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Is weather related to the number of assaults seen at emergency departments?

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ABSTRACT

Background: It is often suggested that the weather can effect behaviour, increasing the likelihood of assaults and resulting in increased admissions to emergency departments (ED). Therefor a better understanding of the effect of climatic conditions could be useful to help EDs in capacity planning. Whilst other studies have looked at this, none have used data collected specifically to look at ED attendance for assaults or have taken account of potential behaviour modifiers.

Methods: We use data from our ED violence surveillance system, the Cardiff Model (CM), married to daily meteorological data to construct negative-binomial regression models. The models are used to estimate changes in the assault rate with changes in temperature, adjusting for day of the week and alcohol consumption.

Results: We find that there is 1% increase in the assault rate for every degree increase in the maximum daily temperature (IRR = 1.01, P-value = 0.033). Additionally, different patterns in alcohol consumption at weekends also provide a significant contribution. However, when we generalise this model to represent temperature in terms of factors of standard deviation from the mean temperature, the IRR relationship changes, plateauing at unusually high temperatures (±1.5 SD above the mean).

Conclusions: The results presented here suggest that whilst temperature does increase the risk of assaults in Dorset, there may be a limit to its effect. This implies the 'curve-linear' relationship for temperature as suggested by others.

Introduction

Anecdotally it is often suggested by medical and law-enforcement professionals that at times when the weather is "good", with increased daylight and temperature, there is more aggressive behaviour resulting in confrontations leading to more assaults.

A number of authors have investigated the relationship between weather and assaults with differing results. Whilst studies that look at crime tend to find a relation between temperature [1–6], two UK studies [1,7] have found significant and positive correlations between daily (maximum & minimum) temperature and paediatric trauma admissions, but only a significant association for adult injuries with minimum temperature [7], whereas another study looking at ambient temperature and violence related ED attendance found no such relation [8]. A recent systematic literature review [9] found that increased temperature is positively correlated with trauma admissions and that paediatric trauma, both in respect of trauma admissions and fracture rate, is more sensitive to the weather than adult trauma. However, they stress that important methodological differences between studies limit the value of the existing literature in building consensus for a generalizable model. Additionally, there is a difficulty in extrapolating the results of local studies because the response of a particular population to the weather is likely to be highly context-specific.

We also note that few studies have attempted to adjust for behavioural effects such as alcohol consumption, which in itself likely to be related to temperature and temporal effects. One other methodological issue we seek to address is that of the assumed linear relation between temperature and crime/trauma. Traditionally, regression techniques are employed to model linear relationships with temperature, however, some authors have suggested that there is in fact a 'curve-liner' association with an underpinning behavioural model: the negative affect escape (NAE) model [2,5,6]. According to the NAE model, relationships between heat and aggression are mediated by a negative effect. This exerts one of two effects on behaviour; initially, moderately high levels of heat tend to increase the probability of aggression, however, as the temperature increases further, a negative affect increases as more

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individuals become interested in escaping the oppressive heat. This therefore reduces aggressive tendencies. This results in the linear relation with assaults plateauing at high temperatures.

It is these final two points we seek to address here. To do this we attempt to construct a generalizable model from a dataset made by combining data from a violence surveillance scheme conducted in three hospital emergency departments, with temperature from a metrological database.

Methods

The assault data was extracted from a local violence surveillances scheme run in three hospitals covered by the Dorset Clinical Commissioning Group (CCG): Dorset County Hospital (DCH), Royal Bournemouth & Christchurch Hospitals Trust (RBCHT) & Poole Hospital Trust (PHT). This is based on the Cardiff Model (CM) initiative described by Florence et al. [10]. Here, individuals presenting at one of the EDs with an assault injury are identified by reception staff and a paper-based questionnaire is completed by medical staff whilst in conversation with the patient. The data captured relates to information about the assault victim (age, sex and postcode), the attacker (stranger, friend, partner etc.), and the assault time and location (home, bar, street etc.).

For this study we used assaults occurring between January 2014 and December 2016. For each assault we extracted only information relating to the date of the assault, the day of the week the assault occurred on, and if alcohol had been consumed by the victim. This alcohol variable is a self-report to the attending clinician during their treatment process. No identifiable data was used in this study, and approval for use of this data for research was given by the local CM steering group and the three hospital research governance boards.

