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# Epidemiology, Etiology, Timing and Severity of Open Fracture - a Five Years Review From a Tertiary Trauma Center, Eastern Province, Saudi Arabia

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## ABSTRACT

**Background:** Open fractures are severe injuries resulting from the bone breaking through the skin, and they have a negative impact on patients' physical, mental, and financial well-being as well as that of the healthcare system. The incidence of open fractures varies globally. These injuries can lead to prolonged disability, increased healthcare costs, and psychological distress. The Gustilo-Anderson classification system is used to classify open fractures into three categories which surgeons use as an index for the severity of an injury and as a prognostic tool. Management involves a multidisciplinary approach, focusing on preventing infection, promoting wound healing, and restoring function. **Objective:** The objective of this study is to provide statistics on the epidemiology of open fractures presented to the emergency department to be used later to create management protocols. **Methods:** This 5-year retrospective observational analysis of open fracture patients at King Fahad Hospital, a tertiary trauma care institute in Alkhobar from 2018-2023, aimed to understand socio-demographics, injury mechanisms, fracture patterns, and timing. Data were collected electronically, and found 373 cases which were reviewed, and only 138 open fractures fit our inclusion and exclusion criteria and were added to the study. **Results:** The study analyzed 138 openly fractured bones in 132 patients aged 2 to 68. Most bones affected were in the lower extremities, the most common being the forefoot bones. The most common mode of injury was a motorbike, followed by MVA. The most common Gustilo type was type 2, with no significant correlation between gender and severity. Musculoskeletal system injury was the highest associated system. Furthermore, we observe a slight increase in cases in Winter/Fall weather seasons. **Conclusion:** Total amount of 84.8% of patients with open fractures are men, compared to 15.2% of women. The average age of patients is  $25.6 \pm 15.6$  years. Motorbike accidents, then MVA, are the two leading causes of open fractures. Weather seasons, especially in fall and winter, may also contribute to an increase in open fractures. We found that type 2 is the most common Gustilo type among the injured bones (59.1%).

**Keywords:** Epidemiology, Open fracture, Severity, Saudi Arabia.

## 1. BACKGROUND

Open fractures are a serious injury that occurs when the bone breaks its way into the outside environment. These types of fractures are severe types of injury that can have significant consequences for patients and the healthcare system (2). These injuries require immediate medical attention and can result in long-term complications if not managed appropriately. This review aims to emphasize the impact of open fractures on patients and the healthcare system, including the economic burden and long-term outcomes, by knowing its epidemiology, etiology, timing, and severity in our region.

Worldwide open fracture incidence was estimated to be 11.5 per 100,000 person-years. However, the incidence varied widely between regions and countries, ranging from 2.0 to 48.6 per 100,000 person-years (1). However, in our hospital, according to a study conducted between 2004-2009, open fractures were found to be surprisingly 47.22% of all fractures (2).

Open fractures can significantly impact patients, including physical, psychological, and financial consequences. Physical consequences can range from mild pain and discomfort to severe disability and amputation. Psychological consequences include anxiety, depression, and post-traumatic stress

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disorder (PTSD). The financial burden of open fractures can be significant, with direct costs including hospitalization, surgery, and rehabilitation and indirect costs such as lost wages and productivity.

- Regarding the Physical impact, Long-term outcomes can also be significant after open fractures. Complications such as infection, delayed union, and non-union can result in prolonged disability and increased healthcare costs. A study by Ovaska et al. (2019) found that patients with open fractures had a higher risk of developing osteomyelitis and non-union, leading to increased healthcare costs and decreased quality of life (3).
- The psychological impact should also be taken into account; Grosdanis et al. in 2017 found that patients with open fractures had higher levels of psychological distress than those with closed fractures. The psychological distress was most pronounced in patients who had undergone surgery and those with longer hospital stay (4).
- Additionally, important is the financial impact on the healthcare system. These injuries require immediate medical attention and can result in prolonged hospital stays, multiple surgeries, and extended rehabilitation. The economic burden of open fractures on the healthcare system is substantial. A study by Court-Brown et al. (2015) estimated that the average cost of an open fracture in the United Kingdom was £8,800, with a total annual cost of £63 million (1).

