



## Original Article

## The epidemiology of traumatic musculoskeletal injuries in Kuwait: Prevalence and associated risk factors

Meshal A. Alhadhoud, MBBCh<sup>a</sup> and Najla F. Alsiri, PhD<sup>b,\*</sup>

<sup>a</sup> Orthopedics Department, Al-Adan Hospital, Ahmadi Governorate, Kuwait

<sup>b</sup> Medical Rehabilitation Department, Al-Razi Orthopedics and Rehabilitation Hospital, Capital Governorate, Kuwait

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### المخلص

**أهداف البحث:** تعتبر الاستكشافات الوبائية للإصابات التصادمية بمثابة معايير أساسية للتخطيط المستقبلي للتحكم في التحديات متعددة الأبعاد. ويتمثل الغرض من الدراسة في وصف الانتشار الوبائي للكسور التصادمية في الكويت بما في ذلك انتشار الخطر والعوامل المرتبطة به.

**طرق البحث:** تمت مراجعة قاعدة بيانات الالتحاق في جراحة العظام الخاصة بمركز الصدمات من المستوى الثاني في الكويت بأثر رجعي اعتباراً من يناير 2018 إلى فبراير 2020. وتم استكشاف الكسور التصادمية في العمود الفقري والأطراف العلوية والسفلية.

**النتائج:** تضمنت الدراسة 564 مريضاً يعانون من 788 إصابة تصادمية بمتوسط عمر 35.91 (النطاق الربيعي 18.87) سنة؛ وكان منهم 78% ذكور و43% كويتيون. وكانت كسور العمود الفقري الأكثر انتشاراً بنسبة 21.7%، تليها كسور قصبية الساق بنسبة 11.3% وكسور راسغ القدم بنسبة 10.2%. وكانت حوادث الطرق هي السبب الرئيس للإصابة بنسبة 37.9% تليها حوادث السقوط والسقوط من المرتفعات بنسبة 29.3% و 16.8% على التوالي. وتم تحديد عوامل الخطر بما في ذلك آلية الإصابة والجنسية والعمر. تُعرض حوادث الطرق لكسور في العمود الفقري والكتف والترقوة والعضد والحوض والخذن والقصبية والشظية بشكل مستديم ويُعرض السقوط للكسور الكعبرية والزندية والخذنية وكسور في الرضفة بشكل مستديم، كما يُعرض السقوط من المرتفعات لكسور القدم ورسغ القدم. ويُعرض الكوييتيون لخطر الإصابة بكسور العمود الفقري والعضد والحوض والخذن، في حين أن غير الكوييتيين معرضون لخطر الإصابة بكسور المفصل الكتفي والكتف والكوع والزند والكعبرة والخذن والرضفة وقصبية الساق والشظية والقدم ورسغ القدم. ويعد العمر من 19-49 سنة هو الأكثر عرضة لخطر كافة أماكن الكسور.

**الاستنتاجات:** تم التعرف على البيانات الوبائية للإصابات التصادمية في الكويت لتوجيه الاستراتيجيات الوقائية وخطط الرعاية الصحية.

**الكلمات المفتاحية:** كسور؛ الطرف السفلي؛ معدل الانتشار؛ العمود الفقري؛ الطرف العلوي

### Abstract

**Objectives:** Epidemiological explorations of traumatic injuries are essential to provide benchmarks for future planning to address multidimensional challenges. The study aimed to describe the epidemiology of traumatic musculoskeletal injuries in Kuwait, including their prevalence and associated risk factors.

**Methods:** The Orthopedic Admission Database of a level II trauma center in Kuwait was retrospectively reviewed from January 2018 to February 2020. Traumatic fractures of the spine and upper and lower limbs were explored.

**Results:** The study included 564 patients with 788 traumatic injuries who were 33.0 (23.0) years of age (median and interquartile range): 78.0% were male, and 43% were Kuwaitis. Spinal fractures were the most prevalent injury, at 21.7%, followed by tibial fractures, at 11.3%, and ankle fractures, at 10.2%. Road traffic accidents were the leading mechanism of injury, at 37.9%, followed by falling over and falling from height, at 29.3% and 16.8%, respectively. Risk factors included injury mechanism, nationality, and age ( $p < 0.05$ ). Road traffic accidents were at risk for sustaining spinal, scapular, clavicle, humeral, pelvic, hip, tibial, and fibular fractures; those for falling over were radial, ulnar, femoral, and patellar fractures; and those for falling from height were foot and ankle fractures. Kuwaitis were found to be at risk of

\* Corresponding address: Al-Razi Orthopedics and Rehabilitation Hospital, Capital Governate, Kuwait.

