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FEATURE

South Australian facial trauma: a population analysis of social economic deprivation and facial fractures—part two

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Abstract

Background: Trauma remains a leading cause of morbidity and mortality in Australia. The objective of this South Australian study was to analyse epidemiological trends in facial fractures and assess the relationship between socioeconomic disadvantage and clinical outcomes.

Method: A retrospective analysis of the relationship was conducted between socioeconomic disadvantage and facial fractures. All paediatric and adult patients with facial fractures who attended the Royal Adelaide Hospital and the Women's and Children's Hospital Adelaide between January 2012 and January 2017 either as in- or outpatients. The medical records, progress notes, imaging and operative notes from plastics, craniofacial and oral maxillofacial surgery teams were retrospectively collated into a registry and reviewed. Ethics approval was granted from the RAH Human Research and Ethics Committee [HREC/17/RAH/402].

Results: A total of 2559 patients, 1976 males (77.2%) and 583 females (22.8%), sustained a facial fracture. The most disadvantaged group had the highest proportion of facial fractures (36.9%), with the highest incidence in the 25–34 age group (22.4%). Assaults were the most common injury with decreasing odds as socioeconomic advantage increased ($p<0.05$). Orbitozygomatic fractures were the most common type of facial fracture (27.7%). Indigenous patients were more likely (OR=2.8) to have surgery compared to non–indigenous patients ($p<0.05$). There were no significant differences in length of stay between socioeconomic groups ($F(4,964.387)=2.091$, $p = 0.080$).

Conclusion: Socioeconomic status strongly influences the mechanisms on injury, types of fracture and likelihood of surgery with the most disadvantaged having higher rates compared to the least disadvantaged.

Keywords: South Australia, facial injuries, social class, socioeconomic factors, registries

This paper is presented in two parts: part one includes methods (study setting, design and data, costs and statistics) and results (aetiology, fracture type, treatment, complication and hospitalisation); part two includes discussion (mechanism of injury, type of fracture, clinical outcomes), limitations and conclusion and should be considered a direct continuation of part one.

Discussion

South Australia (SA) is second only to Tasmania among Australian states in its distribution of economic disadvantage with one quarter of its population represented in the most disadvantaged group of Australians. Almost three quarters of the population are in the first to third quintile with only a small proportion (8.9%) in the least disadvantaged group.[14] This study strongly reflects the Australian Bureau of Statistics population data with the distribution of maxillofacial fractures providing a unique perspective on the social determinants of health that impact the aetiology and type of fracture and, invariably, the clinical outcome and costs. The importance of understanding these determinants is key for prevention campaigns and minimising costs where maxillofacial trauma in New South Wales, Australia, estimated costs to account for over $30 million annually.[15]

Mechanism of injury

Road traffic accidents

Assaults, RTA and falls represent the leading causes of facial trauma worldwide but their relative frequencies have changed over the years due to various interventions.[16] Although RTA remains an important cause in developing countries, our findings are consistent with reports of their overall decrease in the past 30 years.[17] The shift from high energy to low energy trauma, legislative changes and the introduction of airbags have resulted in shifts in the aetiology of facial fractures, with similar findings in other studies.[18] The most disadvantaged population group had a higher proportion of RTA related facial fractures compared to the least disadvantaged across all age groups. The younger group (18–25 years) represented one fifth of all RTA injuries, consistent with Australian data that younger drivers with lower socioeconomic status are at increased risk of crash related hospitalisations compared to drivers with higher socioeconomic status.[19]

Assault

Assaults remain a serious cause of maxillofacial injuries in men and women.[20] Our previous study in the 1990s showed that assaults represented almost half of all cases, followed by RTA and sports related injuries.[21] Our current experience again confirms that assaults are the most common cause for facial fractures in SA.[22] While there are many complex and confounding factors involved in the relationship between assaults and social deprivation, it is established that disadvantaged groups have a higher prevalence of risk factors for physical violence such as alcohol and drug abuse.[23] Wilson and colleagues' study of 290 mandibular fractures in Bristol, UK, identified a strong relationship between deprivation and the incidence of mandibular fractures with a significant trend of increasing frequency of assault with worsening deprivation.[24] Our experience showed lower rates of assault compared to south west England, but held overall similarities regarding the most disadvantaged group who present with a greater proportion (45.2%) of the total number of assaults. Those from lower socioeconomic groups are more likely to have facial fractures from assault compared to the least disadvantaged. Further elaborating on age and sex, this study highlights people aged 18–25 years from higher socioeconomic groups are less likely (33.4%) to have a facial injury compared to the most disadvantaged group. We also established that young men are more likely to experience assaults based on risk taking behaviours than young women, with the highest incidence among the most disadvantaged. The odds of a male sustaining a facial fracture from assault decreases by socioeconomic level of advantage (40.0%), however, there are notable differences between the more and less disadvantaged groups **(Figure 2)**. Interestingly, the non-linear, subtle differences among quintiles suggest variations among the groups and are likely reflective of a wider range of education, income and housing within postcode areas.

