



Climatic Effects on the Incidence of Interpersonal Maxillofacial Trauma

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Abstract

Introduction and Aims: The relationship between interpersonal violence and weather has been described in international studies. This study compared the daily incidence of interpersonal maxillofacial trauma in Brisbane over a 1 year period with respect to local weather conditions and temporal factors, such as weekends and public holidays.

Design and Methods: The cases included in the study were Brisbane residents with maxillofacial trauma who presented to the maxillofacial surgery clinic at the Royal Brisbane and Women's Hospital after being assaulted. The daily maximum and minimum temperatures, rainfall, and solar exposure were recorded at the Brisbane weather station, and this data was used in Poisson regression analyses with respect to trauma data, weekends, and public holidays.

Results: 389 assaults resulting in maxillofacial trauma were identified over the 12-month period, with 89.7% of the patients being male. The number of assault cases was found to be associated with weekends and public holidays ($p < 0.001$ and < 0.05 respectively). With regards to weather conditions, there was a significant positive association between assault cases and rain, and also with daily solar exposure ($p < 0.05$).

Discussion and Conclusions: The significant associations between assault and weather and temporal factors in Brisbane are consistent with international behavioural theories on crime and violence. These findings are relevant to the Australian Police Force and hospital emergency departments with regards to the efficient use of resources in response to interpersonal violence.

Keywords: Assault; Maxillofacial trauma; Weather; Climate; Weekend; Weekday

Introduction

The influence of weather on crime is a fascinating and well researched area. Indeed deterministic criminology has existed since the 19th century and has sought to understand environmental influences on human behaviour [1]. It is well established in studies within moderate climates of the Northern hemisphere that high temperatures and long daily solar exposure have statistically significant positive relationships with the number of assaults committed in a day [2]. However, it has not been established whether these patterns are replicated in sub-tropical climates and conversely whether other climatic affects may have a larger influence.

A ten-year retrospective study of recorded crimes in England and Wales found strong evidence supporting a positive relationship between temperature and violent crime [3] but care must be taken in extrapolating these findings to countries with comparatively elevated year round temperatures, as experienced in Australia.

Aggression and violence is a significant problem in Australia, particularly in and around licensed social establishments [4]. This study aims to be the first to identify any variance in interpersonal violence with weather and temporal factors in a subtropical climate.

Maxillofacial trauma is common in emergency department presentations of interpersonal violence [5], and was therefore chosen as an objective measure of interpersonal violence for the purposes of this study.

It was speculated that interpersonal maxillofacial trauma presentations would increase with more favourable daily weather conditions, such as low rainfall, high temperatures, and high daily solar exposure as seen in Northern hemisphere studies from the United Kingdom and United States. It was additionally hypothesised that the temporal factors of weekends and public holidays would be associated

with increased rates of assault due to increased human interactions as described in the Routine Activity theory of crime [6].

Method

Aim and hypothesis

The purpose of this study was to ascertain whether or not climatic variations and temporal factors have a relationship with the number of assaults committed in Brisbane, in particular those resulting in maxillofacial trauma.

Design

This study involved a retrospective descriptive single-sample survey.

Population

The maxillofacial surgery unit at the Royal Brisbane and Women's Hospital (RBWH) is a major public maxillofacial health service in Brisbane. We analysed all maxillofacial surgery consultations at the RBWH over a 1 year period (2011). From this population 389 patients were victims of assault and these patients were included for further analysis. Of the 389 patients 349(89.7%) were male and 40(10.3%) were female. The age range of cases was 16-63 years (mean: 30.03, median: 27, mode: 21). 262(67.4%) victims admitted to the consumption of

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alcohol prior to injury while 92(23.7%) victims denied any alcohol consumption. In 35(8.9%) cases this information was withheld or not recorded.

The facial injuries suffered in these assault cases included zygoma fractures, maxillary fractures, zygomaticomaxillary complex fractures, orbital fractures, nasal bone fractures, mandibular fractures, frontal bone (sinus) fractures, and dentoalveolar trauma. Of these diagnoses, mandibular (jaw) fractures were implicated most commonly, being present in 134 (34.4%) assault cases.

Meteorological data

Weather data for each day of the same 1 year period were recorded at the Brisbane weather station (altitude 8.13 m, latitude -27.4808, Longitude 153.0389) by the Australian Bureau of Meteorology [7]. Brisbane has a humid subtropical climate, with 2011 recording a mean maximum temperature of 25.9°C (-0.6 difference from historical averages), and a mean minimum temperature of 16.0°C (-0.2 difference from historical averages) [7]. There were 1175.6 millimetres of rainfall recorded in 2011, which is 120% of the historical annual average in Brisbane. For the purposes of this study, the key variables of Brisbane weather were daily maximum and minimum temperatures, rainfall, and solar exposure. It is these particular variables which were analysed for correlation with facial trauma.