E-mail: [dr.alsiri@outlook.com](mailto:dr.alsiri@outlook.com) (N.F. Alsiri)

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spinal, humeral, pelvic and femoral fractures, whereas non-Kuwaitis were found to be at risk of scapular, shoulder, elbow, ulnar, radial, hip, patellar, tibial, fibular, foot, and ankle fractures. The age range of 19–49 years was associated with the highest risk for all fracture sites.

**Conclusion:** Epidemiological characteristics of traumatic injuries in Kuwait have been determined to guide preventive strategies and healthcare planning.

**Keywords:** Fractures; Lower limb; Prevalence; Spine; Upper limb

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## Introduction

Traumatic orthopedic injuries are considered a major health epidemic, posing challenges of high morbidity, mortality, and socioeconomic burden.<sup>1,2</sup> Traumatic orthopedic injuries account for 10% of deaths worldwide and are the leading cause of death among people younger than 65 years of age.<sup>3–6</sup> The associated cost places a tremendous economic burden on the healthcare sector. The average cost of an injury is EUR 31,900,<sup>7</sup> mainly composed of medical and related costs of diagnostic services including surgical consultation and x-rays, conservative and operative treatment, the length of hospital stay, and related costs of productivity loss due to death or disability.<sup>4–8</sup> More importantly, the management of traumatic orthopedic injuries is challenging and complex, and requires high resource utilization.<sup>4,9–11</sup>

The epidemiology of traumatic fractures varies considerably among populations. The calculated fracture incidence is 4.6 fractures per 100 people per year.<sup>12</sup> Generally, traumatic fractures are more prevalent among women than men, at 66%.<sup>13</sup> In England, the annual prevalence of fractures is 3.6%.<sup>12</sup> Road traffic accidents (RTAs) as a mechanism of injury are more prevalent in developed countries, whereas falling incidents are more prevalent in developing countries.<sup>14</sup> A meta-analysis has estimated the incidence rate of traumatic spinal injuries in the Eastern Mediterranean region to be 5.2 per 100,000 people.<sup>14</sup> In Kuwait, the identified prevalence rate of spinal fractures is 28.72%, whereas in Iran, cervical fractures are more prevalent in people approximately 37 years of age and in men, with a prevalence rate of 75.2%.<sup>14,15</sup> Peripheral fractures such as ankle and distal forearm fractures are common; however, most epidemiological studies have focused on hip fractures. For example, in Finland, the prevalence of hip fractures has been reported to be 1.1% for women and 0.7% for men over 70 years of age.<sup>16</sup> However, in Kuwait, the prevalence of pelvic fractures is 3.66% and 1.71% for acetabular fractures.<sup>17</sup> In older people, the proximal and most distal ends of the limb have the highest fracture incidence.<sup>18</sup> In upper extremity fractures, the proximal humerus and distal forearm are the most common sites,

and in lower extremity fractures, those of the hip and ankle are predominant.<sup>18</sup>

Mitigating the multidimensional challenges of traumatic injuries requires optimized strategic planning in terms of management and prevention. Specialized trauma centers with advanced systems can improve the outcomes of traumatic injuries.<sup>4,19</sup> However, the success of specialized trauma centers relies on epidemiological data, including prevalence rates and associated risk factors, to set benchmarks for strategic planning. The epidemiology of traumatic orthopedic injuries varies according to social, cultural, economic, legal, and institutional aspects.<sup>20</sup> The decision-making process requires basic epidemiological data, but various regions throughout the world lack such information. Kuwait is a country in the Middle East with a rapidly growing population. RTAs and falling from height are the most prevalent causes of death in Kuwait, at 64.6% and 13.1%, respectively.<sup>21</sup> The high percentage of accidents is considered a major factor in the increasing rates of traumatic injury in Kuwait. Healthcare strategic planning requires statistical data regarding fractures of various critical anatomical structures, including spinal, and upper and lower limb fractures. However, the literature is limited in epidemiological studies of traumatic orthopedic injuries in the Middle East, including Kuwait. Therefore, this study aimed to determine epidemiological data for traumatic musculoskeletal injuries, including the prevalence rate and associated risk factors for spinal, and upper and lower limb fractures. The study's findings could be used to set benchmarks to guide management and preventive strategies, and aid in healthcare planning and delivery.

## Materials and Methods

### *Study design and ethical approval*

The study used a cohort retrospective research design with universal sampling; therefore, all patients in the specified period were included.<sup>22</sup> The Ethics Board of the Kuwait Ministry of Health approved the study (ref [2019/1198]), in accordance with the Declaration of Helsinki. No contact with patients was required; therefore, informed consent was not applicable. However, patients' privacy regarding personal information was maintained.

