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**An Investigation of Inequalities in Paediatric Thermal Injuries in England And Wales**

# AN INVESTIGATION OF INEQUALITIES IN PAEDIATRIC THERMAL INJURIES IN ENGLAND AND WALES

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# ABSTRACT

This research aimed to investigate inequalities in burns to children and young people in the UK. A review of published research on paediatric burns epidemiology in some high-income countries over 23 years revealed gaps in current knowledge on the subject. Evidence was weak or moderate in some areas, driving the need for better quality research to examine contributions of deprivation levels, ethnicity, geographical variations, supervision levels, additional or complex needs of the child and vulnerable families' characteristics.

The investigation of inequalities involved secondary data analyses of two datasets: The Hospital Episodes Statistics (HES) and Burns and Scalds Assessment Template (BaSAT) datasets. HES collects data on severe burns cases in England admitted to the hospital, while BaSAT collects data of children attending emergency departments (ED) in England and Wales for minor burns.

Analyses used descriptive and inferential methods via multivariable logistic regressions run in STATA 14. Odds ratios and 95% confidence intervals are presented describing the likelihood of admission or attendance at the hospital from a range of individual, family and environmental factors that acted as exposures, mediators, moderators and confounders on the burn outcomes.

HES analyses revealed associations between burn admissions in under 16s and greater deprivation (largest adjusted odds ratios (AOR) in 5$^{th}$ quintile: 1.55 [95% C.I: 1.48-1.63]); minority ethnic groups (largest AOR for Black/Black British: 1.50 [95% C.I: 1.42-1.59]) and living in urban areas (AOR: 1.11 [95% C.I: 1.06-1.15]). BaSAT analyses showed no increase in attendance in children with additional needs. However, there were associations between the application of cool running water first aid in under 16s and having sub-optimal supervision (AOR: 0.56 [95% C.I: 0.34-0.90]) and being from most deprived backgrounds (AOR: 0.43 [95% C.I: 0.22-0.81]). The complex relationship between ethnicity, social deprivation and paediatric burns was explored in further depth.

Both the aetiology and the initial treatment of paediatric burns show socio-demographic inequalities: these findings should inform preventative strategies to reduce the burden of thermal injuries to children.

Keywords: Inequality, deprivation, ethnic minorities, supervision levels, additional needs, urban/rural divide, epidemiology, children, burns, scalds.

# AUTHOR’S DECLARATION

I declare that the work in this dissertation was carried out following the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author**.**

SIGNED: ............................................................ DATE: ..........................

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# List of Abbreviations and Acronyms

AAD- All Available Data

BaSAT- Burns and Scalds Assessment Template

BBA- British Burns Association

CAPT- Child Accident Prevention Trust

CASP- Critical Appraisal Skills Programme

CCS- Complete Cases Series

CRW- Cool Running Water

DAWBA- Development and Well-Being Assessment

DSM- Diagnostic and Statistical Manual of Mental Disorders

ED- Emergency Department

HES- Hospital Episodes Statistics

IMD- Index of Multiple Deprivation

NHS- National Health Service

NICE- National Institute for Health and Clinical Excellence

PHE- Public Health England

RoSPA- Royal Society for the Prevention of Accidents

SEIFA- Socio-Economic Indexes for Areas

TBSA- Total Body Surface Area

WHO- World Health Organisation

# LIST OF APPENDICES

# CHAPTER 1 INTRODUCTION

This research aims to investigate inequalities in burns to children and young people in the UK. The results will contribute to the knowledge base on how to reduce the incidence of burn injuries occurring in children aged 0-16 years living in the UK. The impact of individual, family and environmental risk and protective factors associated with burn injury in children will be explored, and their relationships discussed.

## 1.1 Background

### 1.1.1 Why Injury?

With the reduction in communicable diseases, there has been increasing concern over the impact of injuries on both individual and population health. Murray and Lopez (2013), Paim *et al.* (2011), Schmidt *et al.* (2011) mention that early 20th century (and prior) focused much on the burden of infectious diseases. The authors describe how these gradually spread from just dwelling in rural regions but moving to urban regions with migrating peoples in search of better work and life outcomes for themselves and their families. With the reduction in communicable disease in the last 50 years, there has been an awakening in the understanding of the external factors that could influence one's health outcomes (Viner *et al.*, 2012). Modern public health considers the impact of an individual or populations' exposures that abound in their immediate and surrounding environment. These considerations are irrespective of being physical, mental, biological, social, cultural, spiritual and so on (Ahuja and Bhattacharya (2004), Conrad and Barker (2010), Dahlgreen and Whitehead (2006)). Thus, there has been an increased concern over conditions that may directly occur due to unforeseen or unplanned events often regarded to as "acts of God" (Grossman (2000) and Nilsen, (2007). This concern has been one of the primary reasons as to why injury research has been on the rise since the mid-20th-century to date.

### 1.1.2 Why Burns?

Burns are common injuries all over the world. The World Health Organisation estimates that 250,000 to 300,000 fire-related burn deaths occur around the world each year (Mock *et al.*, 2008). Peden *et al.* (2008) report that 95 000 of these deaths are children and teenagers, i.e. 262 children per day. Burn injuries are quite substantial compared to other injuries because they can have a severe impact on the affected individual and their families both during and long after the injury (Grossman *et al.* (2000) and Hettiaratchy and Dziewulski (2004a)). If the injuries are severe, they can cause disability, lasting disfigurement and stigma (Grossman *et al.* (2000), Hettiaratchy and Dziewulski (2004a) and Mock *et al.* (2008)). Severe medically reported burns are one of the most expensive injuries to be managed, both clinically and socially for the injured victims (Hettiaratchy and Dziewulski, 2004a). Thus, burns are among the top injuries that have huge budgets for treatment (Mock *et al.*, 2008).

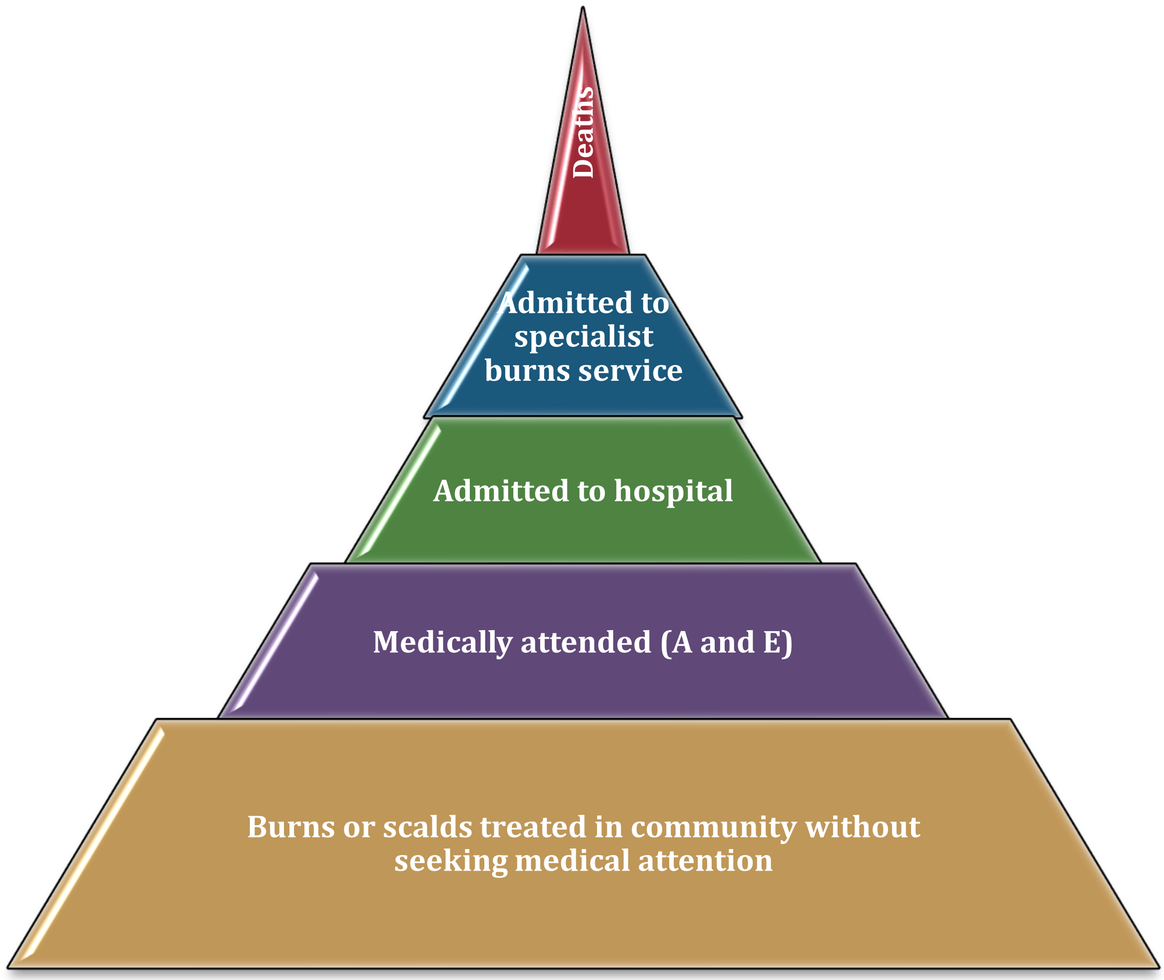
### 1.1.3 The burden of burn injuries

Fire-related burns are said to be responsible for the loss of 10 million Disability Adjusted Life Years (DALYs) in the world each year (Mock *et al.*, 2008). The authors report that this includes victims with contractures and other physical impairments after burn injuries which distort normal functioning and economic productivity. Unfortunately, the social stigma and limited participation of victims in society are often unaccounted for or hard to measure quantitatively (Mock *et al.*, 2008). Peden *et al.* (2008) mention that in regions and countries that lack a detailed and organised rehabilitation scheme, victims especially children and their families can be left physically and psychologically scarred for the rest of their lives.

