

Population-based research on the relationship between summer weather and paediatric forearm shaft fractures

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ARTICLE INFO

Article history:

Received 31 January 2013

Received in revised form 3 April 2013

Accepted 22 April 2013

Keywords:

Forearm fracture
Children
Seasonal variation
Weather
Climate

ABSTRACT

Background: Paediatric forearm shaft fractures show an increasing incidence. The predictive factors of these fractures are not fully understood. Summer weather is suggested to have an effect on the risk of children's fractures. We studied the effect of rainfall, temperature and wind on paediatric forearm shaft fractures in summer.

Methods: All 148 children's forearm shaft fractures in the geographic catchment district during the summer months in 1997–2009 were included. There were 1989 days in the study period. Daily meteorological readings captured the maximum daytime temperature, precipitation and wind speed. The direct daily association between fractures (yes/no) and different weather conditions was analysed in this population-based study.

Results: The risk of forearm shaft fracture was 50% higher on dry days compared to rainy days ($P = 0.038$). Temperature and wind speed had no statistically significant effect on fractures.

Conclusions: The results give support for the presumption by the general public and professionals that summer weather affects children's fractures. A 1.5-fold increase in the risk is especially significant as the forearm shaft fractures are challenging to manage and prone to complications. Paediatric trauma units should prepare themselves for these severe injuries on dry summer days.

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Introduction

Paediatric forearm shaft fractures are challenging breaks, which are prone to delayed healing and long-term sequelae.^{1,2} The incidence of such fractures is increasing rapidly^{3–5} as is their invasive surgical treatment.^{3,6} They are usually caused by a high-energy injury. Children's forearm shaft fractures typically occur in summer.⁷ This is normal for paediatric fractures, generally in both sexes.^{8–13} The rate of bone growth increases in summer and rapid turnover of the physis occurs, increasing the fracture rate in the warmer months.¹⁴ Moreover, the children's holiday increases the risk of injury.¹⁵ Recreational activities such as trampolining, skateboarding and climbing are popular during the summer months.

The background factors affecting forearm shaft fractures are not fully understood. The need for further information about fracture risk factors during growth has been acknowledged.^{16,17} We

became interested in the effect of summer weather on paediatric forearm shaft fractures. Weather is known to affect the overall risk of injuries. Fine weather is related to an increase in children's outdoor activities. The overall fracture incidence is twice as high on above-average sunny days than on days with below-average sunshine.⁹ The purpose of this study is to investigate the effect of rainfall, temperature and wind on paediatric forearm shaft fractures during the summer season.

Material and methods

Fracture frequency

Population-based research on a geographical catchment area of about 86,000 children (<16 years of age) was performed in 1997–2009. There is only one paediatric trauma centre in the area. Both inpatient and outpatient children with both-bone forearm shaft fractures (22-D in the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification) were included. Distal single-bone wrist and elbow fractures, fracture dislocations and pathological fractures were excluded. Fractures that had occurred in and between May and September were included, while indoor injuries ($N = 12$) and

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fractures missing outdoor/indoor information ($N = 7$) were excluded. The final fracture count was 148. There were 134 days when one fracture occurred and 7 days when two fractures occurred.

A clear majority of the patients were boys (65.5%). Mean age was 8.8 years (standard deviation (SD) 3.4 years). The most usual types of injury were trampoline jumping (27.7%), falling from other playground devices (20.3%), undefined playing (18.8%), cycling (12.2%) and swinging (9.5%). Motor device (4.7%), riding (4.1%) and organised sports (2.7%) were more infrequent causes of the fractures.

Assessment of daily weather

Weather data were collected by the national weather service based on daily readings. The data were considered to be representative of the geographical area of the population-based study. Daily readings captured detailed information on the maximum daytime temperature (degrees centigrade), precipitation (rainfall in millimetres) and daily maximum wind speed (m/s, measured as an average of 10 min observation). There are 153 calendar days in the 5 summer months. The total number of the observed summer days in the years 1997–2009 was 1989. On four single days, some meteorological data were missing.

The analysis classified the maximum daily temperature into three groups: $>25^{\circ}\text{C}$ (hot), $15\text{--}25^{\circ}\text{C}$ (warm) and $<15^{\circ}\text{C}$ (cool). Twenty-five degrees centigrade is the established definition of hot weather in the country. Rainfall was grouped into wet ($>1.0\text{ mm}$) and dry (no rain or only little rain $<1.0\text{ mm}$). The latter included both sunny and cloudy days. Wind speed was classified into three groups: 0–3 (calm), 4–7 m/s (moderate wind) and $>8\text{ m/s}$ (strong breeze).