### *Setting*

The Orthopedic Admission Database of Al-Adan Hospital was reviewed from January 2018 to February 2020. Al-Adan Hospital is a level II trauma center covering one of six health regions in Kuwait, the Al-Ahmadi Governance Health Region. It serves 1.2 million people among Kuwait's total population of 4.2 million. The results of this exploration can be generalized to the overall Kuwait population because Al-Adan hospital is the only hospital serving the population of the Al-Ahmadi Governance Health Region, which can be considered representative of Kuwait because of the small geographical area of Kuwait (17,820 square kilometers) and the concentration of the population in coastal regions, supporting the similarities in baseline population

characteristics between the patients in Al-Adan Hospital and the overall population. The Orthopedic Admission Database of Al-Adan Hospital is a chart populated daily by an orthopedic registrar for admissions to the orthopedics department. In cases of missing data in the Orthopedic Admission Database of Al-Adan Hospital, the patients' medical records were reviewed to obtain information regarding age, sex, nationality, and mechanism of injury. The radiology system was examined to compensate for missing data regarding the anatomical fracture site.

A sample from the years 2018, 2019, and 2020 was included through the convenience sampling method. The sample included the year of 2020 before COVID-19 was declared a pandemic in Kuwait, prior to the Kuwait Ministry of Health's application of restrictions. Including a sample from the period of the COVID-19 pandemic might have prevented the generalizability of the study, because curfew and quarantine policies were applied nationally, thus potentially altering the epidemiology of fractures, including both prevalence and associated risk.<sup>23</sup>

#### Data collection

The data were collected with a specially designed Microsoft Excel sheet. The accuracy of data entry was verified three times by two researchers. The demographic characteristics of the included patients were recorded, including age, sex, and nationality (Kuwaiti or non-Kuwaiti). In terms of the primary outcome measure of orthopedic fracture injuries, we recorded the anatomical site of each fracture, including fractures of the upper and lower limbs, and the spine. Additionally, we retrieved information regarding the mechanism of injury. For upper limb fractures, clavicle, humeral, shoulder, scapular, radial, ulnar, and elbow fractures were documented. For lower limb fractures, pelvic, femoral, patellar, tibial, fibular, ankle, and foot fractures were recorded. Spinal fractures referred to cervical, thoracic, lumbar, sacral, and coccyx fractures. Fractures of the skull, chest, and ribs were not explored in the current study. The mechanism of injury was divided into RTAs, falling over, falling from height, electric saw injuries, explosions, motorcycle accidents, fall of a heavy object, being hit by a vehicle, twisting injury, by a vehicle, and assault.

#### Statistical analysis

Statistical Package for Social Sciences (SPSS) was used for the statistical analysis (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM). The Shapiro–Wilk test was used to assess the normal distribution of continuous data. For descriptive statistics, median and interquartile range were used for age as the only continuous variable in the study, and frequencies and percentages were used for categorical variables.<sup>24,25</sup> Fisher's exact test, chi-square tests and phi tests were used for categorical variables as appropriate to explore the risk factors. Mann–Whitney U tests provided a comparison for the continuous variable of age. A *p*-value of <0.05 was defined as statistically significant.<sup>24,25</sup>

## Results

### Demographics

A total of 4270 admissions to the Orthopedics Department of Al-Adan Hospital were identified, comprising 2046 patients in 2018, 1988 patients in 2019, and 236 patients in January and February of 2020. The study included 564 patients with 788 orthopedic fractures, representing 13.2% of the total admissions. Specifically, we included 314 orthopedic fracture injuries from 2018, 357 orthopedic fracture injuries from 2019, and 118 orthopedic fracture injuries from January and February of 2020. In terms of demographic characteristics, the patients' median age (interquartile range) was 33.0 (23.0) years; the minimum age was 1 year, and the maximum age was 101.0 years. Shapiro–Wilk tests suggested that the age variable significantly deviated from normality ( $p = 0.001$ ); therefore, the median and interquartile range were used for age descriptive statistics. The sex distribution was 78.0% males and 22.0% females. The male patients were 33.0 (16.6) years of age, and the female patients were 45.6 (22.6) years of age. The male patients were significantly younger than the female patients ( $p = 0.001$ ). A total of 57% of the patients were non-Kuwaitis.

