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The aetiology of maxillofacial trauma in Australia: A scoping review

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ABSTRACT

Background: The oral and maxillofacial complex is subject to a range of traumas. Injuries to the region are devastating and have a great impact on social health outcomes. This review intends to investigate the aetiologies of maxillofacial trauma across Australia.
Methods: This review was written in accordance with the PRISMA-ScR. Comprehensive searches of CINAHL, MEDLINE, Ovid, Scopus, and Web of Science databases were conducted to identify potentially relevant literature. Quantitative observational epidemiological studies were sought and were required to include at least one aetiology to the maxillofacial region in their data set. A total of 31 eligible studies were included.
Results: The greatest recorded causes of maxillofacial injuries included inter-personal violence (34.98%) falls (20.87%), sports (15.62%), and motor-vehicle accidents (14.31%). These four aetiologies cumulatively accounted for more than 85% of maxillofacial injuries. From all sustained injuries (n = 7661), the orbit was the most prevalent site of fracture (31.85%), followed by the zygoma (22.01%), mandible (21%), nasal bone (12.45%), maxilla (10.04%), dentoalveolus (1.84%), antrum (<1%), and frontal bone (<1%).
Conclusion: Violence was an unprecedented cause of trauma—additional research is recommended to further characterize the correlation between the two variables. Research is also recommended specifically in regional/rural communities, where data was particularly limited. © 2024 Australian Dental Association.

Keywords: Maxillofacial, trauma, scoping review, Australia.

Abbreviations and acronyms: ACT = Australia Capital Territory; CN = crown; DV = domestic violence; GSW = gunshot wound; IPV = inter-personal violence; MM = Modified Monash Model class; MVA = motor-vehicle accident; NOE = naso-orbito-ethmoid; NSW = New South Wales; NT = Northern Territory; OMF = oral and maxillofacial; OZM = orbito-zygomaticomaxillary; QLD = Queensland; RT = root; SA = South Australia; TAS = Tasmania; TMJ = temporomandibular joint; VIC = Victoria; WA = Western Australia; WOS = Web of Science; ZMC = zygomaticomaxillary complex; # = injury/fracture.

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CLINICAL RELEVANCE

The rationale for conducting this review is based on the foundation that trauma to the maxillofacial complex poses a serious risk of morbidity, disability, and fatality. It also bears a tremendous perioperative burden for the treating professionals, patients, and their respective families. The aetiology of maxillofacial injuries in Australia has been investigated but no studies have conducted a broad-scope review to identify patterns of injury. Hence, this paper aims to identify the aetiological patterns of maxillofacial injuries in Australia through a scoping review. Recognising epidemiological differences will help gain a deeper understanding of the subject, characterize injury patterns, and fill gaps within the literature not previously uncovered.

INTRODUCTION

The oral and maxillofacial complex is composed of all hard and soft tissues of the face and jaws.[1] It involves the structures visualized from the anterior view of the skull.[1,2] It can be defined under the following structures: Maxillo – maxilla, mandible, dentoalveolus, palate, and temporomandibular joint.[1–5] Facial – facial dermal tissue, oro-naso-antral structures, facial muscles, masticatory muscles, frontal, nasal, lacrimal, palatine, inferior nasal concha, zygomatic, maxillary, mandibular, and vomer bones.[1–5]

Traumatic injuries are caused by an acute transmission of energy exerted against the body.[3–7] The aetiology of trauma can be diverse and numerous, being primarily a result of blunt or penetrating force, and varying in outcome, ranging from minor injury to instant fatality.[3–7] OMF trauma involves injury to the soft and/or hard tissues. Soft tissue injuries comprise of[5]: Abrasions – loss of superficial layer of tissue; contusions – blunt force resulting in oedema and hematoma formation in the subcutaneous tissue; lacerations – sharp injuries leading to separation of tissue; and avulsions – complete loss of tissue segments.

Hard tissue injuries/fractures can be based on type of fracture, anatomical site of fracture or both.

Dentoalveolar injuries[3]: uncomplicated crown fracture – fracture confined to coronal enamel and/or dentine without pulp involvement; complicated crown fracture – coronal fracture with pulp involvement; root fracture – horizontal fracture confined to the cervical, middle, or apical third of tooth root; crown-root fracture – longitudinal fracture following the axis of a tooth involving the crown and root; concussion – injury to tooth leading to local pain but no displacement or mobility involved[3]; luxation – injury to tooth leading to extrusive, intrusive, or lateral displacement; subluxation – injury to tooth involving mobility but no displacement; avulsion – complete dislodgement of tooth from its socket; alveolar fracture – fracture of overlying alveolar bone of dentition.