### 1.1.4 The Burn Injury pyramid

Few studies have tried to describe the national burden of paediatric burns in recent years which can be said to be quasi-representative of the country's population. This estimate is because most of the burns often reported to the hospitals or clinical services for treatment are an under-representation of the actual number of burn injuries on the broader community (Abeyasundara *et al.* (2011), Kemp *et al.* (2014), Duke *et al.* (2015)). The figure below shows a burn pyramid (Fig: 1.1).

**Figure 1-1 Pyramid of Sources of Burn Information**




## 1.1.5 Global Epidemiology of Paediatric Burns

Burn injury is considered a significant health problem in low and middle-income countries (LMICs) which contribute the most cases to burn epidemiology worldwide (Mock *et al.* (2008), Peden *et al.*, (2008)). Most of the countries in the LMIC category are held back by low levels of national development, corrupt government and politics. These issues result in little or no advances in burn management and with some cases, deep-seated cultural practices that pose risk factors for specific groups, e.g. use of open and unprotected fires among the most deprived groups. (Ahuja and Bhattacharya (2004) and Viner *et al.*, (2012)). Although the rates of injury are lower in higher income countries (HICs), there are still vast inequalities. One should remember that areas within each HICs could also have higher burn rates due to social determinants clustering in some neighbourhoods. The epidemiology of burns varies per region due to variation in contributing risk factors (Mock *et al.* 2008 and Peck *et al.* 2008).

Gender is an essential factor. South-East Asia has the highest female death rates for burns, about 16.9 deaths per 100,000 populations per year. (Mock *et al.*, 2008). Ahuja and Bhattacharya (2004) estimate that In India, there are about 700,000-800,000 burn admissions annually, with most in females aged 16-35 years. Most injuries result from cheap cooking stoves, scalds from boiling water and burns from unsupervised use of firecrackers during cultural festivals (Ahuja and Bhattacharya (2004), Peck *et al.* (2008)). The gap between HIC and LMIC is vast: For example, Nepal is estimated to have 17 times the annual death rate from burns than Britain (Hettiaratchy and Dziewulski, 2004a)

### 1.1.6 Paediatric Burns in Europe

Europe had the least rates of unintentional child injuries (33.3 per 100,000 children below 20 years) compared to other world regions (as stated in the 2004 Global Burden of Disease updates) (Peden *et al.* (2008). This author also states that European HICs and LMICs had the 2nd smallest unintentional injury rate for children compared to other HICs and LMICs: 7.9 per 100,000 and 25.4 per 100,000 children below 20 years respectively. The low rates from the European region were still smaller than the least rates of other world regions like Africa (with its lowest LMIC rate of 53.1 per 100,000 children), Asia (with its lowest LMICs rate of 49 per 100,000) and the Eastern Mediterranean (with its lowest LMIC rate of 45.7 per 100,000)

Reduction in burns mortality is often due to successes in proven interventions. E.g. flame resistant nightwear, smoke alarm installations, thermostat regulators for taps, as well as improvement in burn care and treatment over the past 30-40 years (Grossman (2000), Mock *et al.*, 2008 and Pedan *et al.*, 2008).

### 1.1.7 Paediatric Burns in the UK

Hettiaratchy and Dziewulski (2004a) estimated that about 250,000 people are burnt each year in the United Kingdom; 175,000 adults and children attended EDs with 7.4% of those admitted to hospital. About 300 fatal cases are on record annually (Hettiaratchy and Dziewulski, 2004a). Below is a table from the Office of National Statistics showing cause of death by thermal injuries in children and young people compared to death by other external causes of accidental injury (falls, drowning, mechanical or animal injuries.).

**Table 1-1 2014 deaths by thermal injury in 0-19-year-olds in England and Wales (adapted from ONS, 2015)**

| ICD-10 code | Underlying cause (excludes deaths under 28 days for individual causes) | Sex | All ages | 0-14 years | 15 to 19 years |
|---|---|---|---|---|---|
| W00-X59 | **Other external causes of accidental injury** | **M** | **6,177** | **68** | **73** |
| | | **F** | **5,142** | **31** | **23** |
| TOTAL | | **T** | **11,319** | **99** | **96** |
| W85-W99 | **Exposure to electric current, radiation and extreme ambient air temperature and pressure** | **M** | **20** | **0** | **3** |
| W85-W99 | | **F** | **4** | **1** | **0** |
| X00-X09 | **Exposure to smoke, fire and flames** | **M** | **124** | **4** | **1** |
| X00-X09 | | **F** | **108** | **5** | **3** |
| X10-X19 | **Contact with heat and hot substances** | **M** | **9** | **1** | **0** |
| X10-X19 | | **F** | **21** | **1** | **0** |
| TOTAL | | **T** | **286** | **12** | **7** |

The table shows that 0-14-year-olds account for 0.87% of all deaths due to other external causes of accidental injuries while they account for 4.2% of all deaths due to contact or exposure to thermal injuries. These numbers are a small contribution of burns to the overall injury mortality profile. For children and young people below 20 years old, the 0-14-year-old age group accounted for 50.8% of deaths by other external causes of accidental injury while they account for 63.2% of deaths from thermal injury.

## 1.2 Wider Determinants of Burns

Burns have ‘upstream’ social determinants. Dahlgren and Whitehead (2006b) mention that these determinants are grouped in a hierarchical system with general socioeconomic, cultural and environmental conditions at the head, followed by social and community networks and finally individual and lifestyle factors. This layout is also like that of the broader determinants of injury risk. Age, sex and constitutional factors are individual and lifestyle determinants. The relationship between these determinants: the individual, family and environment often lead to inequalities in the rates of burn injury worldwide (Addor and Santos-Eggimann (1996), Zambon and Loring, 2014).

## 1.3 Inequality in Childhood Health

Wider inequality in child health could directly influence the burden most children will face when it comes to injury (Celko *et al.* (2009), Graham (2010)). Adverse childhood experiences reflect how these social inequalities could affect parents and in turn, children who are most vulnerable if in adverse social environments with issues like poor parenting, housing and care. (Marmot and Bell, 2012). These conditions may lead to burns to young children. Black *et al.* (2003) mention in their study that children from low or middle-income backgrounds within LMICs will have the additional burden of fighting infectious diseases than their counterparts in HICs when exposed to injury. Several studies have also mentioned poorer health outcomes in children from LMICs than in HICs (Abdalla *et al.* (2013), Adamo *et al.* (1995) and Agbenorku *et al.* (2013)). Overall, Black *et al.* (2003) mention that childhood mortality varies worldwide with substantial differences that seem to be increasing. Viner *et al.* (2012) mention that puberty and brain development effects on children as they approach adolescence to lead to new sets of behaviours and capacities that change their family relationships, peer, education and health behaviours. These changes lead to inequalities as socio-economic factors within countries of interest modify them.

Stuckler *et al.* (2008) suggest that more funding is allocated to tackle NCDs and injuries. The author states they have the highest and second highest contribution to global mortality and disability-adjusted life years (DALY). However, they have the least amount of funding, e.g. in the Africa region, the mortality and DALY burden is about 7-9 times the budgetary allocation for NCDs and injuries while in the West Pacific region it is 6-14 times. These numbers may reflect changing global priorities in health in the last 25 years.

### 1.3.1 Inequality in Child Injury

Injuries are important health outcomes in childhood as in most countries they are among the leading reasons for child mortality and morbidity. Peden *et al.* (2008) observed from the WHO ranking of leading causes of death in 0-20-year-olds, three injuries were among the top 15 namely drowning, motor vehicle accidents and fire-related burns. Fire-related burns were third in injuries for all ages while motor accidents and drowning were first and second respectively. In the younger children (1-5-year-olds) they swapped positions.

Most socio-demographic factors that are determinants of injury outcomes are not easily modifiable, resulting in persisting inequalities in outcomes (Grossman (2000) and Sidebotham *et al.* (2014)). For example, with motor vehicle accidents; male adolescents, rural children, living in deprived areas, children from minority ethnic groups (mediated by living in greater social disadvantage) and teenagers that engage in risky behaviours or unhealthy lifestyles have a higher risk of injury than their counterparts (Grossman, 2000).