**Table 1: Prevalence of orthopedic fracture injuries and associated mechanisms of injury.**

Prevalence of fracture per anatomical site (n = 788)		
Trauma anatomical site	Percentage	Frequency
Spine	21.7%	171/788
Tibia	11.3%	89/788
Ankle	10.2%	80/788
Radius	9.4%	74/788
Femur	8.8%	69/788
Pelvic	6.9%	54/788
Fibula	6.6%	52/788
Humerus	6.6%	52/788
Foot	4.7%	37/788
Ulna	3.8%	30/788
Clavicle	2.7%	21/788
Elbow	1.9%	15/788
Patella	1.9%	15/788
Hip	1.5%	12/788
Scapula	1.4%	11/788
Shoulder	0.8%	6/788
Percentage and frequency of the mechanism of injury (n = 767)		
Mechanism of injury	Percentage	Frequency
Road traffic accident	37.9%	291/788
Falling over	29.3%	225/788
Falling from height	16.8%	129/788
Electric saw injury	0.1%	1/788
Explosion	0.1%	1/788
Motorcycle accident	5.5%	42/788
Fall of a heavy object	2.6%	20/788
Hit by a car	5.1%	39/788
Twisted injury	1.8%	14/788
By a vehicle	0.1%	1/788
Assault	0.5%	4/788

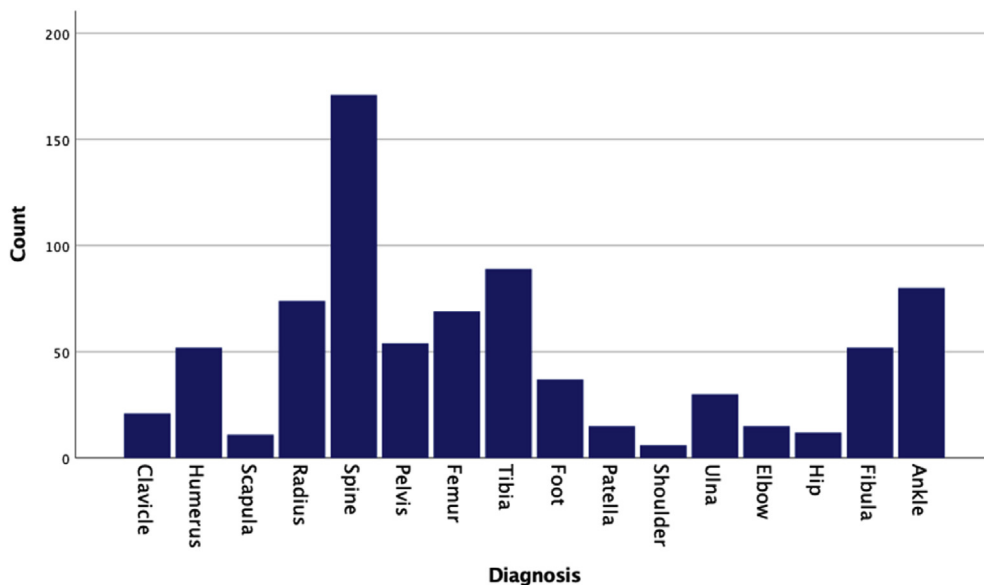


Figure 1: Prevalence of fractures per anatomical site.

*Prevalence of anatomical fracture sites and injury mechanisms*

The most prevalent fracture site was the spine, at 21.7%, followed by tibial fractures, at 11.3% and ankle joint fractures, at 10.2% (Table 1 and Figure 1). A high prevalence of radial and femoral fractures was observed, at 9.4% and 8.8% respectively. Table 1 and Figure 1 show the prevalence of traumas per fracture site. In terms of the mechanism of injury, 767 orthopedic fractures injuries involved RTAs, falling over and falling from height, at 37.9%, 29.3% and 16.8%, respectively (Table 1 and Figure 2).

*Risk factor correlations*

Fisher’s exact test suggested a relationship between the mechanism of injury and the fracture site (Table 2). RTAs were the most common mechanism of injury for spinal, pelvic, tibial, humeral, fibular, clavicle, hip, and scapular fractures. Falling over was the most frequent mechanism of injury for radial, femoral, patellar, and ulnar fractures. Falling from height was the most frequent mechanism of injury for foot and ankle fractures (Table 2). A statistically significant relationship between the mechanism of injury and the fracture site was identified with chi-square tests ( $p = 0.001$ ). Phi tests indicated that the magnitude of the relationship was 0.621.

