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journal homepage: www.elsevier.com/locate/burns

Spatial analysis of pediatric burns shows geographical clustering of burns and 'hotspots' of risk factors in New South Wales, Australia

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ARTICLE INFO

Article history:
Accepted 23 February 2016

Keywords:
Pediatric burns
Trauma
Burns prevention
Health policy
Plastic surgery

ABSTRACT

Objective: Pediatric burns are a significant cause of morbidity and mortality, and it is estimated that more than 80% are preventable. Studies among adults have shown that burns risk are geographically clustered, and higher in socioeconomically-disadvantaged areas. Few studies among children have examined whether burns are geographically clustered, and if burn prevention programs are best targeted to high-risk areas.
Method: Retrospective analyses examined the 2005-to-2014 NSW Severe Burns Injury Service data. Geospatial imaging software was used to map the relative-risk and clustering of burns by postcodes in Greater Sydney Area (GSA). Cluster analyses were conducted using Getis-Ord and Global Moran's I statistics. High- and low-risk populations and areas were examined to ascertain differences by sociodemographic characteristics, etiology and the extent of the burn.
Results: Scalds were the most common types of burns and boys were at greater risk than girls. There was significant clustering of burns by postcode area, with a higher relative risk of burns in western and north-western areas of Sydney. The high-risk clusters were associated with socioeconomic disadvantage, and areas of low burns risk were associated with socioeconomic advantage. In both high- and low-risk areas burns occurred more frequently in the 12–24 months and the 24–36 months age groups. The implication of this study is that pediatric burns risk clustering occurs in specific geographic regions that are associated with socioeconomic disadvantage. The results of this study provide greater insight into how pediatric populations can be targeted when devising intervention strategies, and suggest that an area-targeted approach in socioeconomically-disadvantaged areas may reduce burns risk.

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http://dx.doi.org/10.1016/j.burns.2016.02.026
0305-4179/

1. Introduction

Burns are a significant cause of morbidity and mortality worldwide, and children are disproportionately affected. More than half of the disability-adjusted life years lost to burns occur among those aged 0–14 years [1]. Those with non-fatal burns often experience substantial physical and psychological morbidities [2], undergo surgical interventions and extended periods of rehabilitation [2]. Therefore, pediatric burns impose a high financial cost on the healthcare system, and a significant personal burden to affected individuals.

Declines in burn-related deaths and hospitalizations have been attributed, in part, to prevention strategies [3]. However, these have been less effective among children from lower socioeconomic backgrounds. Studies have estimated that socioeconomic disadvantage is associated with a 3- and 15-fold greater likelihood of hospital admission or death from burns, respectively [4,5].

Geographic information systems (GIS) permit the generation of maps that depict the geographic distribution of burn injuries [6]. This has powerful implications for burn-prevention strategies by enabling programs to be tailored according to the demographic and socioeconomic characteristics of residents [7]. Australian studies have shown that pediatric burns are a major contributor to overall burns in high-risk areas, and such areas are characterized by socioeconomic disadvantage [7,8].

This study examines the geographical patterning of severe burns among children in New South Wales (NSW), Australia and investigates the spatial patterning of risk factors in Sydney.

2. Methods

NSW is the most populous Australian state [11] (Fig. 1), with Sydney the capital. Most of the population resides in metropolitan regions (64%) [9]. There are three specialist burns centers to which severe cases are transferred: Concord Repatriation General Hospital (CRGH), Royal North Shore Hospital (RNSH) and the Children's Hospital at Westmead (CHW).

2.1. Data

Data were obtained from the New South Wales Agency for Clinical Innovation Statewide Burns Injury Service (SBIS) covering 2005–2014. This is a statewide registry of burns admitted to the burn units. Admission is based on criteria established by the Australian and New Zealand Burns Association (ANZBA), and the International Society for Burn Injuries (ISBI). This includes all full/dermal-thickness burns in children with >5% total burn surface area (TBSA), burns to the face, hands, feet, genitalia, perineum and across major joints, chemical, electrical or inhalation burns, circumferential burns of the limbs or chest, burns in patients with pre-existing medical disorders that could adversely affect patient care and outcomes, suspected non-accidental injuries. The SBIS detailed 8,223 pediatric burns in the period. The following data were available for each case: patient demographics, mechanism of burn, extent of burn and adequacy of first aid.

2.2. Analyses

Similar to a previous study, the analyses took place in several stages [7]. Firstly, the relative risks of severe pediatric burns were calculated for each postcode. The binary outcome variable was experiencing or not experiencing a burn. Population data from the 2011 ABS Census data were used as the reference population for each area [11].

For subsequent analyses, only postcodes pertaining to Sydney and the greater Sydney area were included in the current study due to the low prevalence of burns and low population density outside of this area. These were identified by the Greater Capital City Statistical Area (GCCSA), as defined by the Australian Bureau of Statistics (ABS, 2011) [11].

Secondly, the spatial distribution of relative risks of severe pediatric burns was examined using the Getis-Ord statistic [13]. The Getis-Ord test examines the spatial patterning of risk in the areas surrounding each postcode, as it assesses the extent to which each area is surrounded by areas of high or low risk [12], therefore it facilitates the detection of ''pockets'' of spatial association [13]. Positive values (positive z-scores) are indicative of a statistically-significant clustering of high risk, whereas negative values denote a statistically-significant clustering of low risk. A value approaching zero is suggestive of no clustering.

In the third stage of analyses, the abovementioned spatial relative risk and cluster analyses were used to examine the epidemiological and sociodemographic characteristics of the residents of high- and low-risk areas. The Getis-Ord analyses identified ''pockets'' of spatial association based on postal relative risk values as the weighted reference points. These Getis-Ord z-score values were used to define two populations: a high-risk population and a low-risk population. The Getis-Ord methodology produced an unbiased, natural distribution of the relative risk of burns in NSW [14], and the two sub-populations were defined as being the two extreme ends of the distribution. The tails considered for this study pertained to the 99% confidence interval, thus having a significance level of $p = 0.01$, and the Getis-ord z-score of 2.58. Low-risk areas were defined as a score <-2.58 or and the high-risk areas having a score >2.58. These two populations were then contrasted using descriptive statistics to observe differences in age patterns by gender, etiology, extent of burn, adequacy of first aid and sociodemographic variations using Microsoft excel and R-statistical software.

The ABS Socio-economic Indexes for Areas (SEIFA) [10] were used to examine associations with area-level socioeconomic characteristics [10]. This is a composite index that characterizes areas with regard to their education, occupation and income [10]. Associations between spatial clusters of relative risk of pediatric burns, the SEIFA index and four sub-indices derived from the SEIFA index (i.e. Index of Relative Socio-economic Disadvantage, Index of Economic Resources and Index of Education and Occupation (ABS 2011) were examined using scatter plots. Chloropleth maps were also generated for three SEIFA variables: Index of Relative Socio-economic Disadvantage, Index of Economic Resources and