injuries	Weighted number of injuries
0–9	Males	112	3,927
	Females	64	2,677
10–19	Males	1,826	72,682
	Females	227	8,334
20–29	Males	1,097	50,778
	Females	169	8,202
30–39	Males	509	22,318
	Females	111	4,713
40–49	Males	254	11,740
	Females	63	2,823
50–59	Males	87	3,686
	Females	59	2,841
60–69	Males	21	1,008
	Females	34	1478
70–79	Males	15	749
	Females	34	1,633
80–89	Males	9	479
	Females	23	1,094
≥90	Males	1	30
	Females	3	74

up 33.3 % of all hand fractures reported during the 5-year period 2002–2006.

Analysis of gender relation to incidence shows that males made up 83.2 % of the sample, while females encompassed 16.8 %. The IR for males was 23 (95 % CI, 22.94–23.08) compared to 4.5 for females (95 % CI, 4.5–4.5). The incidence rate ratio (IRR) for gender was 5.1, with females as the referent.

Regarding age group distribution, peak incidence occurred during the second (ages 10–19) and third (ages 20–29) decades of life (Fig. 1). The IR of metacarpal fractures during the second decade was 38.8 (95 % CI, 38.6–38.9) compared with 28.4 (95 % CI, 28.3–28.5) in the third decade. The IRR for those in the second decade was 18.3 compared to 13.4 for those in the third decade, using the age group ≥90 as the reference group. The difference in IRR between these decades was significant ($p<0.5$).

The most common mechanism of non-sports-related injury was contact with a wall occurring in a weighted estimate of 43,751 injuries (IR of 3.7; 95 % CI, 3.7–3.7), contact with a door in 8,543 injuries (IR of 0.7; 95 % CI, 0.7–0.7), and falling downstairs in 8,609 injuries (IR 0.7, 95 % CI, 0.7–0.7) (Table 1). In order to account for any bias in the weighted analysis, it is important to note that the unweighted "raw" data mirror this weighted estimate: contact with a wall ($n=1,301$), contact with a door ($n=283$), and falling downstairs ($n=238$) matched the same patterns of occurrence. Analysis of fractures related to aggressive actions revealed that punching or hitting objects resulted in an estimate of 41,748 injuries with an IR of 3.5 (95 % CI, 3.5–3.6).

The majority of fractures occurred at home, representing a weighted total of 78,131 injuries (38.8 %). The second most common location was a recreational setting (13 %). Injury location was not recorded for 35 % of all metacarpal fractures. A total of 558 (11.8 % of all fractures) fractures occurred during recreational activities, representing an estimated 26,220 fractures. The most numerous sports-related injuries occurred while playing basketball ($n=306$; weighted estimate, 12,709), playing football ($n=257$; weighted estimate, 9,726), and bicycling ($n=224$; weighted estimate, 9,774) (Table 2).

For each additional decade in men, the odds of metacarpal fracture are 19 % lower (odds ratio, 0.8; 95 % CI, 0.8–0.8). For each additional decade for women, the odds are 60 % lower (odds ratio, 0.4; 95 % CI, 0.4–0.4). The interaction between age and sex is significant ($p<0.0001$), suggesting that the combination of younger age and male sex is the highest risk for metacarpal fracture.

Discussion

The epidemiology of metacarpal fractures has been reported primarily in single institutions or regions only. Ip et al. noted that in 765 patients with 924 hand fractures, 12.2 % were metacarpal fractures [4]. Their analysis reported the mode of injury, with crush injuries comprising 62.1 % of their fractures, followed by falls and saw injuries; however, these were reported for all hand injuries, and the mechanisms of injury specific to metacarpal fractures could not be extrapolated.

A review of metacarpal fracture etiology in the Netherlands found men within the ages of 10–29 to have the highest IR for metacarpal fracture (2.5 %), with an overall male/female ratio of 1.8 [2]. This study involved a 23-year retrospective review of 235,427 emergency department