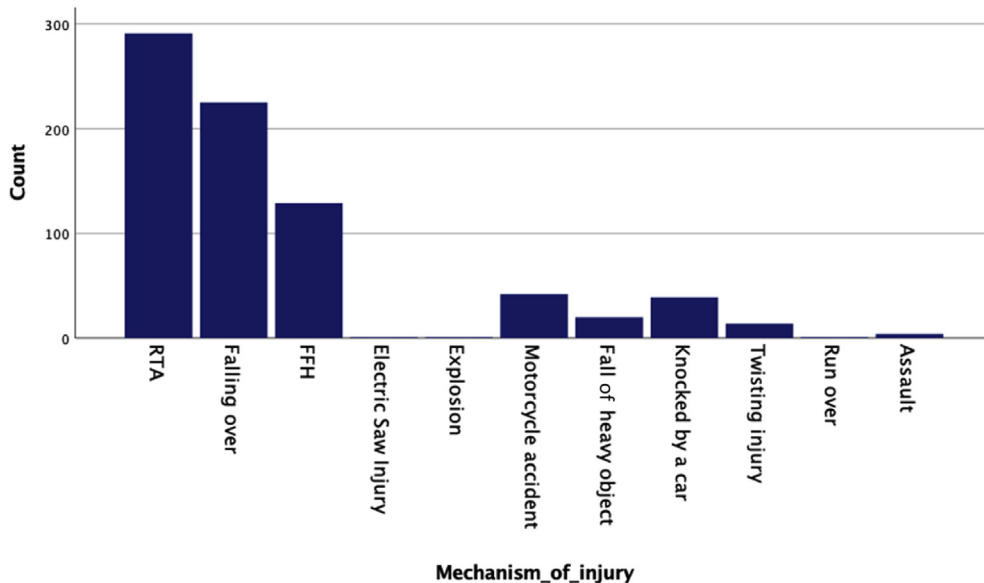


Figure 2: Frequency of mechanisms of injury. Keys: RTA, road traffic accident; FFH, falling from height.

**Table 2: Relationship among fracture site and mechanism of injury, explored with Fisher's exact test.**

	RTA	Falling	FFH	Electric saw injury	Explosion	Motorcycle injury	Fall of a heavy object	Hit by a car	Twisting injury	Run over	Assault	Total
Clavicle	13 <sup>a</sup>	1	2	0	0	4	0	1	0	0	0	21
Humerus	22 <sup>a</sup>	20	5	0	0	1	0	3	0	0	0	51
Scapula	7 <sup>a</sup>	0	1	0	0	1	0	2	0	0	0	11
Radius	19	39 <sup>a</sup>	9	0	0	1	1	1	1	0	1	72
Spine	90 <sup>a</sup>	27	31	0	0	6	1	6	0	0	2	163
Pelvis	28 <sup>a</sup>	6	11	0	0	4	2	3	0	0	0	54
Femur	24	27 <sup>a</sup>	8	0	0	2	2	4	0	0	0	67
Tibia	28 <sup>a</sup>	26	12	1	1	7	1	7	3	0	1	87
Foot	7	4	9 <sup>a</sup>	0	0	4	7	3	1	1	0	36
Patella	1	10 <sup>a</sup>	1	0	0	2	0	0	0	0	0	14
Shoulder	1	3 <sup>a</sup>	1	0	0	0	0	1	0	0	0	6
Ulna	10	14 <sup>a</sup>	2	0	0	2	1	0	1	0	0	30
Elbow	3	5 <sup>a</sup>	4	0	0	2	0	0	0	0	0	14
Hip	8 <sup>a</sup>	3	0	0	0	0	0	0	0	0	0	11
Fibula	19 <sup>a</sup>	16	8	0	0	3	2	4	0	0	0	52
Ankle	11	24	25 <sup>a</sup>	0	0	3	3	4	8	0	0	78
Total	291	225	129	1	1	42	20	39	14	1	4	767

Keys: RTA, road traffic accident; FFH, falling from height.

<sup>a</sup> Indicates the most frequent mechanism of injury for each fracture site.

**Table 3: Relationship between fracture site and patient nationality (Kuwaiti and non-Kuwaiti), explored with Fisher's exact test.**

	Kuwaiti	Non-Kuwaiti	Total
Clavicle	5	5	10
Humerus	22 <sup>a</sup>	18	40
Scapula	0	2 <sup>a</sup>	2
Radius	13	42 <sup>a</sup>	55
Spine	79 <sup>a</sup>	56	135
Pelvis	14 <sup>a</sup>	13	27
Femur	35 <sup>a</sup>	25	60
Tibia	28	48 <sup>a</sup>	76
Foot	8	14 <sup>a</sup>	22
Patella	4	10 <sup>a</sup>	14
Shoulder	1	3 <sup>a</sup>	4
Ulna	3	4 <sup>a</sup>	7
Elbow	1	8 <sup>a</sup>	9
Hip	2	9 <sup>a</sup>	11
Fibula	1	6 <sup>a</sup>	7
Ankle	16	45 <sup>a</sup>	61
Total	232	308	540

Keys: A statistically significant relationship is shown between patient nationality and fracture site by the chi square test;  $p = 0.001$ .