Classification of open fractures based on the severity of the injury and the degree of soft tissue damage. The most commonly used classification system for open fractures is the Gustilo-Anderson classification, first introduced in 1976. This classification system is based on the size of the wound, the degree of soft tissue injury, and the extent of contamination (5). The Gustilo-Anderson classification divides open fractures into three categories: first, Gustilo-Anderson type I is the least severe category of open fractures, and the wound size is usually less than 1 cm in diameter. There is minimal soft tissue damage, and the bone is usually minimally or not exposed. Second, Gustilo-Anderson type II: This category includes fractures with a wound size greater than 1 cm in diameter, moderate soft tissue damage, and variable degrees of contamination. The bone is usually exposed, but there is enough soft tissue remaining to cover the bone. Third, Gustilo-Anderson type III: This category includes the most severe open fractures, with a wound size greater than 10 cm in diameter, extensive soft tissue damage, and significant contamination. The bone is usually extensively exposed, and there may be damage to major blood vessels and nerves. There are also subtypes within the Type III category that takes into account the extent of the soft tissue injury and contamination which is Type A. There is Type B which include those fracture which has significant soft tissue damage that needs a soft tissue flap to cover it. Finally, Subtype C means involvement in a Vascular component injury, specifically an arterial component.

The management of open fractures involves a multidisciplinary approach and is aimed at preventing infection, promoting wound healing, and restoring function. The treatment plan depends on the severity of the injury and the extent of soft tissue damage (6). The general principles of management for open fractures:

- a). Early administration of antibiotics: Intravenous antibiotics should be administered as soon as possible after injury to reduce the risk of infection.
- b). Wound irrigation and debridement: The wound should be irrigated with sterile saline and debrided to remove any foreign material, devitalized tissue, and contaminants.
- c). Stabilization of the fracture: The fracture should be stabilized using external fixation, internal fixation, or a combination of both, depending on the severity of the injury.
- d). Soft tissue coverage: Large soft tissue defects may require coverage with local flaps, regional flaps, or free tissue transfer.
- e). Rehabilitation: Rehabilitation should begin as soon as possible to prevent stiffness and muscle atrophy.

To better equip ourselves as care providers when dealing with open fractures, it's important to have knowledge of their prevalence in different regions, the underlying causes, and the typical severity of cases. This study was conducted to address this need for information.

## 2. OBJECTIVE

The objective of this study is to provide statistics on the epidemiology of open fractures presented to the emergency department to be used later to create management protocols.

## 3. MATERIAL AND METHODS

### 3.1. Study Design

This was a five-year (from January 1, 2018, to March 31, 2023) hospital-based retrospective analysis of a single-center study.

### 3.2. Settings

Records of patients with open fractures who presented acutely and got admitted and managed at King Fahad Hospital of Imam Abdulrahman University, which is a tertiary trauma care institute in Alkhobar City with 400 beds.

### 3.3. Participants

The patient inclusion criteria were as follows:

- An open fracture patient of any age.
- Cases who are eligible have been admitted through Emergency.
- At least three months of follow-up or follow-up until the fracture healed or a complication developed.

We excluded patients with the following:

- Hand fracture beyond carpal bone or rib fracture since our department has not managed it.
- Patients with less than three months of follow-up.
- In/Out transferred patient.
- Patients who did not agree to surgical management.

Bio-Demographic	Number	Percent	Range	Mean±SD
<b>Age (in years)</b>	132		68-2	25.6 ± 15.6
<b>Gender</b>				
Male	111	80.4		
Female	21	15.9		
<b>Nationality</b>				
Saudi	97	73.5		
Non Saudi	35	26.5		
<b>Side</b>				
Right	70	50.7		
Left	68	49.3		

**Table 1. Bio-demographic data of the participants.**

Data concerning the socio-demographics, clinical history, physical findings, radiological impression, mechanism of injury, fracture pattern, type of open fracture, and follow-up were obtained from the patient's files. Ethical clearance and informed consents were obtained. Our institute's Institutional Review Board (IRB), King Fahad Hospital of Imam Abdulrahman Bin Faisal University Number (IRB-PGS-2023-01-199). The authors followed applicable EQUATOR Network guidelines during the conduct of this research project. The electronic records of patients treated for open fractures after admission were assessed. Data concerning the socio-demographics, mechanism of injury, fracture pattern, type of open fracture, and follow-up were obtained from the patient's files. Pre-structured data collection forms ensured uniformity in the data collected.

#### 3.4. Study Size

We retrospectively reviewed 373 patients, regardless the age with open fractures, who underwent operative management.

#### 3.5. Statistical methods

Google Docs was used to collect the data. The data were entered into Microsoft Excel, revised, cleaned, coded, then analyzed using Statistical Package for the Social Sciences Software, version 26 (IBM SPSS Statistics 26). Descriptive analysis based on frequency and percentage was performed for all variables, including the demographic data of the participants; Additionally, the Pearson Chi-Square test was used to measure the significant association between the gender and Gustilo types. The measurements are significant at a 5% level of significance ( $p < 0.05$ ).