Mandibular fractures[3,5]: Mandibular body fracture, angle fracture, condylar fracture, symphaseal/parasymphaseal fracture, fracture of mandibular ramus, and fracture of coronoid process.

Maxillary fractures – as the maxillae overlies several other structures, such as the nasal septum, nasal, zygomatic, and palatine bones, isolated maxillary fractures are often rare. Maxillary fractures are typically described using the LeFort classification.[3,5] LeFort I fracture – traverse lateral antral and nasal wall and lower third of the nasal septum, separating at the pterygoid plates[3,5]; LeFort II fracture – involve most of the nasal, maxillary, palatine bones, lower two thirds of the nasal septum, dentoalveolus and pterygoid plates.[3,5] LeFort III fracture – involve zygoma, maxillae, nasal, palatine bones and pterygoid plates, essentially separating the face along the base of the skull.[3,5]

Zygomatic fractures – the strong buttressing nature of the zygoma and adjacent thin bones result in zygomatic fractures being accompanied by damage to articulating bones.[3] Zygomatic fractures comprise of; zygomatic arch fractures – single fracture isolated to the malar bone[3]; comminute fractures – multiple fracture lines isolated to the malar bone[3]; zygomaticomaxillary complex – also known as a tetrapod or orbito-zygomaticomaxillary fracture, the clinical entity of fractures involving the zygoma and four articulating maxillary bones.[3]

Orbital fractures – involve injury to one or more of the bones which border the orbits and includes; orbital floor fractures – single or comminute fracture of the infra-orbital rim made by the zygoma[3]; lateral wall fracture – predominantly a zygomatic fracture[3]; medial wall fracture – primarily involve lacrimal, maxillary, and ethmoid bones[3]; and orbital roof fracture – fracture to the lower border of the frontal bone with minor contribution posteriorly by the lesser wing of the sphenoid.[3]

Nasal fractures include isolated nasal bone fractures[3]; naso-orbito-ethmoid (NOE) fractures – involve structures forming the NOE complex, including anterior cranial fossa, nasal, frontal, ethmoid bone, and frontal sinus.[3]

Injuries to the OMF complex are often devastating and have a great impact on social health outcomes, as they can be associated with compromised facial aesthetics, impaired speech, mastication, taste, deglutition, and respiration.[3,5–8]

These injuries can be complex and expensive, involving multiple disciplines including emergency physicians, otorhinolaryngology, plastic, and maxillofacial surgical units.[3,5–8] In addition to expensive surgical management, the associated post-operative recovery and rehabilitation process can significantly affect the patient financially and in overall quality of life.[8]

Furthermore, unlike maxillofacial pathology, maxillofacial trauma even when minor, can lead to situations of intense emotional distress for the treating clinicians, patients, and their families. The nature of these injuries also demands swift, and often complex assessments, communication of diagnoses and preparation for treatment – which may lead to less than ideal treatment or treatment which nonetheless retains irreversible damage to the patient's face.[4]

Several authors have documented the epidemiology of maxillofacial trauma in Australia.[6–8] However, the sample population is often limited to a region of interest or state. The aetiology of maxillofacial injuries is variable and highly susceptible to change contingent to social and geographic factors.[6] For example, the area in which a populous is located may influence their general income, ability to access healthcare, the type of job they work, the likelihood of engaging in substance use, the risk of inter-personal/domestic violence, road traffic accidents etc.[6] The influence that such social determinants carry has been linked to not only a higher prevalence of incurring a facial injury but also the access to appropriate treatment of an injury.[6] Additionally, literature also evidences the likelihood of facial injury relative to demography.[6,7] In Australia specifically, First Nations patients are at

disproportionately higher risk of incurring an OMF injury.[6] As a result, it is not sufficient to simply generalize incidences and causes of injury from isolated studies.

Comprehensive review of the paradigm shift within OMF injuries over time is significantly lacking in Australia.[6] This review aims to investigate the primary aetiologies of OMF trauma across Australia and identify sub-populations at relatively higher risk of incurring injury. Accordingly, this review expands on the nature of maxillofacial injuries to aid in their prevention and management, with consideration to varying geographic and demographic factors.

METHODS

The review was conducted in accordance to the PRISMA-ScR extension for scoping reviews 2018.[9] For inclusion, studies needed to comprehensively assess both incidence and aetiologies of any form of trauma to one or more areas of the OMF complex as defined above. Peer-reviewed articles published between 1982 and 2022, written in English, and involving data from Australian patients (alive or deceased following trauma) of all ages were included.