Among indigenous people, assault was the most common mechanism of injury with greater odds (OR=2.926) compared to non–indigenous people. Kruger and colleagues' retrospective analysis of jaw fractures in indigenous people likewise found significantly higher rates across all age groups compared to non–indigenous people.[25] Our study

further established higher rates of mandibular fractures and lower rates of orbitozygomatic fractures (**Table 6**). Women who experience assault are a growing concern with evidence that physical violence against women by a male partner appears to be strongly associated with social deprivation.[26,27] Interpersonal violence was present in approximately one quarter (26.4%) of all female facial fractures with the majority of female assault cases (54.0%) in the most disadvantaged group. Compared to this group, the odds of a woman experiencing assault decreases significantly with each quintile suggesting that they are less exposed to risk factors for violence such as household distress. The risk factors for domestic violence are complex but an Australian longitudinal study has attributed household distress (such as substance abuse, mental illness or living in non–metropolitan areas) to a higher likelihood of domestic violence.[28]

Falls

Falls in the elderly account for a growing subgroup of maxillofacial injuries that can result in serious morbidity and mortality. With an ageing population, the percentage of falls and related comorbidities presenting to a maxillofacial unit will challenge medical practice.[29] In Australia, maxillofacial fractures are the third most common trauma in falls in the elderly after neck of femur and upper limb fractures.[30] The elderly represent another high–risk group associated with inverse inflammatory responses and immunocompromise and substantial delay in wound healing.[31] A retrospective study of 209 elderly patients in the USA reported falls as the cause of 11 per cent of all facial fractures in this cohort;[32] in contrast, we reported a higher rate of falls (13.9%) of all facial fractures. The vast majority occur in the elderly, however, in the 45–55 age group, the least disadvantaged were 3.2 times more likely to have a fall compared to the most disadvantaged group due to alcohol use and outdoor activities.

Sports

Sports related facial fractures occurred most frequently among youths, but the rate of participation in sport is not uniform across socioeconomic status. A 2005 Australian study by Salmon and colleagues found that participation was greater in children from least disadvantaged groups than more disadvantaged.[33] The least disadvantaged children were approximately three times more likely to have a facial fracture than the most disadvantaged. Both 18–25-year-olds and youths were more likely to participate in sport and engage in physical activities than their most disadvantaged counterparts, with popular sports like Australian Football League, bicycle motocross racing or rugby union resulting in injuries. Dollman and Lewis' SA study showed that least disadvantaged kids often have less access to sporting facilities, provision of equipment and less parental support.[34] These findings affirm our results with the least disadvantaged kids having a greater level of engagement, which is reflective of the greater risk of injury compared to the most disadvantaged.

Work

European data has shown that men, younger employees and those in lower occupational classes are more prone to work injuries.[35] Half of the workers who sustained injuries were in the third and fourth quintile, which is consistent with findings that the most disadvantaged are more likely to be unemployed and have lower incomes and in turn have lower odds of a work place related injury.

Animal

Animal related injuries, largely equine, were normally distributed with most injuries occurring in the most disadvantaged group. Schroter and colleagues' 2017 study reported similar distributions among men and women (40.2 vs 24.5 years, 42.8 vs 33.1 years) with the younger female group considered as a high–risk group in equestrian sports with similar degrees of associated injuries.[36]

Type of fracture

Orbitozygomatic

Orbitozygomatic fractures represent the most common type of facial fracture, consistent with similar Australian and international studies.[37,38] Shahim and colleagues' Australian study of 1339 major trauma injuries reported 299 (22.3%) orbtiozygomatic (maxilla) fractures, however, our study included all maxillofacial fractures and is representative of both minor and major trauma.

Fractures that involve the maxilla are usually the result of high energy blunt forces from assaults, falls, sports and RTA. In our study, there was a higher proportion of orbitozygomatic fractures within the most disadvantaged group compared to the least disadvantaged.

Orbit

Fractures of the orbit were the second most common type of fracture to occur, consistent with Alvi and colleagues' Australian study.[39] One in four people sustained an orbital floor fracture with the odds decreasing from the most disadvantaged group to least, however, this occurred principally in the 25–35 age group with the most disadvantaged, largely from assaults.