### 1.3.2 Inequality in Paediatric Burns

Burns is the 6$^{th}$ most significant cause of mortality in children 5-14 years in LMICs (Mock *et al.* (2008)). However, as the children reached early adulthood (15-29 years old), the ranking dropped to the 8$^{th}$ most significant cause of mortality. Healthcare services and support groups are expected to be well organised and advanced to cater to burn victims in HICs. This expectation may not be the case for LMICs that may not have such development to reduce morbidity and mortality rates (Mock *et al.* (2008), Peck *et al.* (2008) and Duke *et al.* (2012)).

The health of some children worsens due to co-existing medical conditions like physical/non-physical impairments and chronic psychiatric/medical illness which increase burn risk and complicate the healing process (Thomas *et al.* (2004) and Prasad *et al.* (2014). Thus, such cases need addressing when attending to patients to enhance recuperation and prevent injury repetition as they are more prone than children who do not have such needs (Hettiaratchy and Dziewulski, 2004a, Rowe *et al.*, 2004).

As shown in Table 1.1 above, paediatric deaths from fire/hot substances are rare. However, the many who survive must live with the aftermath of burn injuries. There are gender differences in burns injuries, most that occur in the under 5s occur in boys. However, by school age, girls are at more at risk of burns compared to other injury types because of their involvement in activities of daily living especially cooking (via exposure to flames) or ironing and wearing loose or flowing flammable clothing (Peck *et al.* (2008). This fact is most common in females for whom most burns are acquired within the domestic environment while for older males; burns are acquired in places outside the home environment especially the workplace (Peden *et al.* (2008), Mock *et al.*, (2011) and WHO (2014)).

#### 1.3.2.1 In Younger Children (Age 0-9 years)

Younger children have been reported to have six times the burn risk of adolescents especially if they lived in crowded dwellings or rented apartments/mobile homes, were from more socially disadvantaged backgrounds, rural homes and wore loose flowing clothes (Grossman (2000) and Hettiaratchy and Dziewulski (2004a)). Children that had family members who smoke and drank have a higher risk of burn injury from residential fires (Hingson and Howland (1993), Grossman (2000) and Hettiaratchy and Dziewulski (2004a))

Most non-fatal burns (70%) in children aged four years and below are estimated to be scalds (Hettiaratchy and Dziewulski (2004a), Riedlinger *et al.* (2012). Burns are the leading cause of injury hospitalisation for under 5-year-olds (Fukunishi *et al.* (2000), Grossman (2000), Pedan *et al.* (2008)). Younger children's injuries happen at home as they are at the stage of development in which they continually explore their immediate environment. This exploration can be out of the innocence of their curiosity; newfound mobility (for pre-schoolers) and energy (Duke *et al.* (2012), Kemp *et al.* (2014), Zambon and Loring, 2014).

#### 1.3.2.2 In Older Children (10 years and above)

Peden *et al.* (2008) noticed a gradual ascension in the ranking of fire-related burns from the WHO 2004 ranking of leading causes of deaths in under 20-year-olds. This ranking sharply rose to the $7^{th}$ position in 15-19-year-olds. The sharp increase is due to risky behaviour in teenagers or accidents from work for those employed (Parker *et al.* (1994), Hendricks *et al.* (1999), Duke *et al.* (2012). As children age, there is a gradual change from mostly scald injuries towards the flame, chemical and electrical burns. These are often initiated by agents like petrol, corrosive chemicals, playing with fire, electrocution- especially while engaging with hazards or in illicit activities amongst teenagers (Henderson *et al.* (2003), Hettiaratchy and Dziewulski (2004a), Vollman and Smith (2006)). Fatal and non-fatal injuries (i.e. burns and others) in older children tend to take place outside of the home like in school or public spaces. The reason is increasing independence and sometimes, an irrational difficulty in decision making without adequately considering the consequences of risky actions at this age (Henderson *et al.* (2003), Zambon and Loring, 2014).

## 1.4 Definitions

### 1.4.1 Burns

The different types of burns are the flame, contact, electrical and chemical burns and scalds, which are thermal injuries from hot fluids (Hettiaratchy and Dziewulski (2004a)). Erythema is not considered to be burn during injury assessments (Hettiaratchy and Papini (2004b)). For this thesis, erythema and friction injuries are not burn injuries. The reason is that friction injuries are usually abrasive wounds having aetiology and treatment that are different to those for thermal burns while erythema is a reddening of the skin which is a sign of inflammation either from infection, allergies, drug reactions, mild burns or scalds and so on. Thus, they are not “true burns”.

Hettiaratchy and Dziewulski (2004b) describe burn mechanisms as the pathway through which a specific burn type occurs after contact with a specific agent. These are shown below in Table 1.2.

**Table 1-2: Burn types (adapted from Hettiaratchy and Dziewulski (2004b))**

| Burn type | Burn mechanisms |
|---|---|
| Scalds | **Through spilling of hot drinks or liquids, e.g. Beverages, liquid food and oils. They could also occur via pouring or immersion (e.g. bath water)** |
| Flame | **Exposure to fire via clothing, residential fires, occupational fires, flammable liquids and other materials.** |
| Contact | **Touching hot objects, surfaces or substances directly or indirectly. It may involve stepping on or fall on such surfaces** |
| Electrical | **Contact with an electrical source that may be low or high voltage creating an entry and exit point of current through the victim or "flash" injuries where the current creates an arc hot enough to wound a victim without passing through the victim.** |
| Chemical | **Through spilling of chemical or corrosive substances. It could also be via pouring, throwing, immersion or ingestion.** |

Burn injuries have classification according to the severity of the injury. Severity measurement occurs in two ways: total burn surface area (TBSA) and depth. The assessment of surface area covered by burn injuries occurs via three methods: palmar surface, Wallace rule of nines and Lund & Browder chart. The last method is the best choice for assessing burns in children (if used correctly) as it considers variation in body shapes and age (Hettiaratchy and Papini, 2004b). Ahuja and Bhattacharya (2004) give a classification (see table 1.3 below) of what is considered a minor to severe burn injuries when triaging (prioritising attendance, management and treatment) at hospitals occurs. Hettiaratchy and Papini (2004a) mention that any burn over 25% of the total body surface area (TBSA) is severe.

**Table 1-3 Burn severity scales (adapted from Ahuja and Bhattacharya, 2004)**

| Burn severity | Description | Site for treatment |
|---|---|---|
| Minor burns to non-critical areas | **< 10% of total body surface area (TBSA) in children or < 20% in adults** | **Outpatient care, dressing, tetanus prophylaxis** |
| Minor burns to critical sites, i.e. face, hands, genitalia | **< 10% TBSA in children or < 20% in adults** | **Short hospital stays, special wound care or operation** |
| Major burns | **20-60% TBSA** | **Admission to burn unit, intravenous resuscitation** |
| Extensive burns | **> 60% TBSA** | **Lower priority for transfer** |
| Minor burns with inhalational injury or associated injury | **< 10% TBSA in children or < 20% in adults** | **Place on oxygen, intubation, transfer to Intensive Care Unit** |

The depth of a burn is related to the impact of thermal energy and the thickness of the victim's skin which happens to be thinner for children (Hettiaratchy and Papini, 2004b). Burn depth classification is via two groups depending on the amount of skin loss namely: full thickness burns- which cover all skin layers into subcutaneous tissues and partial thickness burns- which do not reach into all skin layers. The latter can be sub-divided into three groups as follows:

> Superficial: The epidermis of the skin is affected but not the dermis (as often seen in sunburns). These are also called an epidermal burn.
>
> Superficial dermal: The burn injury affects the epidermis and extends into the upper layers of the dermis causing blistering.
>
> Deep dermal: The epidermis and upper layers of the dermis are affected by the injury extending a bit into the deeper layers of the dermis but not the entire dermis.

Despite this classification, determining burn depth can often be a difficult task as this is also influenced by the type of burn and on how long the victim was in contact with the burning agent. Some burn injuries can have a mixture of different depths, and it is necessary to know the depth of the tissue damage to determine the right pathway of treatment. However, in acute situations, there may not be enough time to assess the injury, and the injury would need to be re-evaluated later as burn injuries are dynamic (Hettiaratchy and Papini, 2004a).

### 1.4.2 Childhood

Childhood is often defined as the phase an individual pass through from birth to early adulthood (Donaldson and Scally, 2009). This definition has different meanings depending on the law, culture, context and environment in which one is described as a child or in childhood (Nixon, 2000). The United Nations Convention on the Rights of the Child defines a child as "a human being below the age of 18 years unless, under the law applicable to the child, the majority occurs earlier" (McGoldrick, 1991). For instance, in the United Kingdom, the law stipulates that a person is considered a child until their 18th birthday.