This review primarily sought quantitative observational retrospective or prospective epidemiological studies to collate incidence of trauma to OMF region. Data must have discussed at least one aetiology to one OMF region. Data could not be diluted by assessing aetiology of injury to a region not under the definition of the OMF complex (e.g., data assessing head and neck injuries involves injuries within and outside of the OMF complex). Data must have been collected from patients who presented to hospitals where all appropriate diagnoses are most likely to be made using a standardized approach. Public data, surveys, questionnaires, qualitative data, case reports/series, keynotes, presentations, grey literature were excluded from this review.

Comprehensive searches of the following electronic databases were conducted to identify potentially relevant literature: CINAHL, MEDLINE, Ovid, Scopus, and Web of Science. The search strategy was drafted in consultation with a university librarian and further refined by the research team. Search results were finalized by 9 June 2022. Results of the database searches were exported to EndNote™ 20.

An initial search was conducted and common keywords in titles and abstracts were identified. All identified keywords and index terms were applied to the search strategy (Appendix A). Titles and abstracts were first screened by two independent reviewers, followed by a full-text screening. A training exercise preceded each stage of screening. Inter-rater discrepancies were resolved through discussion and consensus agreement of both independent reviewers. Furthermore, authors were contacted if articles for full-text screen were unable to be sourced, and reference lists of all relevant reviews were scanned for additional relevant articles. All confirmed articles following screening were verified by the co-reviewers.

A template to determine relevant variables was drafted by the principal investigator and reviewed by the research team. Data was collated by the principal investigator, and the results were discussed and updated if required by the research team in an iterative process.

Extracted primary data included administrative details (i.e., author, name, year of publication), study parameters (location and duration of study), and characteristics (sample size, gender ratio, aetiologies of injury, type and site of injury as defined by the study). Additionally, variables such as age characteristics (range, frequency, mean), Indigenous status, substance use, and geographical remoteness, were recorded where available.

Because no similar review is contemporarily available, our research additionally aimed to assess the methodological quality of existing studies surrounding OMF trauma. Critical appraisal was conducted using the McMaster Critical Review Form for Quantitative Studies by two independent reviewers.[10,11] This was the appraisal tool of choice due to its focus towards concise, yet comprehensive assessment of quantitative evidence, and inter-rater reliability.[10,11]

Disparities between reviewers were resolved following discussion with senior team members. The review form outlines 15 items of consideration to evaluate. To standardize and assist reviewers in consistent evaluation, the authors of the tool developed guidelines regarding each item (Data S2.1).[10,11]

If a study was deemed to meet the criterion of each item, it was given one point. If item criterion was not met, no points were scored. The score given for each item of every study was cumulated to give a total score. Scores were divided into subjective categories of 'excellent' (11), 'good' (10-9), 'fair' (7, 8), and 'poor' (0-6), to determine methodological quality (Data S2.2).

As the primary types of studies assessed in this review were predominantly retrospective observational cohort studies, interventions were not necessarily assessed, nor sample dropouts required consideration. Consequently, items 8, 9, 10 and 14 did not contribute to the final score.

RESULTS

The initial search through bibliographic databases revealed a total of 999 articles. 342 duplicate articles were eliminated. The title and abstract screen eliminated a further 520 articles. Articles were primarily