Statistical Analysis

Poisson regression was used to determine if there was a relationship between the rate of assaults and the aforementioned weather variables. Purposeful selection was used to create a multivariable model by including variables from the univariate analysis with a p-value<0.200. Variables were then excluded from this model that did not reach significance (p<0.05). Excluded variables were added back to the model one at a time to check for confounding factors. All variables were checked for interactions with weekends, and any significant interactions (p<0.05) were included in the final model. The final model was stratified to further examine if patterns for weather variables differ on the weekends or weekdays compared to all days.

Results

Assaults on all days (n=389)

Univariate Poisson regression showed that the number of daily

assaults over the twelve-month period was as expected significantly associated with weekends (p<0.001) (Table 1). The rate of assaults was 2.70 (CI: 2.19, 3.34) higher on weekends compared to weekdays.

In direct contradiction to previous studies rain was significantly associated with the number of assaults per day with an increase of 28% (CI: 1.05, 1.57) when rain was present (p<0.05). Unlike previous UK studies the number of assaults over all days was not found to be significantly associated with minimum or maximum temperature, or season. After adjustment for confounders, the rate of assault on public holidays increased by 1.7 (CI: 1.10, 2.70) (p<0.05), and by 25% (CI: 1.02, 1.54) when it rains (p<0.05).

There was also a significant interaction between rising daily solar exposure and weekends when compared to weekdays (p<0.01), and this relationship is detailed further in sections 3.2 and 3.3 using stratified multivariate models.

Assaults on weekdays (n=129)

When the data was stratified for weekdays only (Table 2) a 2.7% increase in assaults with rising daily solar exposure was observed (p<0.05). There were no other significant relationships between weekday assaults and weather variables.

Assaults on weekends (n=260)

When considering weekend-only data (Table 3), there was no significant association between solar exposure and weekend assault. Rain was found to be significantly associated with weekend assault (p<0.05), with the rate of assaults increasing by 35% when it rained. There were no other significant relationships between weekend assaults and weather variables.

Assaults on public holidays (n=20)

After adjustment for confounders in the multivariate analysis, the rate of assault increased by 1.7 (p<0.05) on public holidays. When the data was stratified for weekdays only, the rate of assaults was 2.1 times higher on weekday public holidays compared to non-public holiday weekdays (p<0.05). When the data was stratified for weekends only, there was a 35% increase in assaults on public holidays, but this increase did not reach significance. There were no associations between public holidays and weather variables; however, this could be attributed to the

Variable	Criteria	N	Rate Ratio	95% Confidence Intervals		p-value
				Lower	Upper	
Weekend	Yes	157	2.701	2.186	3.338	<0.001
	No	208	1	-	-	
Public Holiday	Yes	13	1.468	0.936	2.302	0.095
	No	352	1	-	-	
Season	Autumn	92	1.333	1.01	1.761	0.043
	Spring	91	1.15	0.863	1.534	0.34
	Summer	90	1.022	0.759	1.376	0.885
	Winter	92	1	-	-	0.146
Rain	Yes	134	1.283	1.05	1.569	0.015
	No	231	1	-	-	
Max	-	365	1.007	0.981	1.034	0.59
Min	-	365	1.016	0.995	1.037	0.144
Solar Exposure	-	365	0.997	0.981	1.012	0.667

Weekdays-Monday, Tuesday, Wednesday, Thursday.
Weekends-Friday, Saturday, Sunday.

Table 1: Univariate poisson regression model of assaults and all weather and temporal variables.

Parameter	Criteria	N	Rate Ratio	95% Confidence Intervals		p-value
				Lower	Upper	
Public Holiday	Yes	9	2.133	1.141	3.988	0.018
	No	199	1	-	-	
Rain	Yes	73	1.095	0.751	1.597	0.638
	No	135	1	-	-	
Solar Exposure	-	208	1.027	1	1.054	0.048

Public holiday, rain, and solar exposure were the only parameters analyzed in the stratification process due to significance in the unstratified univariate model (Table 1).

Table 2: Multivariable poisson regression model, stratified for weekdays only.

Parameter	Criteria	N	Rate Ratio	95% Confidence Intervals		p-value
				Lower	Upper	
Public Holiday	Yes	4	1.35	0.694	2.628	0.376
	No	153	1	-	-	
Rain	Yes	61	1.346	1.054	1.719	0.017
	No	96	1	-	-	
Solar Exposure	-	157	0.982	0.963	1.001	0.066

Public holiday, rain, and solar exposure were the only parameters analyzed in the stratification process due to significance in the unstratified univariate model (Table 1).

