Analysis of the pattern of maxillofacial injuries in Saudi Arabia: A systematic review

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Abstract  Objectives: Maxillofacial trauma (MFT) is a serious health problem and in Saudi Arabia is mainly caused by road traffic accidents (RTAs). MFT commonly associated with injuries to the face, head, and jaws and may cause soft tissue lacerations and bruises. MFT can also cause fatal blood loss and airway obstruction. The objective of this review was to determine the prevalence of MFT, identify the major causative factors in males and females in the main cities of Saudi Arabia.

Materials and methods: We performed literature searches of all published studies describing MFT from KSA during the last 20 years.

Results: In Saudi Arabia, males are more prone to MFT than females, although the male: female ratio of MFT varies between different cities. Specifically, Aseer has the highest male: female ratio (10:1), followed by AlHofuf (8.3:1) while AlQurayyat had the least gender ratios of MFT (2:1). Most cases of MFT are associated with RTAs, which accounted for (63%–90.3%) in Medina, (89.1%) in Aseer, (86.1%–87.1%) in Riyadh, (67%–73.1%) in Jeddah, (71%) in Khamis Mushait, (64.2%) in Makkah and (63.3%) in Al-Hofuf. The least percentage of RTA resulting into MFT was recorded in AlQurayyat (24%).

Conclusion: Maxillofacial trauma is a serious health problem in Saudi Arabia. RTAs remain the major cause of maxillofacial injuries especially among males, thus strict implementation of traffic rules is a must to minimize maxillofacial injuries and its physical and psychological impact.
1. Introduction

Facial injuries are considered as part of the human body injuries and can be defined simply as any injury of the face which include major and minor injuries of the soft tissues, bones, blood vessels, nerves, and any other tissues of the human face.

Maxillofacial injuries follow trauma to the face, head, and jaws, and 51% of road traffic accidents (RTAs) lead to maxillofacial injury (Kheirallah and Almeshaly, 2016). These fractures in some cases may cause blood loss and airway obstruction and can be fatal (Seyfer and Hansen, 2000). Previous studies also show long-term psychological impacts of MFT (Seyfer and Hansen, 2000; Auerbach et al., 2008; Glynn et al., 2000). Motor vehicle accidents, violence, sport injuries, and falls predominantly cause facial trauma. While in other part of the worlds, MFT in adults is caused mostly by assaults followed by road traffic accidents and sporting injuries (Ceallaigh et al., 2006), but among children, falling from a height is the main cause of maxillofacial injuries (Gassner et al., 2004). Moreover, jaw bone fractures are more commonly the result of trauma than other causes such as osteonecrosis of bone or cancer (Murray, 2013). Likewise, Facial soft tissue injuries mostly caused by dog bites (Bregman and Slavinski, 2012). Eye injuries, such as retrobulbar hemorrhage, can be associated with MFT and can cause blindness, although this is a rare occurrence (Perry and Dancey, 2005). Intracranial hemorrhage also occurs more often in patients with MFT than in patients without MFT (Keenan et al., 1999).

Several epidemiological studies among different population groups have been reported, such as in Austria (Oji, 1999), Australia (Infante et al., 1994), India (Chandra Shekar and Reddy, 2008), Iran (Mesgarzadeh et al., 2011), Pakistan (Cheema and Amin, 2006), Brazil (Chrcanovic et al., 2012), United States (Shere et al., 2004), Scotland (Adi et al., 1990), United Arab Emirates (Al Ahmed et al., 2004), New Zealand (Kotecha et al., 2008), Nigeria (Obuekwu et al., 2005) and Uganda (Kamulegeya et al., 2009).

Assessments of the prevalence of MFT and the severity of the related injuries are required to determine the importance of prevention strategies. There were number of published studies which investigated the patterns and severity of maxillofacial injuries in Saudi Arabia in different cities such as Al-Medina, Riyadh, Aseer, Makkah, Hofuf, Al-Qurayyat and Jeddah (Al Ghamdi, 1998; Ansari et al., 2000; Samman et al., 2018; Almasri, 2013; Abdullah et al., 2013; Jan et al., 2015; Rabi and Khateery, 2002; Lawoyin et al., 1996; Nwoku, 2004; Alghamdi et al., 2007; Al-Aanazi et al., 2016; Alqahtani, 2018; Al-bokhamseen et al., 2019; Albeshir et al., 2018). Therefore, to gain a clearer picture of the patterns of these fractures in the KSA, the available evidence requires a further refinement. Thus, the aim of the present study was to review the etiologies, patterns and distribution of maxillofacial trauma in Saudi Arabia.