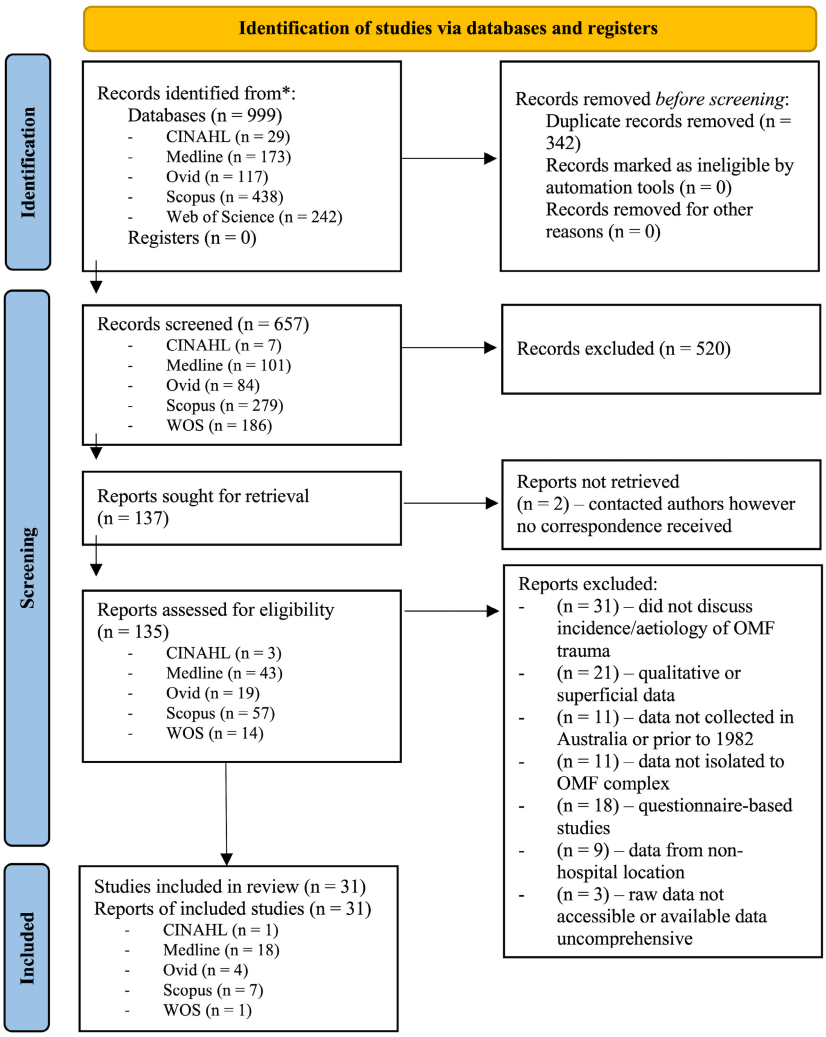

Fig. 1 PRISMA 2020 flow diagram for new systematic-style reviews which included searches of databases and register only.

eliminated here due to not being based in Australia, being conducted, or published prior to 1982, not being in English, or irrelevant to the topic. The full-text screen excluded the remaining 106 articles for a total of 31 eligible studies to be included.[16–46] Screened articles at this stage were mainly excluded due to superficial analysis of epidemiological characteristics or because the studies would measure management protocols of OMF injuries rather than prevalence or aetiology. Figure 1 summarizes the search strategy for this review.

The first set of data (Data S1.1–S1.10) assesses the primary data, summarizing the author of each study, presentation numbers of injuries, sex ratio, duration of sample data collection, aetiology, and site of injury in percentages. Tables 1 and 2 summarize specific characteristics of injuries such as their link to substance use and injuries within the First Nations population, respectively.

Table 1. Alcohol-related injuries

References	*N*	Individuals under influence of alcohol (%)	Individuals under influence of drugs (%)	Most common aetiology (%)
Diab et al.[24]	565	25.7	–	IPV 58.2
Dongas et al.[41]	251	41.4	4.4	IPV 55.0
Elledge et al.[35]	92	34.8	-	IPV 58.7
Diab et al.[21]	2559	17.7	-	IPV 44.6
Diab et al.[16]	583	11.3	-	Fall 48.2
Hoffman et al.[20]	176	11.4	-	IPV 33.0
Nhongo et al.[18]	344	18.9	7.0	IPV 41.0
Tadj et al.[40]	263	30.0	-	IPV 39.9

IPV, inter-personal violence.

Table 2. Injuries in First Nation populations

References	*N*	*N* (Aboriginal and/or Torres Strait Islander %)	Most common aetiology	Incidence of IPV (%)
Schön et al.[42]	114	44.0	IPV	83.0
Diab et al.[24]	565	11.5	IPV	58.2
Oberdan et al.[37]	276	49.0	IPV	74.0
Diab et al.[16]	583	6.70	Fall	26.2
Diab et al.[23]	265	5.30	Sport	15.1

IPV, inter-personal violence.

The methodological quality of sources was predominantly determined to be 'excellent' or 'good' (28/31 studies). All studies met criteria regarding reliability and validity of outcome measures and appropriate analytical methods. Failure to discuss relevant background literature and reporting data in terms of statistical significance were the two most common item criteria not met (12/31 studies). Refer to Data S2.1 and S2.2 for detailed assessment of included studies.

The literature was grouped based on the objectives of the studies. For example, some studies assessed incidence of injuries at specific OMF sites (Data S1.2–S1.4), others assessed injuries from a particular aetiology (Data S1.5–S1.6, S1.10), and some assessed injuries within certain populations (Data S1.7–S1.9). Studies that were general in their objectives or did not follow a recognized trend were grouped together (Data S1.1). Tables of all included studies were also constructed to demonstrate specific characteristics such as use of alcohol/drugs and Indigenous status (Tables 1 and 2).