This definition may be like some other countries around the world, but as always, there are exceptions like Japan which considers childhood ranging from age 0-20 years of age (Burd and Yuen, 2005). The UK National Health Services treats all patients below their 16th birthday as children in clinics or hospitals. Such differences in classification of age make universal application of adolescent research findings/intervention complicated or ambiguous. Thus, not every nation has consistent definitions, and some age groups are likely to be excluded from the benefits of research (Peck *et al.* (2008), Peden *et al.* (2008), Zambon and Loring (2014)). For this thesis, a child means any individual below 16 years old. This benchmark is used because the data analysed in this thesis is mostly from NHS data sources.

## 1.5 The justification for this thesis

Inequalities are not country specific (Zambon and Loring, 2014). Hence, there is a need to understand those of the United Kingdom, and their association with paediatric burn injuries. The World Health Organisation has also reported that worse injury outcomes are not just restricted to children from poorer countries but also those from areas or regions of a tremendous social disadvantage within the high-income countries (Peden *et al.* (2008) and Sidebotham *et al.* (2014)). It is estimated that 90% of burn injuries are preventable, leading to several attempts by researchers and government to reduce their incidence via education and legislation (Hettiaratchy and Dziewulski, 2004a; Zambon and Loring (2014).).

Understanding inequalities are necessary to prevent burn injuries. Ahuja and Bhattacharya (2004) and Hettiaratchy and Dziewulski (2004a) mention that prevention programmes should be targeted to fit high-risk groups of interest. These programmes also need to be persistent, patient and target behavioural and environmental factors that could influence lifestyle. Victora *et al.* (2011) and Viner *et al.* (2012) state that reducing inequalities and barriers in improving the health of young people are heavily reliant on carrying out a systematic study of socio-demographic health across countries of interest. These studies should include improving collection and or the analysis of routine worldwide data on adolescent and young adult health. Thus, this current research will focus on assessing the impact of inequalities in paediatric burns within the United Kingdom.

## 1.6 Aims and Objectives of the Thesis

### 1.6.1 Aims of PhD Research

The overall aim of this thesis is to investigate inequalities in paediatric burns in the UK. This aim will initially involve a systematic review of the literature of quantitative studies using a variety of study designs including RCTs, cohort studies and cross-sectional studies. Secondary analyses will then utilise data derived from two different and complementary datasets: The Hospital Episode Statistics (HES) and the Burns and Scalds Assessment Template (BASAT) databases. The null hypothesis will be that there are no associations between inequalities related to a child's environment, family or development and the risk of burn injury.

### 1.6.2 Objectives of PhD Research

1. To carry out a critical appraisal and synthesis of published literature reporting inequalities in paediatric burn injuries.
2. To identify the gaps in the literature and generate hypotheses relating to inequality, for exploration in subsequent analyses of the HES and BASAT datasets.
3. To carry out descriptive and comparative analyses of burns data in these two datasets to examine underlying inequalities.

4. To explore the relationships between burn injury and measures of inequality using inferential analysis.
5. To make recommendations for future research and describe the implications of the findings for policy and practice.

## 1.7 Research Questions of PhD Thesis

The following research questions came forth from an initial review of the literature:

1. Is there a consistent relationship between burn injury in childhood and social disadvantage?
2. Do children living in rural regions have a higher risk of burns than those that dwell in urban regions?
3. Do children from ethnic minorities have a higher risk of incurring a burn injury compared to children from the ethnic majority group?
4. Do children with additional needs have a higher risk of burn injury than children with no additional needs?
5. Do children with sub-optimal supervision have a higher risk of burn injuries than children with optimal supervision?

## 1.8 The organisation of the PhD thesis

The thesis will start with an introduction into burns, their importance and a brief overview of the epidemiology of paediatric burns globally, in Europe and then the UK. This chapter will conclude with the overall aim and objectives of the thesis, along with research questions and a description of the organisation of the thesis (Chapter 1). The next chapter will present a systematic review of literature of burn epidemiology across the UK, Australasia, North America and Europe, identifying evidence for inequalities associated with paediatric burns, and the gaps in the literature which are to be addressed by this work (Chapter 2). The next chapter will describe conceptual diagrams depicting variables that influence burn risk (Chapter 3).

Chapter 4 will include a description of Hospital Episode Statistics (HES) data, the methods used for analysing HES data for paediatric burn injuries, methodological challenges in using the dataset, and the results of the descriptive and inferential analyses. In Chapter 5, the research questions were investigated using the Burns and Scalds Assessment Template (BASAT) database. This section will describe the methods used in analysing BASAT data for paediatric burn injuries, methodological challenges contained within the dataset, and the results of descriptive and inferential analyses. Chapter 6 will involve an in-depth discussion of one of the main exposures of interest, i.e. ethnicity as it encapsulates the effect of how other variables interact with it in influencing burn outcomes in children and other general health outcomes. A discussion of the strengths and weaknesses of this research and an interpretation of the study results in the light of existing literature will form the basis for Chapter 7. The conclusion of the thesis with recommendations for future research as well as the implications for public health policy will also be in Chapter 7.

For research outputs e.g. publications, oral/poster conference presentation, please see Appendix for Chapter 3 in Appendices.

# CHAPTER 2 : A COMPREHENSIVE REVIEW OF STUDIES REPORTING BURNS AND SCALDS IN 0-16-YEAR-OLD CHILDREN

## 2.1 Background

A literature review was carried out to retrieve relevant knowledge as well as identify gaps in burn and scald research from studies with diverse designs. The synthesis of these papers has informed the subsequent analysis of burns data.

This chapter describes the aim and objectives of the systematic review, the criteria used to include and exclude studies, the search strategies and databases searched, and methods used for review, data extraction and analysis of study/paper quality. Critical appraisal of the papers selected was based on study design and examined paper quality, and the risk factors and outcomes reported.

## 2.2 Aim and Objectives of the Review

### 2.2.1 Aim:

To review the epidemiological evidence on unintentional burns and scalds in children and young people

### 2.2.2 Objectives:

- To create the inclusion and exclusion criteria to guide the retrieval of literature.
- To develop a sensitive search strategy to identify any relevant studies from available resources.
- To create an electronic database to manage and sort references during the screening process.
- To extract essential data from selected studies and critical appraisal of study quality.
- To conduct a narrative analysis of available and appropriate literature regarding burn epidemiology in children and young people.

- To outline findings from the review that could be measured and observed during data analysis.

## 2.3 Criteria for Studies in this Review

### 2.3.1 Inclusion Criteria

Based on several styles used in most literature reporting the epidemiology of burns, for a study to be eligible for this review, it had to fulfil all the following criteria:

Study type:

- The study reported quantitative data: randomised controlled trials (RCT), systematic reviews, cohort studies, case-control studies, and cross-sectional studies.
- Studies could be either prospective or retrospective in nature.
- Studies had been published worldwide and, in any language, but with an English translation.

Participant type:

- Children and young people aged 0-16 years of age with non-fatal and fatal burn injuries.
- Any study recruiting participants from hospitals, burn units, and including population-based data.

Outcomes:

- Any study reporting unintentional and external scalds, flame or contact burns in children aged 0-16 years sustained at any point in their life history.
- Any study reporting prevalence/incidence of burns and scalds in sample and population (where applicable).
- Any study reporting several injuries but with a subset of burns data.
- Any study reporting only external burns and scalds or alongside internal burns.
- Any study reporting unintentional burns only or both intentional and unintentional burn injuries.

### 2.3.2 Exclusion criteria

Studies were excluded from the review if they met any of the following criteria:

- Any study solely reporting on adult burn/scald cases.
- Any study solely reporting on intentional burns.
- Any study solely on the psychology of burn victims after the incident.
- Any study solely on microbial infection of burn wounds and or their epidemiology.
- Any study solely on clinical description, care and study of burns/scalds.
- Any study solely on immunological/physiological responses after burns.
- Any study solely on other child/adolescent/adult diseases/conditions.
- Any study solely on internal burns.

## 2.4 Search Strategy for Identifying Studies

This strategy was developed to search for all possible and available sources of literature for studies using the inclusion criteria.

### 2.4.1 Search from electronic databases

Free text terms and thesaurus terms describing three concepts; the participant group, the outcomes of interest and study designs put in the search strategy to identify potentially eligible papers from the electronic databases.

To create an optimum search strategy/history, several search terminologies within each concept were combined with those observed in previous research. This action ensured that the search was sensitive enough to identify any potentially eligible papers or “hits” meeting the inclusion criteria and specific enough to avoid those not meeting the inclusion criteria. There were no restrictions on language of publication and the time frame searched was 1980 to Dec 2017. The search history was developed and tested with MEDLINE-OVID SP. Published keywords from authors’ citations which were likely to bring forth more specific hits were used to refine search history.

The finalised MEDLINE search strategy was adjusted to fit the different electronic databases used as each had a different interface.