Mandibular

Edwards and colleagues' SA study showed over one third (38.9%) of facial fractures were mandibular fractures with half caused by assaults, predominantly involving young men.[40] Compared to international studies,[41,42] assault represented approximately half of the mandibular fractures but there has been an overall shift in patterns in Adelaide over the years. In the representation of mandibular fractures, RTA have decreased (21.0% to 7.2%) but falls in the elderly (17.8%) and sporting injuries (20.5%) have increased. Compared to the 18–25 most disadvantaged group, there were half the numbers of mandibular fractures in the middle disadvantaged group and a third in least disadvantaged group, respectively. A mandibular fracture is less likely (50.0%) to occur in the middle disadvantaged group compared to the most disadvantaged group likely attributable to greater risk-taking behaviors in younger men and substance abuse.

Sinus

The least disadvantaged group aged 25–35 years were four times more likely to have a frontal sinus fracture compared to the most disadvantaged group ($p<0.05$) largely accounted for by sport or animal related injuries.

Cervical spine

The incidence rate for cervical spine fractures is reported between two and 10 per cent.[43,44] Of cervical spine injuries (1.7%), almost half (45.5%) occurred from RTA then falls, consistent with the global literature.[31] Van den Bergh and colleagues' study demonstrated lower cervical spine injuries (0.2%) were solely from RTA, reflective of higher energy trauma.[20] The aetiolgoical changes in cervical spine injuries today are reflective of the shift away from RTA presentations to an increase in falls. As such, all patients with maxillofacial fractures should be systematically assessed for cervical spine and concomitant injuries, particularly for groups with a high risk of RTA and falls.

Associated injuries

Associated injuries in Adelaide have increased from 11.3 to 24.7 per cent with two key risks groups from RTA and falls who are more likely to sustain higher energy trauma. Of the total associated injuries, approximately one quarter (24.7%) sustained a neurological injury. Although our rate of brain injury was lower, Hohlreider and colleagues' study reported brain injuries ranging from 2.5 to 9.7 per cent depending on the facial fracture type.[45]

Clinical outcomes

There are notable trends in the disadvantaged group and indigenous population with almost half the cases admitted to hospital. The most disadvantaged group had consistently higher proportions of admissions across all age groups, except in the elderly. By age group, the youngest most disadvantaged group had significantly higher admission rates than those from other age groups and disadvantage levels. Interestingly, the middle disadvantaged group was the second largest group for admissions across all ages, but the elderly represented the largest. Admissions by principal diagnosis did not show any statistically significant odds by age group and socioeconomic status, but the proportion of hosptilisations drew attention towards the most disadvantaged groups, particularly those aged between 18–45 years. In contrast, the least disadvantaged were less likely to be admitted in all age groups. This may be attributed to the smaller likelihood of facial trauma, however, hospitalisation and transfer to other private hospitals may be a confounding factor. Kruger and colleagues' retrospective analysis reported similar rates to our study with higher hospitalisation rates for indigenous people compared to others, particularly those who are male, live in rural and

remote areas and who are socio-economically most disadvantaged.[25] The most disadvantaged groups had an overall greater likelihood of injury that required surgical intervention. The odds of surgery decreased significantly across each socioeconomic group with the least disadvantaged yielding less chance of an operation (surgery=62.4%, ORIF=60.8%). These findings highlight that each quintile is less likely to sustain facial trauma compared to the most disadvantaged, but age group showed no statistical significance. For the most disadvantaged, who are more likely to have facial fractures from assaults that require surgery (and ORIF), if aged between 25–35 years, they are two times more likely to require an ORIF compared to the middle disadvantaged group.

A Western Australian study on socioeconomic disadvantage showed that, in oral related disease, those who are most disadvantaged stayed on average longer in hospital than others and the average cost per admission was highest in this group.[46] While this study did not specifically focus on facial fractures, it provides additional insight into the general trend of oral care. Although there were no statistically significant differences in mean length of stay between the different socioeconomic groups ($F(4,964.387)=2.091$, $p=0.080$; **Table 8**) the data from this study concurs with our results that the middle disadvantage group are second to the most disadvantaged group in presentations for facial trauma. Interestingly, the most disadvantaged group may present with more facial fractures, but based on mean length of stay compared to the middle disadvantage group, they are less likely to be admitted.

A unique socioeconomic comparison between these two groups, the most disadvantaged and the middle disadvantage, is tenable within the population. On one hand, there is the least disadvantaged who generally do not have fractures and have less procedures compared to the most disadvantaged; and then there is the middle disadvantage group who have more presentations for facial trauma, are less likely to injure themselves and have operations, but are more readily using the health care services compared to the most disadvantaged. This thought-provoking finding reflects the nuances among socioeconomic groups in SA where linearity does not consistently and clearly exist in the analysis. These findings highlight the need for public policy focused on trauma for these two groups, particularly the most disadvantaged as they are overall less likely to seek medical care. The measures of cost are generally conservative and, in many cases, indirect costs from travel and time are not included. Furthermore, indigenous people were noted to have longer hospital stay and higher rates of complications but travel, regional or rural living and different social systems must be accounted for.