<sup>a</sup> Indicates the most prevalent nationality per fracture site.

Fisher's exact test indicated a relationship between patients' nationality (Kuwaiti or non-Kuwaiti) and fracture site (Table 3). Kuwaiti patients sustained a higher number of fractures of the humerus, spine, pelvis, and femur, whereas non-Kuwaiti patients sustained a higher number of fractures of the scapula, radius, tibia, foot, patella, shoulder, ulna, elbow, hip, fibula, and ankle joint (Table 3). The prevalence of clavicle fractures was equal between the Kuwaiti and non-Kuwaiti patients. A statistically significant relationship was observed between patient nationality and fracture site by the chi square test ( $p = 0.001$ ). The phi

**Table 4: Relationship among fracture site and patient age group explored with Fisher's exact test.**

	Patient age group			Total
	≤18 years	19–49 years	>50 years	
Clavicle	3	14 <sup>a</sup>	2	19
Humerus	11	22 <sup>a</sup>	13	46
Scapula	1	6 <sup>a</sup>	1	8
Radius	7	52 <sup>a</sup>	12	71
Spine	17	99 <sup>a</sup>	37	153
Pelvis	3	36 <sup>a</sup>	9	48
Femur	14	33 <sup>a</sup>	20	67
Tibia	21	51 <sup>a</sup>	14	86
Foot	4	28 <sup>a</sup>	4	36
Patella	2	11 <sup>a</sup>	2	15
Shoulder	0	5 <sup>a</sup>	0	5
Ulna	6	20 <sup>a</sup>	2	28
Elbow	2	6 <sup>a</sup>	4	12
Hip	1	6 <sup>a</sup>	3	10
Fibula	6	36 <sup>a</sup>	8	50
Ankle	6	55 <sup>a</sup>	15	76
Total	104	480 <sup>a</sup>	146	730

A statistically significant relationship is shown between patient age group and fracture site by the chi square test;  $p = 0.033$ .

<sup>a</sup> Indicates the most prevalent age group per fracture site.

test indicated a correlation of 0.309. No statistical relationship was identified between fracture site and sex ( $p = 0.493$ ; phi test = 0.161).

The patients were categorized into three age groups: (1) ≤18 years, (2) between 19 and 50 years, and (3) >50 years. A statistically significant relationship was found between age group and fracture site with the chi square test ( $p = 0.033$ ). A correlation of 0.250 was suggested by the phi test. Table 4 shows that patients 19–49 years of age were at the highest risk for all fracture sites, as compared with the age groups of ≤18 years and >50 years.

## Discussion

The present study presents a comprehensive exploration of the epidemiology of orthopedic fracture injuries in Kuwait, considering spinal, and upper and lower limb fractures, in a sample from an extended period from January 2018 to February 2020. The findings of the present study should be essential for future healthcare management and preventive strategic planning. Orthopedic fracture injuries were most prevalent among males and among young adults in their 30s, and were more common among non-Kuwaitis. Spinal, tibial, and ankle fractures were the most prevalent fractures in Kuwait, accounting for 43.2% of the total. We observed a 21.7% prevalence for spinal fractures, 11.3% prevalence for tibial fractures, and 10.2% prevalence for ankle fractures. We also observed a high prevalence of radial and femoral fractures, at 9.4% and 8.8%. RTAs were the leading cause of fractures, at 37.9%, followed by falling over and falling from height, at 29.3% and 16.8%, respectively.

Orthopedic fracture injuries are associated with a specific mechanism of injury, which may be related to the effects of the trauma on the skeletal system. Spinal, clavicle, and pelvic fractures were mainly reported as a result of RTAs. RTAs can lead to various events, including front, side, and run-off-road impacts, which place an axial load on the spine and cause extensive acceleration of the upper body.<sup>26</sup> Such impacts explain the high prevalence of spinal fractures from RTAs.<sup>26</sup> Additional factors further complicate RTAs, including the stiffness of the vehicle structure, seat and seatbelt design, seatbelt usage, airbag activation, and victim factors such as age, height, and weight.<sup>27</sup> Similarly, clavicle fractures are associated with RTAs, and are related to three-point restraint seatbelts and directional impacts on the clavicle.<sup>28</sup> By contrast, pelvic fractures with RTAs are associated with victims unrestrained by seatbelts.<sup>28</sup>