The initial search yielded an unmanageable number of potential studies requiring a full-text review. Thus, a decision was made along with the supervisory team to refine the inclusion criteria. The following additional inclusion criteria were:

- Studies published from 1995-Dec 2017- papers published within these 22 years might report trends or similarities with current burn epidemiology yet to be fully understood or underexplored;
- Studies published in “Western” high-income countries only (i.e. if they were from the UK, Europe, Australasia and North America).This restriction was justified in order to compare UK data with those from other high-income countries. These countries share similar geography, a way of life, development and cultures as reported from previous literature.
- Studies are focusing on child and adolescent data only- as they form our participant group of interest.

Below is the table with finalised search history used to search MEDLINE OVID (1980-8 Jan 2018)

### Table 2-1 MEDLINE search history

| No. | Search Terms |
|---|---|
| 1. | adolescent/ or child/ or child, preschool/ or infant/ |
| 2. | minors.tw. |
| 3. | Paediatrics .tw. |
| 4. | (adolesc* or preadolesc* or toddler* or boy* or girl* or child* or infan* or preschool* or juvenil* or school* or pe?diatri* or pubescen* or prepubescen* or puberty or teen* or young* or high school or classroom* or schoolchild* or early life or baby or babies).tw. |
| 5. | 1 or 2 or 3 or 4 |
| 6. | burn*.tw. |
| 7. | scald*.tw. |
| 8. | 6 or 7 |
| 9. | epidemiolog*.tw. |
| 10. | prevalen*.tw. |
| 11. | inciden*.tw. |
| 12. | (risk adj factor*).tw. |
| 13. | (cohort adj stud*).tw. |
| 14. | (observational adj stud*).tw. |
| 15. | (characteristic* adj behavio?r*).tw. |
| 16. | (epidemiolog* adj stud*).tw. |
| 17. | (epidemiolog* adj method*).tw. |
| 18. | 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 |
| 19. | 5 and 8 and 18 |
| 20. | limit 19 to humans |
| 21. | limit 20 to "all child (0 to 18 years)" |
| 22. | limit 21 to ("reviews (best balance of sensitivity and specificity)" or "therapy (best balance of sensitivity and specificity)" or "diagnosis (best balance of sensitivity and specificity)" or "prognosis (best balance of sensitivity and specificity)" or "causation-etiology (best balance of sensitivity and specificity)" or "economics (best balance of sensitivity and specificity)" or "clinical prediction guides (best balance of sensitivity and specificity)" or "qualitative (best balance of sensitivity and specificity)" or "costs (best balance of sensitivity and specificity)") |
| 23. | limit 22 to yr="1980 -Current" |

Twenty-two electronic databases were selected from Metalib via the University of Bristol Library systems as potentially able to provide papers meeting the inclusion criteria. Seven of these were chosen for this literature review: MEDLINE, EMBASE, CINAHL, Child Development and Adolescent Studies (CDAS), International Bibliography of Social Sciences (IBSS), Scopus, and ScieLO

The MEDLINE search history had an adjustment for search in the other six databases (Table 2.2) that cover medical and social science journals reporting paediatric burn injuries. All resulting papers were put into Endnote Desktop (Version 8.0) for reference sorting and management.

**Table 2-2 Electronic databases used for review**

| Date of Search | Search No. | Electronic databases | Publications retrieved |
|---|---|---|---|
| 8.12.2017 | 1. | MEDLINE (1950 to present) | 2211 |
| | 2. | EMBASE (1974 to 2015 May 04) | 1725 |
| | 3. | CINAHL (1980 to present) | 1809 |
| | 4. | CDAS (1982 to present) | 164 |
| | 5. | IBSS (1980 to present) | 96 |
| 12.12.2017 | 6. | SCiELO (1997 to present) | 105 |
| 12.12.2017 | 7. | SCOPUS (1980 to present) | 1077 |
| Total | | | 7187 |

Grey literature sources were considered but the short time frame to do a thorough review of these and many hits retrieved from the electronic search meant that this was not feasible.

This review was first conducted in 2015 but updated in January 2018 to add in any new literature published in the interim.

## 2.5 Review Methods

### 2.5.1 Reference Management

Potentially eligible studies identified from the electronic database searches were put in Endnote Desktop (Version 8.0) software. Duplicated references were excluded, and a title and abstract review of imported studies were carried out to remove any ineligible studies.

### 2.5.2 Data Extraction and Critical Appraisal of Study Quality

Quality appraisal of papers meeting the inclusion criteria was carried out using the validated and reliable Critical Appraisal Skills Programme (CASP) tool developed by a team of researchers based in Oxford with the Better Value Healthcare, a training organisation led by Professor Sir Muir Gray. Each study design was appraised using their respective CASP tool formats.

Two data extraction tables were created for each study design (one for general information and the other for methods and outcome) using Microsoft Excel 2013 (see Appendices section for chapter 2). Headings representing information extracted were as follows: authors, year of publication and study location, population, sample number and selection criteria. Also, the type of burn/scald injury and study objective (all these for general information) while the type of study and data source, factors measured, and outcomes observed are listed in the table for methods and outcome. All revisions, critical appraisals and data extraction were carried out by the thesis author. Decisions and conflicts were discussed with and clarified by Prof Emond (AE) or Dr Mytton (JM).

For CASP appraisals, a spreadsheet using Microsoft Excel 2013 was created using the questions in each study design as headings for appraising data quality. Systematic reviews, case controls and cohort studies had ten headings while cross-sectional studies had nine headings (see Table 2.3). Answers were a “yes”, “no” or “unsure”. After appraising papers, those having 5 and above “no” or “unsure” responses were adjudged as “poor quality” and excluded from the final narrative analysis. Those with 3-4 responses of “unsure” or “no” were given a “fair quality” rating while those with 0-2 responses of “unsure” or “no” were given a “good quality” rating. Papers with good and fair quality rating are included in the narrative analysis.

**Table 2-3 CASP quality appraisal questions used for studies and different questions per study design**

| Criteria no. | Quality questions |
|---|---|
| 1. | **Is there a clear aim or focused question? (For case controls only, this question was asked: is the study right for a case-control study?)** |
| 2. | **Were the samples, cases or cohort appropriately recruited (For systematic review only: were the right papers included?)** |
| 3. | **Were controls properly recruited? (for case controls only) For systematic reviews only: were the relevant studies included?** |
| 4. | **Was bias minimised in the exposures? (for case controls, cohort and cross-sectional studies) For systematic reviews only: how rigorous was the quality of included papers assessed for the review?** |
| 5. | **Was bias minimised in the outcomes? (cohort and cross-sectional studies only) For systematic reviews only: was it reasonable to combine results?** |
| 6. | **Did the authors identify any confounders? (for all *except* systematic reviews)** |
| 7. | **How were the results and their presentation? (For cohort studies only: was a proper follow up done?)** |
| 8. | **Are the results precise?** |
| 9. | **Are results applicable to the population of interest?** |
| 10. | **Do the results agree with ample evidence? (For systematic review, does the paper have all outcomes?)** |
| 11. | **Is the study relevant to the current research? (For systematic review, is the study worth the cost, benefit or harm?)** |

Critical Appraisal Skills Programme (2018). CASP Studies Checklist. [online] Available at https://casp-uk.net/casp-tools-checklists/ Accessed: 31st March 2018.

### 2.5.3 Analysis of included studies

Given the variety of study designs and the heterogeneity across all the papers recruited, a meta-analysis was not feasible, and therefore a narrative analysis was undertaken. The heterogeneity is due to issues like variable study quality, missing data, different populations, varying sample sizes, different outcomes measured and different presentation of data. To reduce the effect of this variation, it was decided to undertake a narrative analysis of the literature. Within each study design, the papers' quality was discussed, and any resulting information from observed protective/ risk factors was explained under subheadings.

After this, an overview of the findings from each study design was compiled. A table of all the papers within each study design was made showing general information, outcomes and significant results were applicable (See Appendices for CASP tool tables (AS 2.3), Table of Methods (AT 2.7) and Table of Results (AT 2.8)).

## 2.6 Results

### 2.6.1 Retrieval of Included Studies

Seven thousand one hundred and eighty-seven (7187) references were imported into Endnote Desktop (version 8.0) from all 7 electronic databases. One thousand five hundred seventy-four duplicates were excluded using the "Find Duplicates" option leaving 5613 references. After a title and abstract review and consultation with senior research team members (AE and JM) on some 186 unclear references, 1414 of the 5613 references seemed eligible for a full-text review.