The social gradient has been well documented and numerous studies have demonstrated this in the Australian context of oral health.[47] This study demonstrates findings consistent with other parts of the developed and developing world that areas of high socioeconomic deprivation have higher incidences of all trauma.[48,49,50] The geospatial mapping of risk for facial fractures is a useful tool for policy makers and local health networks to target and deliver focused intervention strategies around areas of disadvantage. These findings provide insight into the need for educational awareness about specifically vulnerable groups and instilling holistic multidisciplinary care early to improve clinical outcomes.

Limitations

This study significantly advances Australian research, specifically within the SA population, for understanding the impact of socioeconomic status on maxillofacial fractures, their management and costs. By using postcode areas we were able to provide a detailed analysis on socioeconomic characteristics in SA, identifying both high and low risk residential groups. Although this method of analysis has been used in other areas of medical research, this is the first Australian focused, geospatial and socioeconomic analysis of deprivation to specifically examine the determinants of injury on maxillofacial fractures. This study covers the whole of SA, including rural and regional areas and with the major tertiary and quaternary trauma units making it the closest representation of the SA population in the literature.

Limitations include retrospective bias, selection bias and collection of data. All attempts to document and include patients in the registry

relied heavily upon the accuracy of trainees to document and record entries. However, in cases of abuse or domestic violence, the exact mechanism of fracture and the role of substance misuse were not always clear. Alcohol status was inferred from patient history, clinical assessment and/or blood alcohol levels. Formal blood alcohol levels were not mandatorily taken for trauma patients and compliance for testing is equivocal across centres. Prospective studies should include a mandatory blood alcohol level for facial fracture injuries presenting to an emergency department, just like Canadian studies have previously instilled in tertiary centres for trauma.[51]

One of the strengths and limitations with this study is the use of postcodes to understand socioeconomic impact. The use of socioeconomic parameters and timing of injury (SEIFA) is essentially derived from the population weighted average of smaller unit scores but one of the concerns with its use is the possibility of masking socioeconomic diversity within an area. South Australia, unlike other Australian states, has three quarters of the population in the most disadvantaged to middle disadvantaged groups; the middle group has notable observations of social diversity and heterogeneity of socioeconomic status that was reflected in presentations, admissions and rates of seeking medical care. Although the sample size is one of the largest in Australia, the use of postcodes is a proxy for socioeconomic disadvantage within which individual diversity of an area must be considered. The decision not to include a sub analysis of SEIFA based scores specific for indigenous Australians was based on statistical and conceptual reasons concerning housing, residency and connection to country, however, future analysis specifically on indigenous presentations would be invaluable.[52] Ongoing longitudinal surveys of maxillofacial fractures are crucial to understanding epidemiological patterns and trends. In future studies, we intend to report the findings of the specific subgroups and comparatively assess their changes over time.

Conclusion

The changes in SA over recent decades reflect similar findings and are consistent with the Australian and international literature. Road and traffic accidents are decreasing due to changes to driving laws but falls and sports injuries are becoming an increasing presentation to trauma units. The most disadvantaged group are more likely to have a facial fracture from assaults with significant odds decreasing between least disadvantage groups. Fracture type has shifted towards the midface, orbitozygomatic and orbits, as the most common type of injury. The socioeconomic distributions of these injuries are greatly represented in the most disadvantaged group with odds decreasing per quintile.

This study shows that socioeconomic status strongly influences the mechanism of injury, type of fractures and surgery with the most disadvantaged having higher proportions compared to the least disadvantaged. The socioeconomic determinants of health are complex and an understanding of high-risk groups can aid in clinical assessment, education and multidisciplinary care. Public policy and interventions should focus on the most marginalised groups to reduce these inequalities. Understanding facial fracture aetiology and management requires considerable attention to vulnerable groups. The multidisciplinary approach unique to South Australia incorporates these salient points in vocational education and surgical management so multiple specialties can use sub-specialty skills to optimise patient care and clinical outcomes. A sound understanding of social determinants and a comprehensive registry with ongoing surveillance will provide clinicians with the armamentarium needed to stratify risks and better manage those from disadvantaged areas presenting with facial trauma.

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Patient consent

Patients/guardians have given informed consent to the publication of images and/or data.

Conflict of interest

The authors have no conflicts of interest to disclose.

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The discussion presented in this paper is based on data presented in 'South Australian facial trauma: a retrospective population analysis of social economic deprivation and facial fractures—part one'.

Supplementary online material

Appendix 1: Mechanism of injury at admission, by age group, in relation to socioeconomic disadvantage of area of residence

Appendix 2: Primary facial fractures by age group in relation to socioeconomic disadvantage of area of residence

Appendix 3: Odds ratios for primary facial fractures at admission, by age group, in relation to socioeconomic disadvantage of area of residence