Eight studies assessed incidence and aetiologies of multiple sites in the OMF complex. Notably, two of these studies utilized data from the exact same sample hence they were grouped into the same data set.[17,20] Twelve studies assessed incidence and aetiologies of injuries to specific sites in the OMF complex. This included zygomatic fractures (1 study) mandibular fractures (7 studies) and dentoalveolar injuries (4 studies) (note: Martin et al[46] assessed injuries at two different sites, hence was tabulated into two separate data sets). Four studies assessed OMF injury incidence and aetiologies in specific populations: two studies[23,43] assessed paediatric populations and one study each assessed a geriatric[33] and female[16] population. Five studies assessed OMF injuries from specific aetiologies: the commonest aetiologies specifically assessed were sport[28,45] (two studies) and animal-related[22,31,37] (three studies) OMF injuries. Two studies[19,25] assessed incidence and aetiologies of OMF injuries inclusive of a specific variable. Both studies investigated maxillofacial trauma in cases of family homicide.

Within the included studies from 7661 sustained injuries that recorded causes for OMF injuries (n = 9441), the four most common causes were due to inter-personal violence (34.98%), falls (20.87%), sports (15.62%), and motor-vehicle accidents (14.31%). In total, these four aetiologies accounted for more than 85% of OMF injuries (Figure 2).

There was an overwhelming gender predilection, with males accounting for three times more injuries sustained than females.

See Figure 3 for distribution of injuries by facial bones. From 7661 sustained injuries, the orbit was the most prevalent site of fracture (31.85%) isolated or combined. Followed by the zygoma (22.01%), mandible (21%), nasal bone (12.45%), maxilla (10.04%), dentoalveolus (1.84%), antrum (<1%), and frontal bone (<1%) – note: only studies which assessed injury to multiple OMF (Data S1.1) sites were considered to ensure incidence data was not skewed to a specific site. Isolated or concomitant soft tissue injuries were too difficult to quantify as most studies excluded their incidence or did not assess them at all.

The average presentation rate of maxillofacial fractures was approximately 360 injuries per hospital per annum (Data S1.1 – other studies were unaccounted as they would not be represented of general presentation numbers because incidence and aetiologies of multiple sites were not assessed).

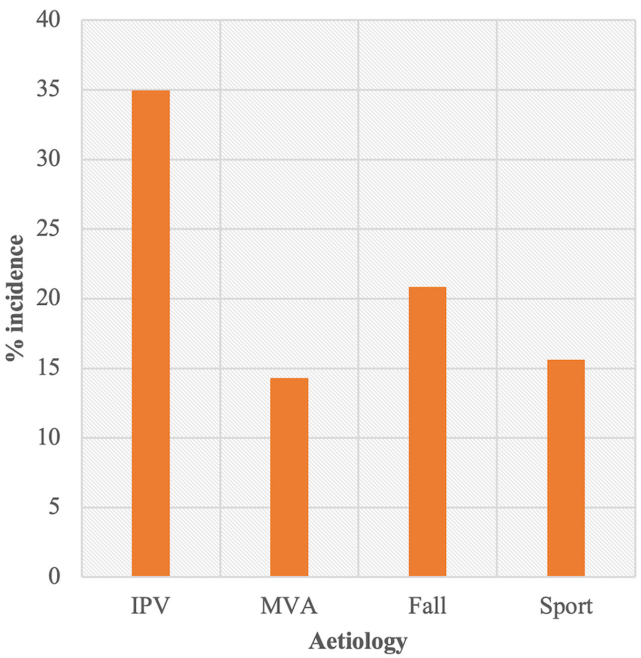

Fig. 2 Distribution of primary aetiologies of OMF injuries. IPV, inter personal violence; MVA, motor vehicle accident; OMF, oral and maxillofacial