Falling over leads to high numbers of radial, patellar, and ankle fractures. This association may be related to the effects of the falling direction on the skeletal system and the mechanism of falling. The etiology of falls is multifactorial, and falls are relatively more common among older patients, and patients with cognitive impairment, postural imbalance, arthritis, and various comorbidity factors.<sup>29,30</sup> Standing-level falls have been reported to be the leading mechanism of injury for radial fractures, thus supporting the findings of the current study.<sup>31–33</sup> The association between radial fractures and falls may also be related to other comorbidities, such as osteoporosis and aging. Osteoporosis is a risk factor for radial fractures but accounts for only a small percentage of cases.<sup>34</sup> Although younger adults slip as frequently as older adults, the recovery process (preventing falling when one is about to fall) is slower and less effective in older people, because of the reduced limb strength and sensation associated with aging.<sup>35</sup> Additionally, the upper extremities act as a shock absorber during standing-level falls, thereby potentially explaining the high prevalence of radial fractures resulting from falls.<sup>36</sup> Falling causes direct blows to the knees, thus possibly explaining the association between falling and patellar fractures. The risk of sustaining patellar fractures increases with the intensity of the activity preceding the fall, and differs if the fall follows walking, running, or participating in recreational activities.<sup>36</sup> Ankle

fractures were also found to be associated with standing-level falls, a finding possibly related to turning during the fall event and additional risks due to patient weight.

Orthopedic fracture injuries were more prevalent among non-Kuwaitis than Kuwaitis. Additionally, the site of fracture differed between Kuwaitis and non-Kuwaitis. Kuwaitis sustained more fractures of the humerus, spine, pelvis, and femur. By contrast, non-Kuwaitis sustained more fractures of the scapula, radius, tibia, foot, patella, shoulder, ulna, elbow, hip, fibula, and ankle joint. This finding may be related to the nature of work among non-Kuwaitis. Many non-Kuwaitis typically work as laborers, and such work carries unique risks regarding trauma and mechanism of injury. This epidemiologic observation should be targeted for future preventive plans by developing robust safety measures and regulations.

To our knowledge, no previous study has comprehensively evaluated traumatic injuries for the entire skeletal system in the same cohort, without limiting the exploration to specific age or comorbidity factors. Therefore, not all the findings identified in the current study can be compared with the literature, owing to differences in the inclusion criteria. However, among the comparative studies identified, the reported prevalence values are largely consistent with our current findings. For traumatic injuries of the upper limbs, the general prevalence in this study was 26.6%, a value similar to the value of 32.4% reported in KSA for upper limb traumatic fractures.<sup>37</sup> The determined values are also comparable to the international prevalence rates. For example, the identified rate of 6.6% for humeral fractures is consistent with the 5.7% rate reported in France.<sup>38</sup> In the United States, the previously reported prevalence of scapular fractures is 1%, in agreement with the 1.4% found in our study.<sup>39,40</sup> In Italy, the reported prevalence of clavicle fractures is 2.6%, in agreement with our finding of 2.7%.<sup>41</sup> For lower limb fractures, the inclusive prevalence was 51.2%, a value similar to the 48.59% identified in KSA.<sup>37</sup> Similarly, the prevalence of pelvic fractures of 6.9% is consistent with the values of 3–10% reported in international studies.<sup>42</sup> Furthermore, the prevalence of pelvic fractures of 6.9% is consistent with the recently identified rate in Kuwait of 5.37%.<sup>17</sup> The 1.9% prevalence of patellar fractures is comparable to the previously estimated value of 1% in Germany.<sup>43</sup> Azizeih (2015) has reported a prevalence of 13.3% for hip fractures in Kuwait, which is higher than the 1.5% identified herein. However, the current study reflects data from a specific level II trauma center, whereas Azizeih (2015) presented a general value based on National Center of Health data, thus potentially explaining the difference between studies.<sup>44</sup> For spinal fractures, the determined prevalence was 21.7%, which is similar to values previously reported in Kuwait, KSA, and the United States (28.72%, 18.91%, and 18%, respectively).<sup>15,37,45</sup>