2. Materials and methods

All articles published during the last 20 years (1998–2018) on maxillofacial injuries in the KSA were analyzed. The following databases were used: PubMed/MEDLINE, Scopus, and Google scholar and Web of Science. Relevant studies were identified using the MeSH terms and Boolean operators “maxillofacial trauma” AND “injuries” AND “Saudi Arabia.” “Road Traffic injuries”. The full-texts of all these articles were thoroughly examined by two authors. Further measures such as hand searching on Journals of included studies and personal contacts with investigators of previous studies for missing data were also made. The Boolean operator NOT was used to exclude the following MeSH terms: facial nerve, eye and burns, since a high number of studies are linked with these terms. Inclusion criteria includes; Availability of the full-text article, Retrospective or prospective studies, All age groups and Non pathological type injuries. All retrieved studies which reported trauma to the mandible, maxilla, or facial soft tissue in the KSA, and/or the prevalence, severity, and causality of MFT were retrieved. Data from these studies were used to review the pattern and causes of MFT in the main cities of Saudi Arabia.

Titles and abstracts were screened first then the full texts of relevant publications were obtained and reviewed independently in duplicate by (FA and KB), who also performed the data extraction. For every study, the following information was retrieved and analyzed; etiology of the injury, peak age of incidence, gender predilection, site of injury, period and location of the study. The present systematic review was performed according to PRISMA Statement–Preferred Reporting Items for Systematic Reviews and Meta-analyses and the study protocol was registered with PROSPERO Register# CRD42019122711. The PECO question was used in this review, P (Patient Population of adults and children with maxillofacial injuries), E (Exposure—etiology of maxillofacial trauma), C (Comparison between different cities in KSA), and O (Outcomes, prevalence of maxillofacial trauma for each etiology). Studies that met the inclusion criteria were selected...
for further analysis. As outcome variables were not homogeneous across the selected studies, cumulative analysis could not be performed. Ethical approval was obtained from ethical review committee of Ajman University, (Reference Number: D-F-H-19-05-16).

3. Results

A total of 16 full-text articles and abstracts were identified. Three articles not fulfilling our inclusion criteria were excluded. A total of 13 publications published between 1998 and 2018, were therefore included in the review (Fig. 1). These publications were summarized in (Tables 1 and 2). A total of 4571 patients (3841 males and 730 females) with age range between 0 and 97 years who sustained maxillofacial injuries during the study period were included in the analysis (Table 2). In Saudi Arabia, males are more prone to MFT than females, although the male: female ratio of MFT varies between different cities. Specifically, Asser has the highest male: female ratio (10:1), followed by AlHofuf (8.3:1) while AlQurayyat had the least gender ratios of MFT (2:1). Studies have shown that most cases of MFT are associated with RTAs, which accounted for (63–90.3%) in Medina, (89.1%) in Aseer, (86.1–87.1%) in Riyadh, (67–73.1%) in Jeddah, (71%) in Khamis Mushait, (64.2%) in Makkah and (63.3%) in Al-Hofuf. The least percentage of RTA resulting into MFT was recorded in AlQurayyat (24%) (see Table 3).

In KSA road traffic accident (RTA) was the major cause of maxillofacial injuries in both children and adults in all the cities and the other causes represent very low percentages. The peak age of incidence of maxillofacial injuries was 10–29 years in most centers followed by 31–40 years. Among children, injuries occurred mostly in children aged > 6 years (Table 1).

4. Discussion

The distribution of maxillofacial injuries may vary widely across countries and is dependent on several cultural and socioeconomic factors (Boffano et al., 2014).