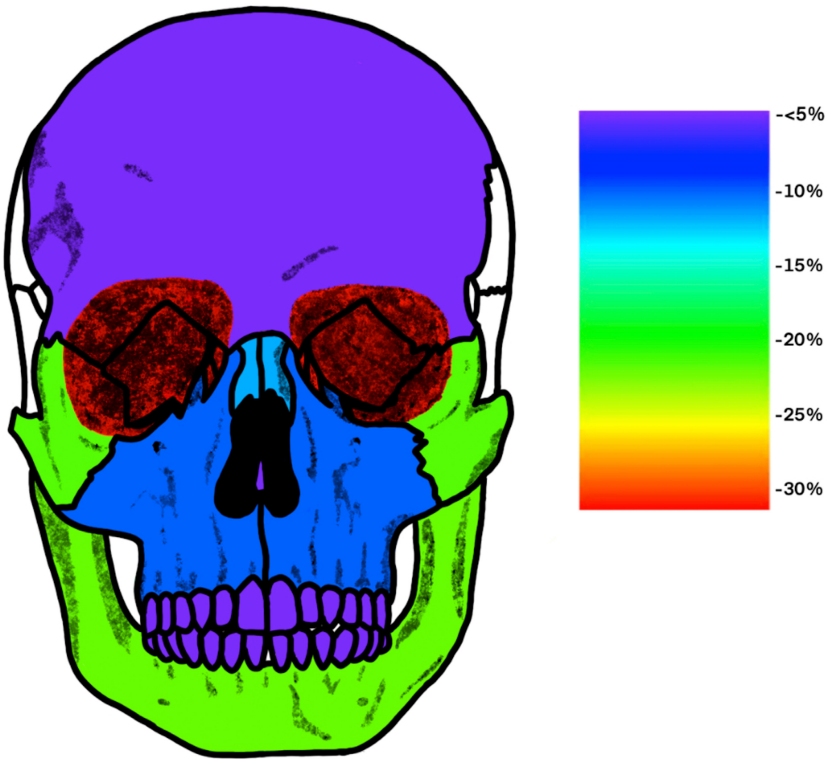

Fig. 3 Human skull illustrating distribution of injuries (left). Colour scale indicating distribution in percentage (right)

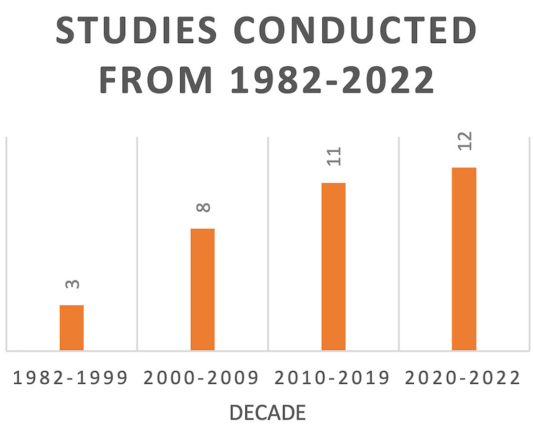

Fig. 4 Distribution of studies conducted between 1982–2022

With passage of time over the last 40 years, the number of studies investigating maxillofacial trauma have been continuously increasing. Figure 4 presents a graph characterizing the number of studies conducted from 1982 to 2022.

DISCUSSION

The search identified 31 studies addressing epidemiology of maxillofacial trauma in Australia from 1982 to 2022. Findings indicated several trends within data that illustrate aetiological patterns.

Isolated injuries

61.3% of mandibular fractures (n = 1724) were a result of IPV with the angle being the most prevalent site of fracture (26.66%, see Data S1.3). 40% of zygomatic fractures (n = 263) were a result of IPV with a tetrapod ZMC as the most common type of injury (61%, see Data S1.2). It is interesting to note that most studies assessing isolated facial fractures focused on the mandible, despite the orbital bone being twice as likely to be fractured and the most prevalent site of fracture out of all facial bones.

Dentoalveolar injuries

The primary aetiology of dentoalveolar injuries (36.5%) was falls (n = 1575). Luxation injuries (47.7%) were the most predominant type of injury within this category (see Data S1.4). However, it was difficult to quantify which specific type (i.e., subluxation, lateral luxation, intrusion, extrusion, etc.) was most common, as some studies grouped all luxation injuries together, whereas others separated them.

Sport-related injuries

Predilection of injury due to sport was unequivocally towards males. From a sample of 271 incurring sport related OMF injuries, 96% were male (see

Data S1.5). Evidently, Rugby (League/Union) and Australian Rules Football, sports dominated by males, were the most ubiquitous sports to be associated with an OMF injury.[12–15] 33% and 38% of incidences occurred from Australian football and rugby, respectively. This incidence is highly susceptible to change depending on where in Australia an individual is located. For example, the states of NSW and ACT reported approximately 237,000 participants playing at all ages and levels of Australian football.[12] Comparatively, Rugby League had more than 479,000 registered club players in the Greater Sydney region of NSW alone.[13] This difference in participation is reflected in the study by Kim et al[28] – a study conducted in Canberra, ACT – which recorded an incidence of OMF injuries five times more from Rugby than Australian football. Conversely, Australian football reigns as the most popular sport in SA, with 367 registered clubs as opposed to 24 Rugby Union and League clubs across the state.[14,15] Accordingly, this reflects Lim et al's[45] study conducted in Adelaide, SA – which revealed an incidence of injury nine times more from Australian football than Rugby.

Animal-related injuries

Animal-related OMF injuries (n = 163) were one of the uncommon categories which revealed predilection towards females (59%, Data S1.6).