## 4. RESULTS

The initial data collection shows 373 openly fractured bones, only 138 of them met the inclusion criteria and were added for analysis. A total of 138 bones were injured in 132 patients, 112 (84.8%) males and 20 (15.2%) females aged between 2 and 68 years (Mean age 25.6), mean age for males is (25.31±16.03) and females (20.3±13.09). Regarding their nationality, 97 (73.5%) were Saudi, the vast majority, while 35 (26.5%) were non-Saudi. When considering the Laterality or side of the fracture,

Bone Injured	Number	Percent
Upper Extremity	32	23.2
Clavical+Scapula	1	0.7
Humerus	7	5.1
Both bone Forearm	14	10.2
Radius	5	3.6
Ulnar	5	3.6
Lower Extremity	106	76.8
Femur	6	4.4
Patella	5	3.6
Tibia (+fibula)	36	26.1
Fibula	1	0.7
Ankle	4	2.9
Talus	2	1.4
Calcaneus	8	5.8
Midfoot	1	0.7
Forefoot	43	31.2

**Table 2. Percentage and count of the bone injured from upper and lower extremity.**

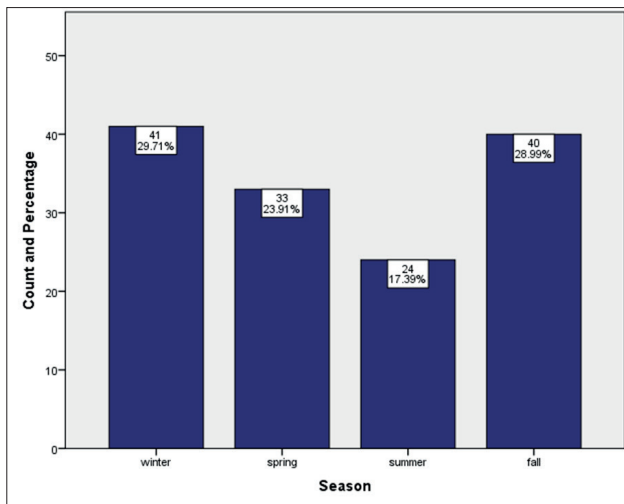
most patients were injured on the right side 70 (50.7%), followed by the left side 68 (49.3%) (Table 1).

The number and percentage of bones injured were categorized into upper and lower extremities; most of the open injuries in our study were in the lower extremities 106 (76.8%), being the most bones segment injured were forefoot (including phalanges and Metatarsals) 43 cases (31.2%), followed by tibia 36 (26.1%), and calcaneus 8 cases (5.8%). In contrast, only one injury in the Midfoot makes it the lowest segment to be injured. While in the upper part, 32 bones (23.2%) were injured in the upper extremity, the forearm was the most bone openly injured from the upper extremity 14 (10.2%), followed by the humerus 7 (5.1%) and radius 4 (2.9%). In contrast, the least bones injured openly are the clavicle and scapula (Table 2).

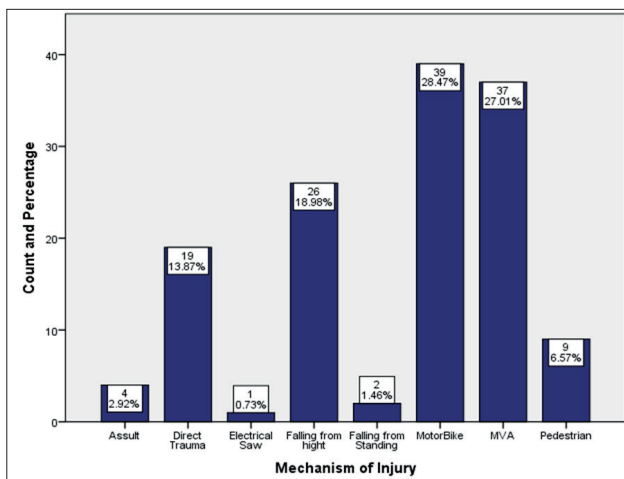
We analyzed the number of cases during each season based on the weather, and it was found that the winter season (December-February) had the highest number of cases. The fall season (September-November) had a significantly high number of cases as well, followed by the spring season (March-May). The summer season (June-August) had the lowest number of cases. (as shown in the Figure 1).

In terms of how the injuries were caused, we discovered that the majority of them, 28.47%, were due to motorbike accidents. This was followed by motor vehicle accidents at 27.01% and falling from a height due to work-related risks or suicide at 18.96%. On the other hand, the least common cause of injury was from an electrical saw at 0.7%, which was also work-related (see Figure 2).