Regarding the etiology of maxillofacial fractures, we found the commonest mode of injury was RTAs. These findings were in agreement with reports from other developing countries in which road traffic accident is considered to be the most common cause of facial trauma (Oji, 1999; Qudah and Bataineh, 2002; Al Ahmed et al., 2004; Nwoku, 2004; Obuekwe et al., 2005; Cheema and Amin, 2006; Chandra Shekar and Reddy, 2008; Kamulegeya et al., 2009; Mesgarzadeh et al., 2011; Chrcanovic et al., 2012) and this may be attributed to the rapid and wide economic expansion of the country economy following the oil discovery (Ansari et al., 2000). Other possible reasons could be due to high speed driving and the ignorance of traffic roles, but the current findings differ from reports published in other parts of the world in which assault was regarded
as the main cause of facial injuries (Shepherd et al., 1987; Huang et al., 1998; Arosarena et al., 2009). Researchers highlighted various causes for RTAs such as over speed and improper turning (Ali Aba Hussein and El-Zobeir, 2007; World Health Organization, 2011; Barrimah et al., 2012; Farah et al., 2015).

The car structure most commonly thought to have been responsible for facial injuries of any severity were the windshield and the steering wheel followed by the interior rear-view mirror. It has been shown that seat belts effect protection of the restrained occupant by preventing, or at least reducing the extent of movement away from the seat. In a previous review of the car occupants, it was shown that there was a substantial reduction in the overall incidence of head injuries amongst the belted occupants (Sabey et al., 1977).

### Table 1  Summary of the studies that reported the causes of MFT in KSA.

| Author/Year | City | Source of data | Common causes | Fracture site (%) |
|-------------|------|----------------|---------------|------------------|
| Lawoyin, 1996 | Tabuk | Hospital Records | – | Maxilla |
| Rabi, 2002 | Madinah | Hospital Records | RTA (63.0%) | Mandible (41%) |
| Nwoku, 2004 | Riyadh | Hospital Records | RTA (87.1%) | Maxilla (61.4) |
| Almasri, 2013 | Asceh | Hospital Records | RTA (89.1%) | Mandible (50.6%) |
| Abdullah, 2013 | Riyadh | Hospital Records | RTA (86.1%) | Mandible (56.4%) |
| Jan, 2015 | Jeddah | Hospital Records | RTA (67.0%) | Mandible (58%) |
| Almasri, 2015 | Makkah | Hospital Records | RTA (64.2%) | Mandible (54.19%) |
| Alghamdi, 2007 | Jeddah | Hospital Records | RTA (73.1%) | Mandible (60.4%) |
| Al-Aanazi, 2016 | AlQurayyat | Hospital Records | RTA (24.0%) | Mandible (21.0%) |
| Samman, 2018 | Madinah | Hospital Records | RTA (90.3%) | Only Mandibular fractures studied |
| Al-Qahtani, 2018 | Khamis Mushait | Hospital Records | RTA (71.0%) | Mandible (27%) |
| Al-Bokhamseen, 2019 | Hofuf | Hospital Records | RTA (63.3%) | Mandible (54.6%) |
| Albeshir, 2018 | Madinah | Hospital Records | RTA (8.20%) | Mandible (7.9%) |

### Table 2  Gender and age distribution.

| Author/Year | City | Male | Female | M:F ratio | Age range | Total |
|-------------|------|------|--------|-----------|-----------|-------|
| Lawoyin, 1996* | Tabuk | – | – | 5.2:1 | 21–30 Years | 980 |
| Rabi, 2002 | Madinah | 337 | 66 | 5.2:1 | 21–30 Years | 403 |
| Nwoku, 2004 | Riyadh | 828 | 158 | 5.2:1 | 9–70 Years | 986 |
| Almasri, 2013 | Asceh | 92 | 9 | 10:1 | 20–30 Years | 101 |
| Abdullah, 2013 | Riyadh | 172 | 28 | 6:1 | 10–29 Years | 200 |
| Jan, 2015 | Jeddah | 728 | 125 | 6:1 | 3–87 Years | 853 |
| Almasri, 2015* | Makkah | – | 82 | 4.4:1 | 3–97 Years Mean 51 Years | 965 |
| Alghamdi, 2007 | Jeddah | 532 | 80 | 6:6:1 | 11–60 | 612 |
| Al-Aanazi, 2016* | AlQurayyat | – | 2 | 2.1:1 | – | – |
| Samman, 2018 | Madinah | 165 | 32 | 5:1:1 | 30–86 Years Mean 28 Years | 197 |
| Al-Qahtani, 2018 | Khamis Mushait | 215 | – | Only Males | 15–50 Years | 215 |
| Al-Bokhamseen, 2019 | Hofuf | 241 | 29 | 8:3:1 | 2–77 Years Mean 24–29 | 270 |
| Albeshir, 2018 | Madinah | 531 | 334 | 1.6:1 | 0–12 Years | 865 |
| Total | 3841 | 730 | | 5.2:1 | 0-97 Years | 4571 |

* Incomplete data.
investigators highlighted other contributing factors such as prolonged exposure to heat, adverse weather conditions and driver errors as possible causes for RTAs (Nofal and Saud, 1997). In one report, Hypoglycemia was identified as possible cause of RTA (Al Madani, 2010).