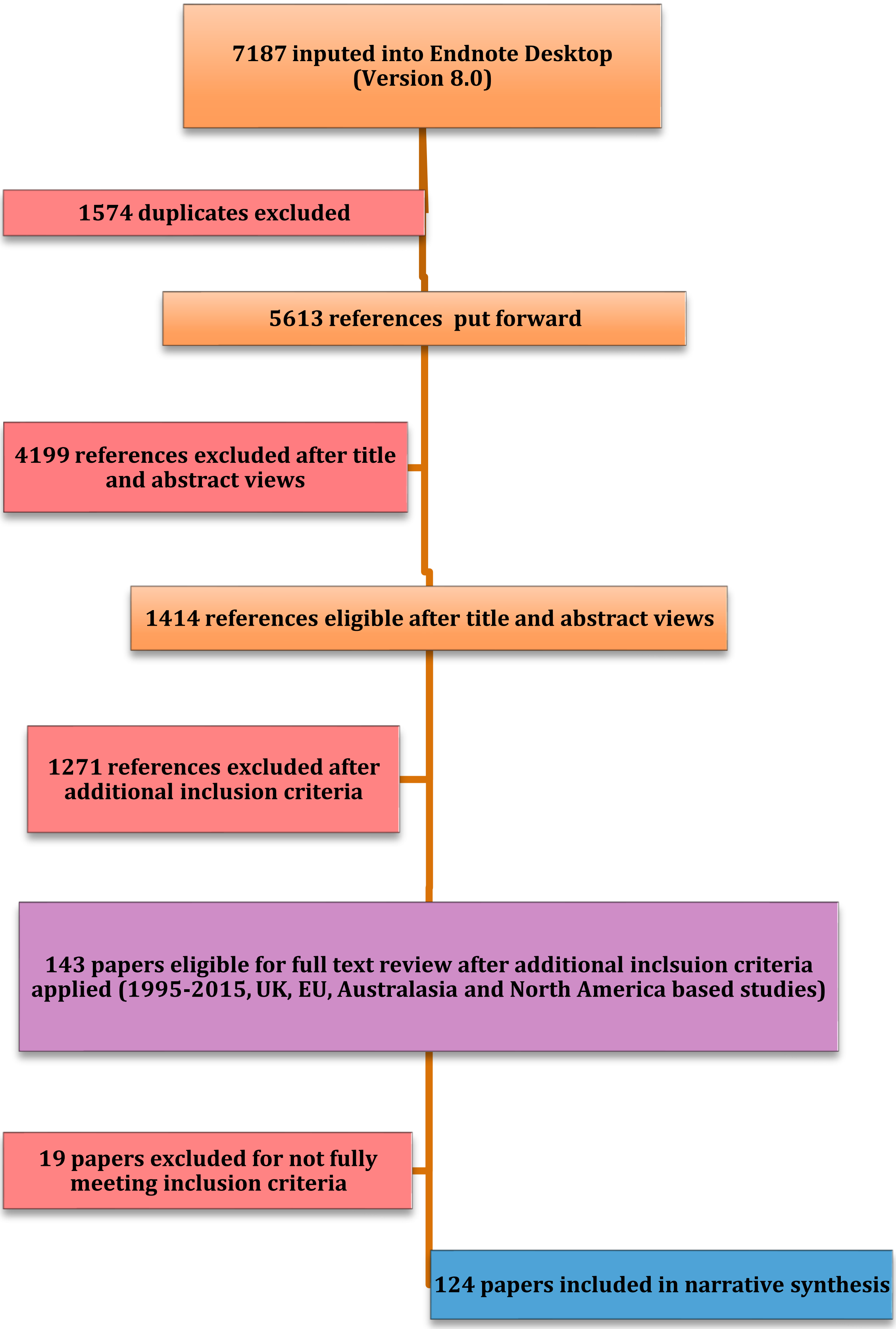
Given the high number eligible, the 1414 references were subjected to an additional set of inclusion criteria were:

- Studies that were published from 1995- 8 Jan 2018.
- Studies from high-income countries only (i.e. only if they were from the UK, Europe, Australasia and North America)
- Studies solely including friction burns were excluded
- Studies focusing on child and adolescent burns data only.

One hundred and forty-three of the 1414 (10.1%) references met the defined criteria, including studies from the UK (32), Europe (34), Australasia (30) and North America (47). These were also all based-on samples of children and adolescents: 97 of them were only on burns while 46 of them were mixed injuries (with a subset of burns). Five studies focused on fatal cases only, 98 on the mixed severity and 40 on only non-fatal cases. As per electronic databases that sourced the 143 references, 31 were from CINAHL, 38 EMBASE, 51 MEDLINE and 23 from SCOPUS.

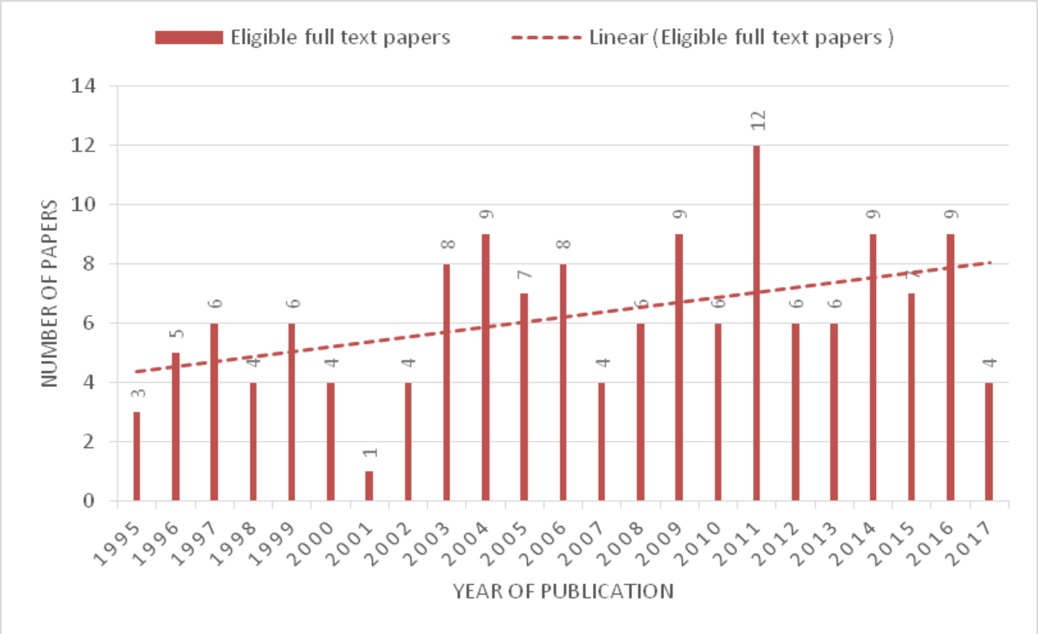
Following the full-text review, 124 (86.7%) of the 143 papers truly met all the inclusion criteria and were therefore used in the narrative synthesis. Figure 2.1 below shows a flowchart used to obtain the final included papers.

**Figure 2-1: Flowchart showing the identification of studies**



The year with the highest number of publications was 2011 (12 papers), followed by nine papers each in 2004, 2009, 2014 and 2016. Below is a graph showing papers by year of publication (Figure 2.2)

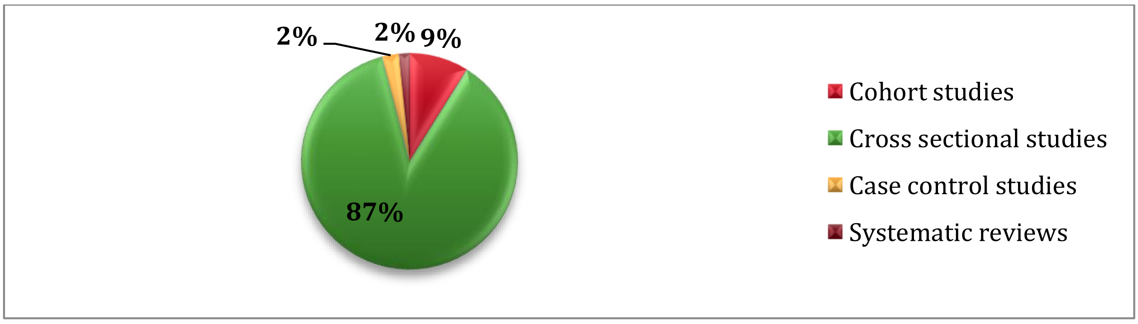
**Figure 2-2: 143 papers eligible for full-text review by publication year**




Overall, the final number of studies eligible for full-text review was 143 papers, representing 2% of the original 7187 papers imported into Endnote.

By hierarchy of evidence, the final 124 papers contributing to the narrative synthesis include two systematic reviews, four prospective cohort studies, seven retrospective cohort studies, 3 case-control studies and 108 cross-sectional studies (see Figure 2.3). The data extracted regarding methods and results are in two tables namely: Table of Methods and Table of Results. (See Appendices AT 2.7 and 2.8).

**Figure 2-3: 124 studies used for narrative synthesis by a hierarchy of evidence**



### 2.6.2 Overview of findings

Most of the evidence came from cross-sectional studies. Bangdiwala (2000) and Norton *et al.* (2006) reported that the strength of the evidence in injury research usually comes from observational studies especially cross-sectional studies. One can argue that this was due to the number of studies reporting only the frequencies of injuries, but it is worth mentioning that some papers with cross-sectional design studied in detail the interplay between some social factors and burns including ethnicity, deprivation and how these influences burn risks/outcomes. This statement is also confirmed in Bangdiwala (2000) who states that the cross-sectional nature allows for injury data and exposures to be investigated given that injuries are usually unforeseen circumstances that occur by chance, however; the strength of a causal relationship is weak. CASP ratings across the studies show that 56.5% scored “fair”, 41.9% scored “good” and 1.6% scored “poor”. The two studies that scored poorly were Hayes and Groner (2005) and Suominen *et al.* (1998). Both were mixed injury studies, but the former had more information all round especially regarding the research questions of interest.