Description of weather in the study phase

The climate in the study area is described as intermediate, combining the characteristics of maritime and continental climates. Typically the warmest month is July with daily maximum temperatures exceeding 20°C while in May and September the daily maximum temperature typically remains below 15°C . The temperature statistics and monthly distribution during this study period, 1997–2009, fit the normal climate conditions (Fig. 1). The annual amount of precipitation is 500–

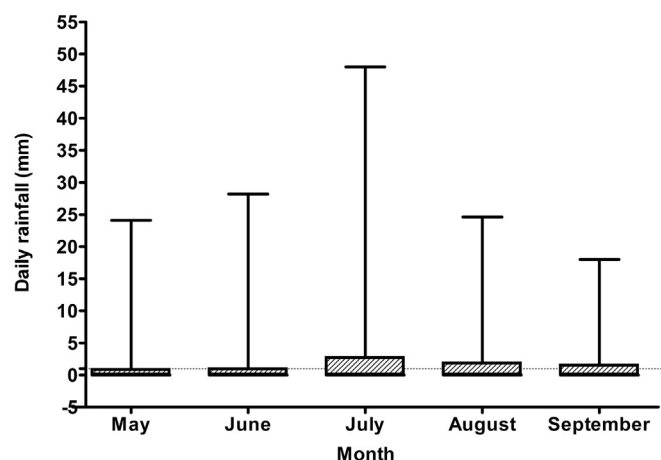


Fig. 2. Daily rainfall (mm) in the geographical catchment area during the summer study period from 1997 to 2009, described monthly in quartiles.

650 mm. July and August are typically the rainiest months with monthly precipitation about 70 mm (Fig. 2). Wind variability is about the same during the summer months with a slight increase in September (Fig. 3).

Statistical analyses

The direct association between fractures (yes/no) and different weather conditions on every day was analysed. Summer days were thus classified into fracture and non-fracture days. Fracture frequencies are given according to different weather variables. There were both school term and summer holiday in the study time between May and September. Summer holiday was determined as 1 June–15 August in every year. The data were subgrouped according to date of injury into the holiday period as opposed to the school-term time. Logistic regression models were constructed to estimate the influence of weather conditions (daily rainfall, maximum temperature and wind speed) on paediatric forearm shaft fractures. The analyses were performed separately for each variable as was multivariate analysis for all weather conditions simultaneously. The tests were driven among the whole study population, all together. In addition, the holiday and the school term subgroups were analysed separately. Statistical analyses were driven by IBM Statistical Package for the Social Sciences (SPSS) Statistics version 20.0.0. The statistical significance threshold was set at 0.05.

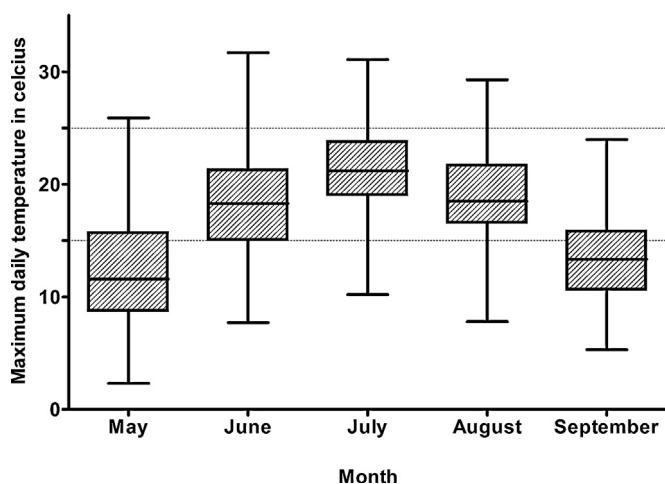


Fig. 1. Maximum daily temperature ($^{\circ}\text{C}$) in the geographical catchment area during the summer study period from 1997 to 2009, described monthly in quartiles.

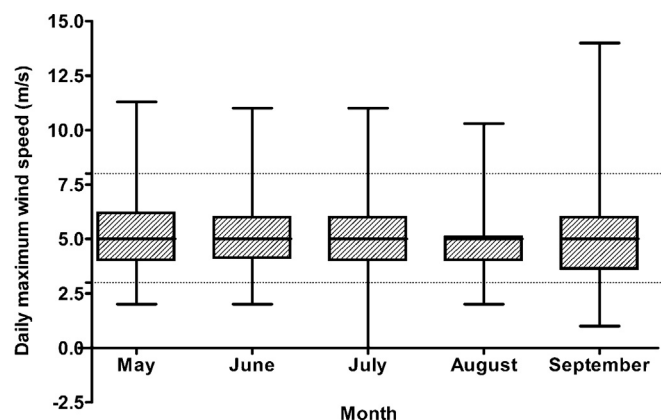


Fig. 3. Maximum wind speed (m/s) in the geographical catchment area during the summer study period from 1997 to 2009, described monthly in quartiles.

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