The other etiological factors of maxillofacial injuries in the present study include falls, assault and sport-related injuries which constituted only limited number of the facial fractures, for example assault was reported only by 6% of patients at Aseer, and 2.5% at Madina as the cause of the facial injuries, but assault largely replaced RTAs as the main cause of maxillofacial injuries in other parts of the world (Oji, 1999; Infante et al., 1994; Arosarena et al., 2009). This difference may be explained by the conservative nature of Saudi culture and cultural differences among countries. Huang et al. (1998), reported an inadequate documentation of assaulted female patients with maxillofacial injuries and patient interviews failed to satisfactorily identify and/or document the alleged assailant in 68% of cases.

Falls accounted for 6% (Samman et al., 2018) to 89.1% (Albeshir et al., 2018) of the facial injuries’ cases. The injuries may occur either in the elderly patients who may fall and sustain injuries of the fragile edentulous mandible, or among young adults who fall forward onto the chin and often sustained bilateral condylar fracture.

Sports related injuries are uncommon in the reviewed studies and range between 0.4% in Madinah (Albeshir et al., 2018) to 2.0% in Aseer (Al Masri, 2013). Previous reporters confirmed a significant proportion of sports-related facial fractures (Perkins and Layton, 1988; Adi et al., 1990).

Industrial causes of facial fractures were not described in the reported studies from KSA, however, reports from other parts of the world described midfacial bone fractures as the predominant cause but, in European studies the etiology varied, with assaults and road traffic crashes being the most important factors, furthermore, in all the reviewed studies men outnumbered women with a ratio of 2:1.

Most of the fractures of maxillofacial skeleton involve the mandible, these results were similar to reports from other parts of the world (Brown and Cowpe, 1985; Al Ahmed et al., 2004; Erol et al., 2004), this may be attributed to the fact that the mandible has less bony support than the maxilla also the shape and the mobility of the mandible have been implicated as the reason for high vulnerability of mandible to injuries (Oji, 1999; Nwoku, 2004). In contrast to our findings, other investigators reported that midfacial bone fractures were more common than mandibular fractures (Gassner et al., 2004).

5. Conclusion

The limitations of the study are those characteristics of the retrospective design or methodology which included, incomplete records, missing patient information and inadequate documentation of patients. Other limitation of this study, as outcome

| Author       | City      | Main cause of MFT in males | Main cause of MFT in females | Other causes | Total |
|--------------|-----------|----------------------------|-----------------------------|--------------|-------|
| Almasri      | Aseer     | Road Traffic Accidents (88.7%) | Road Traffic Accidents       | Physical Violence (6%) and Sport injuries (2%) | 101   |
| Abdullah     | Riyadh    | Road Traffic Accidents (86.1%) | 10–29 years – > Road Traffic Accidents 0–9 years > Falls | Falls (50%) of causes in males aged from 0 to 9 years Falls (60%) of causes in females aged from 0 to 9 years | 200   |
| Almasri      | Makkah    | Road Traffic Accidents (90.35%) (178 patients) | Road Traffic Accidents | Falls (6.09%) (12 patients) Physical Violence (2.53%) (5 patients) Sport Injuries (1.01%) (2 patients only) | 965   |
| Alghamdi     | Jeddah    | Road Traffic Accidents 7.1% | Road Traffic Accidents 1.0% | Fall 89.1% Violence/abuse in 1.38% Sport 0.46% | 612   |
| Albeshir     | Madinah   | Road Traffic Accidents | 0–9 years > Falls | – | 865   |
variables were not homogeneous across the selected studies, cumulative analysis could not be performed.

Maxillofacial trauma is a serious health problem in Saudi Arabia. RTAs remain the major cause of maxillofacial injuries especially among younger males, but less common among females. To minimize maxillofacial injuries and its physical and psychological impact on the society, more coordinated strategies for action by various actors are warranted. 

Ethical statement

Ethical approval to carry out this study was obtained from ethical committee of the Ajman University.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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