It is important to mention the issue of representativeness of the sample in injury research. A representative sample is one that accurately reflects the population under investigation (Thomas *et al.* (2011). As illustrated in the burn pyramid in Chapter 1, the injuries that report to a hospital are only a tip of the iceberg (approximately 15%) from the true amount in the population. Thus, it may be safe to say that samples used in most of the studies reviewed were representative of medically reported injuries. To speak on representativeness, one must understand the concepts of reliability and validity (Bell 2010). Reliability involves the extent to which a measurement tool used in a study gives stable and consistent results over repeated use (Bell (2010) and Kibel *et al.* (2012)). Validity, on the other hand, refers to how close a measurement is to the truth (Bell (2010) and Kibel *et al.* (2012)). There are two main forms of validity to consider in research. Firstly, internal validity, which relates to how valid a study is, including both the design and the instruments used. Thus, internal validity is the extent to which a study’s measurements truthfully reflect the variables being explored (Bell (2010) and Thomas *et al.* (2011). In other words, it depends on whether appropriate and adequate indicators have been chosen. For burn injuries, this would depend on clinical indicators used to assess the type and extent of the burn injury when the affected children present to hospital for treatment. Predictive factors investigated are often based on general individual factors that may not have standardised means of measurement, e.g. age, gender. Secondly, there is external validity which relates to how generalisable the study findings are to a wider population and can be claimed to be representative (Thomas *et al.*, 2011). E.g. would study findings on medically reported paediatric burn injuries in Soweto, South Africa be generalisable only to that population or also to children in Lancaster, England. It is also important to note that a valid measure must be reliable, but a reliable measure may not always be valid (Kibel *et al.*, 2012).

Getting an overall range of prevalence and or incidence was difficult as 65.3% of the studies used in the review did not state their denominator, i.e. total population number from where their samples were retrieved. This observation is similar to that made by Bangdiwala (2000) and Flowers (2006). The few prospective studies that examined some of the poorly documented social and family factors agree with those found in retrospective studies. Regarding methodology, cohort and case-control studies had few or no losses of participants and proper matching respectively.

Population-based studies or those linked to population-based databases are recognised to contribute richness of evidence related to research questions of interest compared to those based merely on hospital records/ chart reviews- this was most true for cross-sectional studies. Studies variably reported prevalence or incidence depending on the study design. If the study was cross-sectional and/or retrospective, i.e. examining the occurrence of thermal injuries across a population or sample over a period, they were likely to report injury occurrence in the population as prevalence. However, if the study aimed to examine a defined population and the interest was in new cases of thermal injuries, then the measurement reported was incidence.

Memon (2008) state that cohort studies examine the associations between one or more exposures and several outcomes over a period (e.g. months, years etc.). If participants are classified according to an exposure, they can be followed over time to see the incidence of the outcomes of interest. The follow up time can be “into the future” at which point one defines this as a prospective cohort study. If the objective is to however “look back in time”, then this becomes a retrospective cohort study. Limitations of cohort studies include being expensive to conduct, loss to follow-up, not ideal for studying rare outcomes, inadequate data and time consuming in yielding results (Memon, 2008). These issues are most true for prospective cohort study. In all, cohort studies, if well done, are considered the "most robust" of observational study designs because a temporal sequence can be established as the exposure at baseline is assessed up to the moments the outcomes manifest in the exposed and unexposed groups (Memon (2008), Webb and Bain (2011). Thus, for burns, prospective cohort studies may provide less biased opportunities for sociodemographic factors of interest to be monitored from baseline and see how they are associated with the development of burn outcomes over time. For example, Karimi *et al.* (2015) reported findings from a 46 years prospective cohort study using national population registers which gave their study enough power to study the effect of parental birth country on the risk of fatal unintentional injuries. Female children of "foreign born" ethnic background was found to have higher risk of fatal burn injuries compared to their Swedish counterparts.

Mixed injury papers seemed to provide more details from multivariable analysis than most burn injury specific papers that were more descriptive. These papers helped in presenting unadjusted and unadjusted odds ratios (OR), risk ratios (RR), incidence rates (IR) and hazard ratios (HR). However, due to the mixed nature of injuries, most of these papers did not focus on burn injuries in detail. Bangdiwala (2000) states that if not adjusted for other injuries, results of burn and risk associations in mixed injury research will be confounded in models. Some authors who described burn outcomes mention that over the years, burn types have risen and fallen depending on changing trends. E.g. a study reported how the burning agent changed from teapots to cups for scald injuries- given that teapots are not as common in the home as they once were (Eadie *et al.* (1995), Peden *et al.* (2008) and Duke *et al.* (2015)). Other burns are increasing in incidence- namely, contact burns from hair straighteners and disposable barbecues (Sarginson *et al.* (2014) and Veermaak *et al.* (2012). These burn types can be due to changing technology trends, lifestyle changes and convenience. Thus, there is a great need to begin to fully understand these burn injuries and their agents/ mechanisms over time so that new prevention strategies can be designed and tested (Baker (2000), Flowers (2006) and Norton *et al.* (2006))

Age, gender and admission rate seemed to be the most frequently documented of all the variables across most of the papers. However, other variables associated with burn risk and outcomes are understudied or hardly considered in the studies appraised. Risk factors include ethnicity, deprivation status, socioeconomic status, family size, home size, parent or carer marital status, carer's presence at the time of injury, while outcomes include the degree of burn, burn type and %TBSA. Collection of some of these variables depended on if there was admission or fatality if they were of interest to the researchers before the project and if clerical or clinical staff collected incomplete info or incorrectly coded information (Bangdiwala, 2000 and Flowers, 2006).

Given the costs of linkage and the price of working with non-anonymized data, it is likely that this is one of the primary reasons some researchers do not go the extra mile to ensure data are complete. Petridou *et al.* (1998) tried to examine new variables that could answer questions regarding burn outcomes by deriving variables from questionnaires. It is likely that this approach will be adopted in this current research when working with secondary data of interest that relates to burning research. That is if the "skeletal framework" of possible questions is already in the datasets.

An exciting development noticed in this review is some health researchers are beginning to estimate the financial burden of burn care treatment on health care and families. Major burns have been reported as being one of the most expensive injuries to manage due to the intensive care and extensive rehabilitation that greatly inflate expenses. In addition, affected patients may be subjected to prolonged follow up and multiple admissions.

Thus, there is an urgent need to reduce their occurrences via prevention strategies. In the narrative synthesis section below, each of the central themes explored has shown some association with injuries as seen in injury reports like 2008 WHO World Report on Child Injury (Peden *et al.*, 2008) and the 2014 PHE, CAPT and ROSPA summary report (Godson *et al.*, 2014).

## 2.6.3 Narrative Synthesis of Inequalities in the Literature

### 2.6.3.1 Inequalities by deprivation levels

#### *2.6.3.1.1 The strength of evidence:*

There is substantial research evidence that socioeconomic deprivation is associated with worse outcomes in many areas of health and disease (Bangdinwala (2000), Flowers (2006), Nazroo and Williams (2006), Norton *et al.* (2006), Becares *et al.* (2010), Bradby and Chandola (2010) and Graham (2010)). This review found 29 papers (29/124 studies (23.4%)) exploring the association between deprivation and burns as an outcome.

The 29 papers which reported data on socioeconomic status/deprivation levels and burns are in the Table of Methods and Table of Results (see Appendices for Chapter 2- AS 2.2)

Nine of the 29 (31%) papers stated in their aims that they planned on investigating socioeconomic status/ deprivation in burns. Five of these nine papers were from the UK (Orton et al. (2014), Shah et al. (2013), Alnababtah et al. (2011), Hughes *et al.* (2014) and Mardsen *et al.* (2016)). One study each was from USA (Soleimani *et al.* (2016), Sweden (Hjern *et al.*, 2001), Spain (Zoni *et al.*, (2017) and Australia (Poulos et al., 2007). In the other 20 papers, socio-economic status (SES) was a covariate. The synthesis concluded that there is inequality in burn risk, with higher disadvantage associating with an increased risk of burns at all ages. This finding is consistent in all 29 studies (except Emond *et al.* (2017) that showed no association between IMD scores and burn injury) across diverse settings and populations, irrespective of study design, their position in the hierarchy of evidence and whether they are high or low-quality papers.

#### ***2.6.3.1.2 <u>Representativeness:</u>***

The 29 papers involved data mostly derived from hospitals (20/29 studies), followed by 3/29 studies which used data from GP surgery/primary care centre, another three studies reported using population-based questionnaire surveys, one used census data, one used national injury registry data, and one used health insurance data. Based on these numbers, 2(6.9%) of these 29 studies may have questionable internal validity since the data were not originally intended for injury research.