We obtain daily temperature measurements from nine weather stations in the Dorset CCG area. This dataset is collected and made available for research via the UK meteorological office integrated data archive system (MIDAS) [11]. We used the data from the nine weather stations to derive an average daily minimum and maximum air temperature, see Fig. 1. These are then combined with the assault data to derive the number of assaults, and number of days, at each degree of (minimum and maximum) temperature.

To investigate any links between temperature and the number of assaults we develop a multivariable regression model. There are two possible forms this model could take – Poisson or Negative Binomial. However, it has been argued in the literature that, in this context, count data will likely be overdispersed (there is more variability in the data than can be accounted for by a Poisson model), and so a negative binomial model is preferable [7,12]. We find overdispersion within our count data and so adopt this technique here. Additionally, from this point forwards we only consider daily maximum temperature. We do this because we are interested not in the actual temperature, but in the effect of a per degree change in temperature, and because we wish to avoid thinning the dataset into maximum-minimum temperature combination groups. We also note here the high degree of correlation between maximum and minimum temperature (correlation coefficient = 0.95, P-value < 0.001). This is a similar strategy to that used by other authors [4]. Finally we note that the behavioural models mentioned above all relate to the effect of heat, and it therefore makes intuitive sense to examine the effect of maximum temperature.

Our initial model contained variables relating to daily (maximum) temperature and year of assault. Binary variables indicated if the assaults occurred on a weekend or if alcohol was a factor in the assault. A dummy categorical variable was also included to account for any fixed effects of the three emergency departments where the data were collected.

Once the initial model had been constructed a stepwise process was used to eliminate any non-significant variables (P-value > 0.05). We then tested for any interactions between remaining variables and all coefficients where converted to incident risk ratios (IRR) for a 1 °C change in temperature.

Finally, in an attempt to make this model as generalizable as possible, we explore the effect of substituting the temperature variable for one relating to relative changes in temperature in the form of standard deviations from a mean temperature range.

All analysis was performed using STATA 12.

Results

From January 2014 to December 2016 4226 assaults where recorded by the Dorset CCG CM. 44% of the assaults attended RBCHT, 26% DCH and 30% PHT, see Table 1. There was little seasonal variation with 7–9% of assaults occurring each month. Over the same time period the average maximum daily temperature varied from 3 °C to 23 °C with a median temperature of 14 °C. Temperatures are rounded to the nearest 1 °C. A standard linear regression found similar and significant relationships between the calculated assault rate and minimum and maximum air temperatures. This is to be expected given the strong correlation between the two temperature variables mentioned above, and further suggesting that there is no need to include both variables in the model.

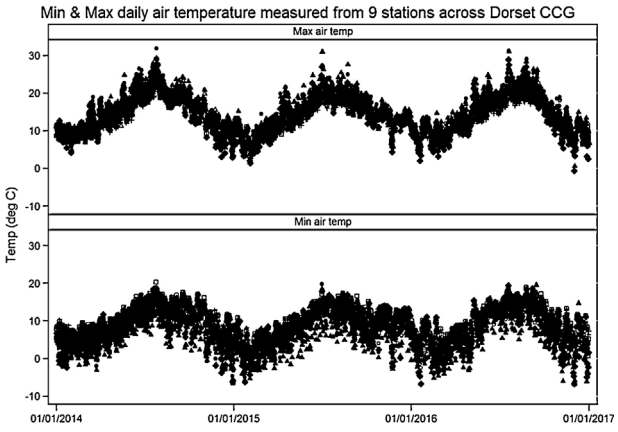

Fig. 1. The daily maximum and minim air temperature from the 9 weather stations across the Dorset Clinical Commissioning Group region. Each point type represents a different weather station.

Table 1
The study population.

Variable	Assaults	%
ED		
RBCHT	1,875	44.4
DCH	1,076	25.5
PHT	1,275	30.2
Year of assault		
2014	1,389	32.9
2015	1,417	33.5
2016	1,420	33.6
Day of the week		
Week day	1,585	37.5
Weekend	2,641	62.5
Alcohol consumed		
No	521	12.3
Yes	1,382	32.7
Unknown	2,323	55.0