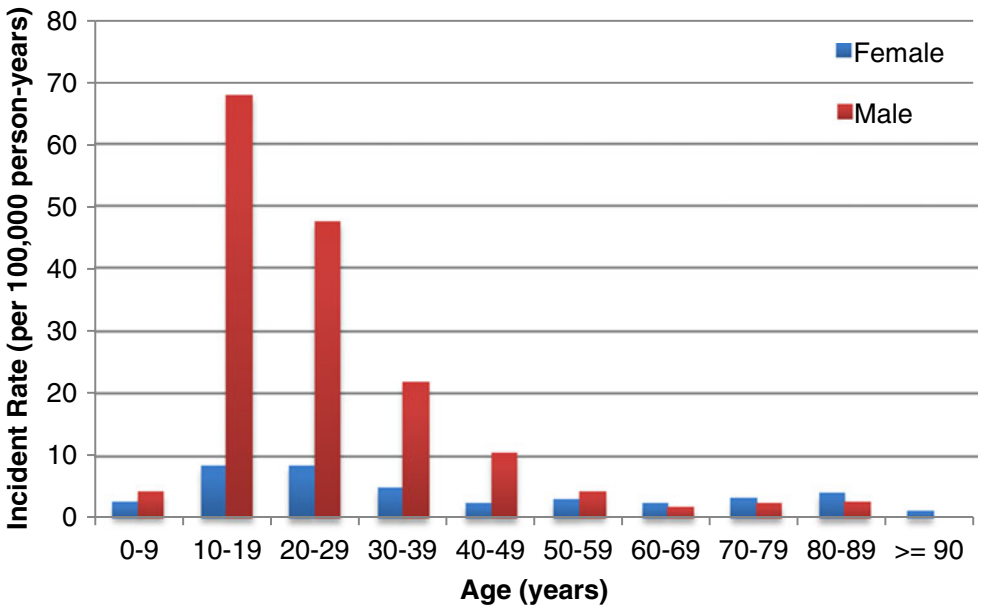

Fig. 1 Incidence rate by gender and age

Table 2 Injuries by mechanism of metacarpal fractures

Mechanism/ object of injury	Raw number of injuries	Weighted number of injuries
Wall	1,301	56,009
Basketball	306	12,079
Door	283	11,157
Football	257	9,726
Bicycle	224	9,774
Stairs	238	10,636
Baseball	101	4,499
Floor	114	5,032
Table	86	3,838
Boxing	79	3,497
Carpet	12	512
Handrail	8	225
Pole	7	453

visits, of which 3,858 were metacarpal fractures. They found that accidental fall was the most likely mechanism of injury for patients <9 and >50 years old, while transportation method (moped and bicycle) was a major risk factor for all ages. Another epidemiological study in the same region showed that 283 (33 %) of 855 hand fractures presenting over 1 year were metacarpal fractures, with two thirds occurring on the right hand [10].

Stanton and colleagues evaluated patients presenting with hand fractures over a 6-month period in their institution, finding that metacarpal fractures were most common (47 %), with the majority involving the fifth metacarpal [6]. The most common site of metacarpal fracture was the metacarpal neck in all but the retirement group, wherein diaphyseal and basal fractures were most common.

Our data support most of these previous reports, with some variability. We used an emergency department-based database capable of estimating incidence within the US population to characterize the epidemiology of metacarpal fractures presenting for acute care. The overall incidence during the 5-year period from 2002 to 2006 was 13.6 (95 % CI, 13.6–13.67) per 100,000 person-years. Our results show that the peak incidence of metacarpal fractures is within younger age groups, with the highest incidence in the second, followed by the third, decade. There was a predominance of metacarpal fractures in males (82.3 %) compared to females (16.8 %). When stratified by age and gender, the highest incidence of metacarpal fractures occurred in males during the second decade.

We report an overall IR of 13.7 metacarpal fractures per 100,000 person-years, comprising 33 % of all hand fractures within the US population—less than the 47 % reported by Stanton, but similar to the findings in the Netherlands [7, 10]. Younger age and male gender are the factors most associated with these injuries. The most common sporting activities related to metacarpal fractures were basketball, bicycling, and football. The most frequently reported mechanisms were falls and direct impacts. These findings suggest a need for protective equipment and public education regarding outlets for aggression. While it would be difficult to utilize safety equipment to limit the occurrence of metacarpal fractures in "hand-dominant" sports requiring manual dexterity such as basketball or football, it may be possible to protect cyclists or other non-manual athletes with such equipment, thereby limiting fractures in these groups. Aggressive activities including punching or hitting a wall accounted for a high rate of metacarpal fractures in this analysis, particularly in males in the second decade (Table 3). While potentially difficult to implement, an educational program about prevention of common hand fractures, as part of health education in the high-risk adolescent groups, could potentially reduce the number of metacarpal fractures suffered in the overall US population.

This study has limitations, most of them due to database reporting issues. The NEISS database is driven by emergency room encounters in a nationwide hospital sample and does not account for metacarpal fractures presenting to walk-in clinics and private physician offices, or not presenting for treatment. We therefore likely illustrate an underestimate of the actual incidence of metacarpal fractures. In addition, many patient encounters lacked complete reporting of demographic data. Injury location was not reported for 35 % of encounters, and injuries at work are not specifically stratified. Further improvement in the NEISS reporting system should focus on complete data-field reporting. Other limitations include inability to report open vs. closed fracture types, which are not separately stratified unless noted in the narrative field. These data are based on coding for hand fracture only, necessitating manual analysis of typed descriptive reports to isolate metacarpal-specific fractures. It is possible, therefore, that

Table 3 Metacarpal fractures due to impact/punch

Age	Males	Females	Total
0–9	5	–	5
10–19	571	48	619
20–29	382	49	431
30–39	107	20	127
40–49	53	5	58
50–59	8	–	8
60–69	2	–	2
70–79	–	–	–
80–89	–	–	–
90+	–	–	–
Total	1,128	122	1,250

some metacarpal fracture reports were missed if the descriptive terms were unusual, not using typical terminology (i.e., metacarpal, boxer's, etc.). Finally, there were no radiographic data, so the particular metacarpal or metacarpals fractured were not clearly identified.

The assumption that the NEISS database represents the entire US population is paramount to the validity of these data. The model employed by the CPSC to create the NEISS database makes its information more valuable than single-center data as it correlates to a cross section of the US population. This represents a strength of this report, in that use of the NEISS data has been validated for analysis. These data therefore likely provide a more accurate analysis of overall metacarpal fractures in the USA than either single- or multi-institution studies.

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