From three relevant studies, Diab et al[22] had the only one which assessed OMF injuries inclusive of all animals, whereas the remaining two studies[27,31] specifically investigated equine related OMF injuries. Albeit the study by Diab et al[22] indeed revealed 82% of OMF injuries were from horses (n = 50).[22]

Paediatric facial injuries

Injuries within the under 18 population was markedly different from the general population in aetiology and site of injury (Data S1.7). From a sample of 332 patients, the most common aetiology of injury was sports (42.7%) and the most prevalent site of injury was the mandible (44.5%).

Injuries in the elderly and female populations

The elderly (>60 yo, n = 40) and female (n = 583) populations shared similarity in aetiology in which both groups' most common cause of injury was falls. 85% and 48% of the elderly and female groups, respectively, were injured from falls (Data S1.8, S1.9). The most common injury type for the former was ZMC fractures (38%), whereas the latter was injured primarily from OZM (30%) fractures. The geriatric group was also one of the few sub-populations which had female predilection (35%).

OMF injuries from family homicide

Two studies assessed OMF injuries present in cases of family homicide (Data S1.10). Both studies were conducted by Sarkar et al[20,25] in 2020 and 2021. The former assessed cases of adult (>18 yo, n = 118) family homicides and the latter assessed child (<18yo, n = 36) family homicides. From the adult sample, 61.9% of females succumbed to homicide. Conversely, male children (63.9%) were the predilected sex amongst the under 18 group. The primary aetiology of injury in adults was from penetration by knife or knife-like objects (45%), whereas injury in children was from blunt force trauma (56%).

Alcohol-related injuries

Eight studies reported the incidence of intoxication within their sample populations (see Table 1). It is notable to mention that for every sample, with exception to the female-only group, the most common aetiology of injury was IPV. Studies by Elledge et al[35] (34.8%) and Dongas et al[41] (45.8%) reported the two highest population percentages to be under the influence of alcohol or drugs.[35,41] Interestingly, their groups also represented the first (58.7%) and third (55.0%) highest incidences of IPV respectively.

Injuries in regional/rural/remote areas

From the studies which assessed IPV and MVA in a general population, differences in rate of occurrence were noted with respect to samples originating from regional and metropolitan areas. The Modified Monash Model was utilized to determine the rurality of a region.[48] Those which were rated MM1 were deemed as metropolitan sites and a rating of MM2< was designated as regional/rural.[48] Studies which collected data in a regional hospital (n = 1015) had an IPV and MVA prevalence of 60.08% and 11.77% respectively. Comparatively, studies which collected data in a metropolitan hospital (n = 5664) had an IPV and MVA prevalence of 42.41% and 14.04%.

Injuries in first nations populations

There has been a notable correlation between OMF injuries, IPV and Indigenous (see Table 2). Five studies reported the incidence of individuals who identified as Aboriginal or Torres Strait Islander within their sample. Studies by Schön et al[42] (44%) and Oberdan et al[37] (49%) had the two most prevalent samples of those who identified as Aboriginal or

Torres Strait Islander. These samples were also the two highest out of all 31 reported studies to have been injured due to IPV (83%, 74%) – an increase of 39% compared to the mean of every other study which reported IPV as an aetiology of OMF injury. It should also be noted that both studies by Schön et al[42] and Oberdan et al[37] were conducted in MM2 regional areas.

Studies from other countries

The aetiology and epidemiology of OMF injury presentations has been abundantly reported worldwide.[49] The four primary causes of OMF trauma identified in this review are consistent with the aetiology of injuries in other countries.[49] However, their prevalence was variable. MVAs for instance, are predominant in the Middle East, South America, and Africa, ranging from 33% to 91%.[49] This is likely attributable to comparatively lenient traffic law enforcement and regulations.[50] Conversely, Western countries such as Denmark, Sweden, the United Kingdom, and France have shown a decline in MVAs and an upward trend in IPV.[51] The implementation of effective drink-driving policies has correlated with the reduction in MVAs, while the rise in IPV may be linked to a lack of policy development, growing social acceptance, or excessive alcohol consumption.[49,52] This is further supported by the prevalence of IPV injuries in Islamic countries where alcohol consumption is prohibited,[53] such as the United Arab Emirates and Iran, with rates ranging from 2.9% to 9.2%.[49] Countries such as New Zealand, known for their sporting culture akin to Australia,[54] have displayed a prevalence of sport-related injuries from 18% to 20%.[49] Notably, 75% of injuries were attributed to rugby.[49] The nature of sport-related injuries varies across nations; for example, skiing in Austria, and soccer in France, which are most prominent in their respective countries.[49]