Three significant risk factors for traumatic fractures—the mechanism of injury, and patient age and nationality—were identified to potentially direct preventive strategies toward effective solutions. RTAs were found to be a substantial risk factor for major traumatic fractures including spinal and pelvic fractures. RTAs are a public health concern, and population and economic growth increases the need for

implementing traffic management strategies. RTAs result from human, vehicle, and external factors.<sup>46</sup> In terms of human factors, the United States has used effective strategies to control RTAs, including monthly sobriety checkpoints with alcohol sensors, automated enforcement with speed and red-light cameras, enforcement of safety belt laws, and lowering of speed limits.<sup>47</sup> Many of these laws exist in Kuwait; however, these strategies are underutilized. Although the influence of human factors predominates worldwide, controlling non-human factors could reduce the risks of RTAs.<sup>46</sup> Kuwait's dependency on road-based transportation systems with poor road infrastructure has resulted in high-density road use.<sup>46</sup> Ultimately, developing a non-road-based public transportation system, and improving road infrastructures, road ratios, and traffic management measures in Kuwait could minimize RTAs. Notably, railway transport modes are not available in Kuwait, and only buses are used as public transportation. Additionally, the causes of RTAs could be identified in each context with predictive models; such modeling is recommended in future research to determine the relationship between RTAs and road characteristics, and consequently promote road safety. For example, in Ethiopia, residential zones with high exposure to traffic and non-signalized intersections at nighttime are strongly associated with RTAs.<sup>48</sup>

The current study also indicated that non-Kuwaitis are at higher risk of traumatic injuries. Non-Kuwaitis in Kuwait mainly work as laborers in the construction and industrial workforce. Statistics have indicated that most workplace accidents in Kuwait have occurred in the construction industry sectors,<sup>49</sup> and that no injured workers were Kuwaitis; the nationalities were 58.4% Egyptians, 10.4% Indians, 7.1% Syrians, 5.2% Pakistanis, 2.6% Iranians, and 3.2% Bangladeshis.<sup>49</sup> The risk of injuries among non-Kuwaitis in Kuwait is a serious national issue. The health and safety of contingent workers in Kuwait has led to a call for employment reform in Kuwait. This area is a major focus among human rights groups and the International Labor Organization.<sup>50</sup> In 2003, the organization Human Rights Watch recommended that Kuwait ratify the International Convention on the Protection of the Rights of all migrant workers.<sup>50</sup> Robertson and Lamm (2008) have discussed that project management consultants should be accountable for workplace safety for contractors. However, the risk in Kuwait arises because the chain of command breaks down: contractors sub-contract labor, and the sub-contractors in turn re-subcontract the labor, thus exposing workers to greater danger and health hazards.<sup>50</sup> The accident causation factors among laborers in Kuwait are mainly associated with the increase in the number of self-employed contractors and sub-contractors, the lack of accurate and relevant data of accidents, the lack of occupational health and safety, and the focus on gaining high profits with unrealistic timelines and tight project deadlines.<sup>50</sup> These issues should be resolved by stakeholders in Kuwait to minimize traumatic injuries among non-Kuwaitis. Additionally, workplace safety could be enhanced by the application of measures to prevent work-related accidents and ensure safe working environments. Strict regulations should be applied, and the working environment should be equipped to handle unforeseen circumstances. Using proper uniforms, such as hard hats, appropriate outfits, helmets, and goggles is

imperative. The group 18–49 years of age was found to be at the highest risk of traumatic injuries, because they are the most active in terms of working demand and road utilization. Therefore, controlling RTAs and ensuring safe working environments would reduce the risk for this age group. Additionally, awareness programs should target this age group to control their high risk of developing traumatic injuries.

## Conclusion

The epidemiological findings established by the current exploration can be considered essential benchmarks to direct future healthcare preventive and management strategies for orthopedic fracture injuries. Spinal, tibial, ankle, and radial fractures were the most prevalent among all fractures. Accordingly, we recommend that these fractures be prioritized for future management and preventive plans. Future rigorously controlled epidemiological studies will be crucial. For example, the improvement of post-accident medical care could be directed toward the traumatic injuries with high prevalence, including spinal, tibial, and ankle fractures. RTAs should be considered in future planning, because it is the leading mechanism of injury. A trauma registry should be established in the Kuwait healthcare system, using standard disease classification codes to assist researchers and policymakers in epidemiological studies and improve healthcare. To support the establishment of preventive policies, more details must be considered for the development of a trauma registry, including the mechanism of injury; RTA events of the front, side, and run-off-road impact; seat belt type; and air bags.

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## Conflict of interest

The authors have no conflict of interest to declare.

## Ethical approval

The Ethics Board of Kuwait Ministry of Health approved the study (ref [2019/1198]), in accordance with the Declaration of Helsinki. Date: 2019.

## Author contributions

MA conceived and designed the study, conducted research, provided research materials, and collected and interpreted data. NA conceived and designed the study, conducted research, analyzed and interpreted data, and wrote the initial and final draft of article. All authors have critically reviewed and approved the final draft, and are responsible for the content and the similarity index of the manuscript.

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