We used the Gustilo Classification and the involvement of other systems to measure or evaluate the severity, and we found that type 2 is the most common Gustilo type among the injured bones 81 (59.1%); it is



**Figure 1.** shows the season of winter witnessed the highest number of cases, with fall and spring following suit. Conversely, summer had the lowest count of cases.



**Figure 2.** shows Through our analysis, we have determined that motorbike accidents were the leading cause of injuries, accounting for 28.47% of all incidents. Motor vehicle accidents followed closely behind, contributing to 27.01% of the injuries. Falling from a height, whether due to work-related hazards or suicide, was the third most common cause at 18.96%. Conversely, work-related injuries caused by an electrical saw were the least common, accounting for a mere 0.7% of all cases.

much higher than the prevalence of other Gustilo types 1 (9.4%), 3A (13.8%), 3B (2.9%), and 3C (15.2%). We also tried to look for any significant difference between gender and severity, which did not show any correlation. We also found that most had no associated injury involvement 78 (59.9%), but in those with an association injury musculoskeletal system was the highest associated system, followed by head injury.

## 5. DISCUSSION

In our Institute during 2021, open fracture is about 0.5% of all emergency admissions. Open fractures have been reported in the literature to be commoner in males than females (1, 7). We observed in our study that male patients considered 84.8% and 15.2% females, and the ratio male to female was 5.3:1. This finding is explained by the fact that males are generally more prone to injuries due to exposure to risky activities (7, 10).

The average age of patients in this study was  $25.6 \pm 15.6$  years. This average age is higher than  $23 \pm 1.5$  years reported by Arti et al. but lower than 36.4, 38.08 years, and 45.5 years recorded by Odatuwa-Omagbemi et al, Kombate et al, and Court-Brown et al. respectively (9, 11, 12). However, the last three studies were carried out in adult populations of 15 years and above, which might partially explain the higher mean age reported. It could be because this age group is attracted to motorbike transportation which considers the first reason causing an open fracture in our study. Court-Brown et al (12), in their 15-year review, show that the finger phalanges are the commonest bone to have an open fracture, followed by tibia and fibula. Since in this study, we exclude hands fractures, the commonest open fracture appeared to be in the forefoot, which includes phalanges and metatarsals, followed by Tibia (+/- Fibula). Which we believe is due to the barefoot tendency that still exists in our culture, especially during camping.

Regarding the mechanism of injury, studies in our country still show that the number one reason to have a fracture or an open fracture is a motor vehicle accident (2, 13). In our study, motorbike and motor vehicle accidents are the cause of open fractures in more than half of the cases.

As has been observed subjectively in our department, Weather seasons have been considered as an influence in increasing the number of fractures in general, specifically in the fall and winter seasons (September–February) when the temperature drop below that 35C degree in the morning when the population around the city favors the weather for outdoor activity.

This study shows that the commonest type of Gustilo classification is Type II, which is about 57.8% similar to Court-Brown et al. (1). from the UK; they observed that most of their cases were Type II open fractures as well. However, our institute by Sadat et al (2). reported that from 2004-2009 the commonest Gustilo Type was I, which was about 55.5% of all open fractures, which may indicate that there has been an increase in severity since then. In the literature (12), a different percentage in the association of open fractures with other injuries has been reported. In one of the studies, 75.9% of the sample has isolated open fractures. On the other hand, our study shows that only 59.9% were isolated.

### Limitation of the study

Our retrospective study aimed to describe the epidemiological aspects of open fractures in our country. However, we must note that its limitations include its retrospective nature and small sample size. Nonetheless, this study provides valuable insights into the prevalence of this condition in our population.

## 6. CONCLUSION

Open fractures have a significant impact on the health of patients and healthcare institutes. The management of these fractures has been a challenge for orthopedic and trauma surgeons, as well as other physicians who treat fractures, since ancient times. This continues to be the case today. Open fractures pose an increased risk of



contamination, infection, fracture non-union and mal-unions, delayed union, neurovascular complications, increased amputation rate, prolonged morbidity, mortalities, and other complications, depending on the level of tissue damage. In order to reduce the risk of infection and improve outcomes, open fracture statistics can have a substantial impact on patient health and healthcare institutes. The epidemiology of open fractures can be better understood to aid healthcare professionals in creating efficient prevention and management plans.

Abbreviations: MVA-Motor vehicle accident, ATLS-Advanced Trauma Life Support, IRB-, Institutional Review Board

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