Data linkage refers to the process of combining information corresponding to the same individuals and events from different sources, to create a more unified dataset. Especially in the context of investigating maxillofacial trauma, data linkage would allow for the integration of information and facilitate the identification of trends, epidemiological patterns, and the effectiveness of interventions over time. However, the endeavour to include data linkage studies into this review was quite challenging due to minimal studies conducting data linkage. Variations in data formats, discrepancies in record-keeping practices and differential data quality pose logistical challenges to link the information across different domains. However, the data linkage studies were assessed for inclusion during the electronic database search. Three studies used the term 'linkage' within their text of the manuscript. Two of the studies by White et al[55] and Febbo et al[56] were excluded from this review during abstract and full-text screening respectively, as they did not meet the inclusion criteria. The remaining study by Shahim et al[38] was included in this review. Regardless, none of the above-mentioned studies used the term 'linkage' in the context of data linkage studies, effectively meaning no data linkage studies were identified in the literature search conducted during this scoping review.

There were some limitations of this scoping review. No studies within our criteria were found to have assessed OMF injuries in WA or NT to date. This is particularly significant since the Northern Territory has the highest relative First Nations population by state.[47] Considering, the findings from Schön et al[42] and Oberdan et al[37] pertaining to the higher incidences of OMF trauma in the indigenous population, there is likely a large gap of information which remains absent. Additionally, the data collected from regional sites is significantly lesser in volume than the metropolitan areas. Therefore, this scoping review which aims to assess injury prevalence across Australia can still be considered far from complete. This review was also limited in that some studies assessing general populations (Data S1.1) such as Cabalag et al[32] excluded dentoalveolar trauma from their assessment – ultimately skewing results against their incidence. Additionally, the critical appraisal tool utilized for our review scored each study out of 11, instead of 14 as originally suggested in the tool. The issue with the approach of this scoring system is the tendency to oversimplify assessment of methodological quality by weighing all items equally.[10,11]

This scoping review provides an initial understanding of the incidence and aetiologies of OMF trauma in Australia, even with a significant lack of data linkage studies. It has discerned the overwhelming prevalence of injury due to IPV with the primary affected population being indigenous males, followed by a prevalence of injury due to sports and falls within the paediatric and female/elderly populations respectively. Further data-linkage studies are recommended, specifically in regional/rural communities, and the states of WA and NT, where data is particularly limited. It is hoped the findings of this review raises understanding of OMF injuries and serves as evidence to help employ policies in their prevention.

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CONFLICT OF INTEREST

All authors declare no personal or financial conflicts of interest.

AUTHOR CONTRIBUTIONS

SSR Pabbati: Conceptualization; investigation; funding acquisition; writing – original draft; methodology; visualization; validation; writing – review and editing; software; formal analysis; project administration; data curation; resources. **P Thomson:** Supervision; formal analysis; project administration; writing – review and editing; conceptualization. **D Sharma:** Supervision; formal analysis; project administration; writing – review and editing; funding acquisition. **S Bhandari:** Data curation; software; formal analysis; methodology.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Data S1.

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APPENDIX A

FINAL SEARCH STRATEGY

Maxillofacial:

Maxillofacial OR maxillo-facial OR OMF OR maxillomandib* OR maxillo-mandib* OR maxilla* OR mandib* OR condyl* OR oral OR facial OR orofacial OR oro- facial OR dental OR alveolar OR dentoalveolar OR dento-alveolar OR jaw OR "lower jaw" OR midfac* OR mid-fac* OR panfac* OR panfac* OR nasal OR orbital OR nasoorbit* OR naso-orbit* OR naso-orbital-ethmoid* OR naso-orbitoethmoid* OR "naso-orbital ethmoid*" OR nasoorbitoethmoid* OR nasoorbitalethmoid* OR nasoethmoid* OR naso-ethmoid* OR "naso ethmoid*" OR NOE OR zygom* OR "zygomatic arch" OR "zygomatic complex" OR zygomaticomaxill* OR "zygomaticomaxill* complex" OR ZMC OR orbitozygom* OR orbito-zygom* OR OZM OR "orbital wall" OR "combined orbital" OR le- fort OR lefort OR "le fort" OR palat* OR palatoalveolar OR palato-alveolar

Injury:

trauma* OR fractur* OR injur*

Pattern:

pattern* OR trend* OR inciden* OR prevalen* OR aetiolog* OR etiolog* OR epidemiol* OR frequen* OR number

Australia:

Australia (added with QLD, NSW, WA, NT, TAS, ACT, VIC, SA) *in cinahl and ovid MeSH term*