Table 3: Multivariable poisson regression model, stratified for weekends only.

low sample size with regards to public holidays within any 1 particular year (Figure 1).

Discussion

This study retrospectively analysed the relationship between 389 maxillofacial assault cases at a major metropolitan hospital in Brisbane and weather and temporal factors over the period of one year. Based on the statistical analysis performed, there are some clear associations between weather variables and assault cases. As per findings by McLean [2] and Field [3] it was expected that better weather conditions-in terms of temperature and solar exposure-would accompany a raised incidence of assault. Instead, an unexpected positive association between assault and the presence of rain was observed.

We theorise that the event of rainfall forces more people within a confined indoor space: as per the Routine Activity theory of crime [6], rainfall may serve as the motivating factor for frustrated potential offenders, and the confined indoor space increases the chance of potential offenders encountering potential targets.

Unlike previous studies we found no associations between assaults and temperature or season. We suggest that this is due to a humid subtropical climate with a mean maximum temperature of 25.9°C, and a mean minimum temperature of 16.0°C. The significant seasonal variation in assault figures identified by Rock [8] and Michael [9] cannot be generalised to this study, as these investigations were carried out in the United Kingdom and the United States of America respectively where there are more extreme weather variations throughout the course of the year. The initial hypothesis that better weather conditions would accompany increased assaults was in line with studies by McLean and Field, both of which were conducted in the United Kingdom [2,3].

Another unexpected finding of this study was that when examining all days, there was a significant positive association between assault rates and solar exposure. This result has, thus far, not been reported in any other studies. When data was stratified for type of day (weekday or weekend), there was only a significant positive association between weekday assaults and rising solar exposure.

There are fewer assault cases on weekdays (Monday-Thursday) than there are on weekends (Friday-Sunday) and public holidays, which

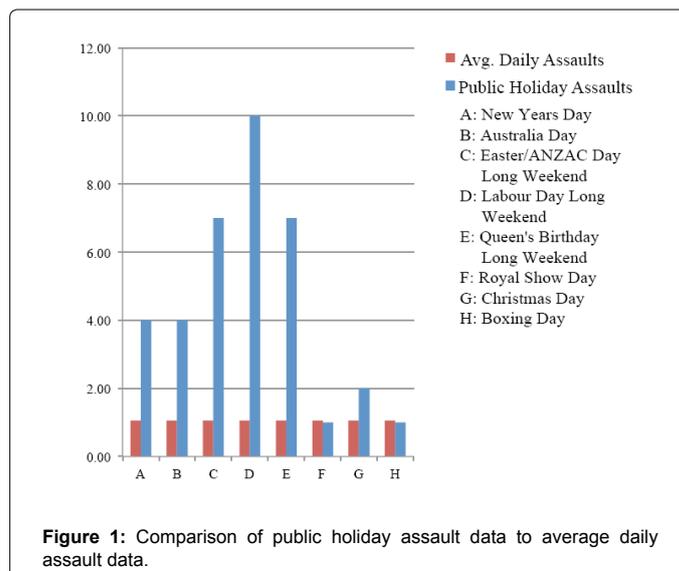


Figure 1: Comparison of public holiday assault data to average daily assault data.

suggests that social activities that result in assault are more commonly engaged in on weekends and public holidays. As disclosed in the methods section, alcohol intake was admitted to in 67.4% of assault cases. These findings are consistent with a report published by the Australian Institute of Criminology which states that Australians aged 18 to 30 are more likely to spend their free time in licensed premises and outdoors in the streets where there are higher risks of violence and injury [4]. The consumption of alcohol in the night-time economy is widely accepted as a significant part of Australian culture, and is also responsible for a range of social and health-related problems [10]. Australia Day and New Year's Day are two public holidays in particular that are notorious for celebrations involving excessive alcohol consumption and violence [11]. 2011 did not differ from this trend, with both days recording equal third highest number of daily assault presentations to the RBWH. Thus, further studies on the relationship between climatic effects and interpersonal assault should additionally quantify the consumption of alcohol and drugs.

It is important to note that not all interpersonal violence results

in maxillofacial trauma or even presentation to hospital: Maxillofacial trauma was selected as an objective measure of interpersonal violence for the purposes of this study [5]. Further studies could additionally collate police data on reported interpersonal violence over a given study period.

The potential implication of identifying trends in assault with weather and temporal factors is an increased awareness amongst Australian police and hospital accident and emergency departments: Significantly positive assault associations with weather and temporal factors could prompt the modification of resource allocation and response protocols in accordance with the data. Further research over a longer period of time across multiple metropolitan sites in Australia should be considered in order to strengthen the findings of this study.

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