Eleven of the 29 (37.9%) studies used data from a single hospital; others were from several hospitals in a region, which was stated to be representative of the population. Three of the 11 studies from a single hospital carried out data linkage to other population-wide databases within the regions of study. The authors that carried out linkage did so to make their data or study more “robust” or representative of the population especially if data were missing. In all, 19 of the 29 (65.5%) studies were reported by their authors to be representative of their general population. Most of the studies were on medically reported injuries, but these may fail to capture the actual burden of burns in the community. Thus, it may be safer to infer that 65.5% of these 29 studies exhibit external validity for medically reported injuries.

Given the nature of burn injuries, most occur at home, and only a proportion attend hospital. The burn injury pyramid describes this phenomenon and serves as a critical pictogram in burn injury research (Bangdiwala (2000), Hjern *et al.* (2001), Hughes *et al.* (2014) and Orton *et al.,* 2014). Bias is inherent in studies investigating SES and burns based on hospital–derived samples because of access issues (more impoverished families may not be able to get to the hospital) which will underestimate reported burn incidence. However, if the hospitals were in deprived areas, there may be high levels of reporting of burn cases. Such reports of burn incidence would not be generalisable to the whole country or region (Flowers, 2006).

Two of the 29 (6.9%) studies explained their findings on socioeconomic status and health-seeking behaviour. Laursen and Nielsen (2008), a cross-sectional study, observed that people from lower SES sought immediate healthcare for their children with injuries whether at an emergency department or for admission. Orton *et al.* (2014) also observed this in a prospective cohort study. However, these authors report that children from low SES attend the GPs more when they are injured, and this inflates incidence in their group. Orton *et al.* (2014) mention that this causes injury ascertainment bias. Their analyses were inconclusive on the effect of socio-economic patterning of health seeking behaviour.

First aid application or knowledge was reported in only 3 of the 29 (10.3 %) studies. Cronin *et al.* (1996), a cross-sectional study reported that only 87% of cases had some form of first aid before presenting to the hospital, 30% of parents felt they had basic first aid knowledge, and 38% of parents reported taking precautions against sunburns for their children. This information was quite impressive given that 77% of all the patients were from low income or state-supported families. Two cross-sectional studies also report some findings on first aid: Cheng *et al.* (2016) and Goltsman *et al.* (2016). Cheng *et al.* (2016) mention that parents with low health literacy did not know what to do when a child sustained a burn injury [AOR 1.45; 95% CI: 1.29-1.63].

Furthermore, most of these parents had public insurance (91.8%). Goltsman *et al.* (2016) further reported that children in high-risk areas (HRAs) had lower usage (52.27%) of cool running water first aid than low-risk areas (LRA) (64.77%). Health-seeking behaviour (more impoverished families use ED for minor complaints because they do not have alternative resources) may be a reason for the association between low SES and burns. It is also likely that if an alternative treatment is available or the families of the victim consider the injury to be of little or no severity, they may engage in self-treatment of their children leading to underreporting of burn injuries at the hospital. Thus, if such treatment proves unsuccessful, leading to complications with the injury due to wrong use of alternative medicine or first aid, e.g. infection of wounds or longer healing time; an over-reporting of complicated/infected burn injuries from children with poorer backgrounds may occur.

#### *2.6.3.1.3* ***Bias due to study design:***

Regarding study designs, there were three prospective cohort studies, four retrospective cohort studies, one case-control study and 21 were cross-sectional studies. The case-control (Shah *et al.*, 2013) and one of the three prospective cohort studies (Orton *et al.*, 2014) specifically tried to look for the relationship between SES and burn epidemiology. Shah *et al.* (2013) found that children from the most deprived quintiles were 1.82 times more likely to have a burn than those from the least deprived quintiles. Orton *et al.* (2014) reported a 56% reduction over time in the incidence rates of burns in children from the most deprived quintiles compared to those from the least deprived quintiles. The other two prospective cohort studies (Emond *et al.* (2017) and Randall *et al.* (2017) gave conflicting results. Emond *et al.* (2017) reported no association between IMD scores and burn injuries in children aged 0-11. One possible reason for this finding was the preferential loss to follow up of the most disadvantaged families, a problem common in cohort studies. Randall *et al.* (2017) gave a more descriptive approach with SES in that most burn patients sampled in their study had low SES.

Furthermore, one of the four retrospective cohort studies, Baker *et al.* (2016) also mention that burns had a significantly higher incidence rate ratios (IRR) in children from the most deprived backgrounds than those from the least deprived backgrounds. These IRRs decreased by age; 0-4 years old (1.68), 5-9 years old (1.61) and 10-14 years old (1.57), though 95% confidence intervals were not reported.

Regarding quality of the study, the cohort studies and the case-control study all were given a “good” rating using the CASP tool, while only 52.3% of the cross-sectional studies had a “good” rating, with the rest scored as “fair”. All the cohort and case-control studies reported an association between children from low SES/ most deprived status with unemployed parents and increased burn risk except Emond *et al.* (2017). These findings were similar in all cross-sectional studies irrespective of if they were of good or poor quality.

Prospective cohort studies focusing on burn injuries were few. The reason may be because of how expensive they are to conduct (Bangdinwala, 2000). Therefore, one relies on the evidence from cross-sectional studies which have inherent biases like reverse causality, lack of ability to study a temporal association between exposure and outcome or rare conditions. Also, retrospective cohort studies may have misclassification, recall bias, inability to control for all confounders/mediators/moderators when linking datasets or to compare separate cohorts respectively (Levin (2006), Mann (2003); Webb and Bain (2011)). Cross-sectional studies often measure the “one point in time” occurrence of burn injuries and any associated exposures.

##### ***2.6.3.1.4 <u>Bias due to measurement:</u>***

Eighteen (62.1%) of the 29 papers measured SES by deprivation score. Six (20.7%) of the 29 papers measured socio-economic inequality in burns using income or social status data; 3 of the 29 papers used insurance payer information while 1 of the 29 papers used housing and job status/type respectively. There are many ways of measuring socio-economic status. Galobardes *et al.* (2007), Shavers (2007) and Cheng and Goodman (2015) mention the following as ways of measuring SES, especially in health research. These ways include educational attainment, occupation, income, wealth, composite indicators (e.g. IMD), life course SES, perceived social status, housing, unemployment, overcrowding and other proxy indicators. Education is often perceived as the easiest to measure as it excludes few participants, is less affected by health outcomes in adulthood, is stable beyond early adulthood; straightforward, convenient and said to capture lifestyle and behaviour. However, it has several disadvantages. Higher education does not always equate a high income. It fails to consider other or straightforward non-Western forms of education, it may yield different results regarding rewards depending on race/ethnicity and gender, and it does not show the direct impact of lifestyle or behaviour on the injury.

Income has the advantage of showing the ability of individuals to access goods and services that may influence health positively or negatively. The disadvantage of relying on income as a measure of SES is that it depends on age, doesn’t include all assets an individual has such as wealth, health insurance and benefits. Income may not reveal racial/ethnic disparities in the quality of goods and services sought and received. It is also considered to be an unreliable measure compared to education because it often has a high rate of non-response in datasets. The unresponsiveness is reported to be because of some research participants considering income status as a sensitive and private topic (Galobardes *et al.* (2007), Shavers (2007) and Cheng and Goodman (2015)).

Wealth is often considered as an SES measure because it is more linked to social class than income and it considers the impact of assets on an individual’s status in times of financial or economic troubles. However, it has sensitivity issues when it comes to reporting, and multiple factors are contributing to its makeup are difficult to calculate (Galobardes *et al.* (2007), Shavers (2007) and Cheng and Goodman (2015)).

Occupation can be a proxy measure of the association between educational attainment and income. It is also more reliable as a measure of SES than income alone as it gives one an idea of the environmental, psychological and working conditions the individual has and how that affects health. However, it is not precise in measurement. It fails to consider other forms of earning an income or skill (home workers, illegal workers, volunteers and retirees) other than those classified in recognised occupation scales. Occupation is not a good measure for women (as most of the scales were initially for men) and racial/ethnic differences in carrying out the same duties are not available (Galobardes *et al.* (2007), Shavers (2007) and Cheng and Goodman (2015)).

Composite measures (e.g. Index of Multiple Deprivation [IMD]) are considered excellent measures of SES in area-wide planning. Also, if used alongside individual-level measures of SES, it can give good insight into the how these measures relate and their influence on health. They are aggregates of several measures, based on average deprivation associated with a postcode and not individual families (Galobardes *et al.* (2007), Shavers (2007) and Cheng and Goodman (2015)).

Proxies like the number of siblings, infant and maternal mortality rates, single parenthood, and parental marital status, if the child is an orphan or illegitimate are advantageous where none of the traditional measures of SES available. However, they are not strict indicators of SES and may not give in-depth ideas of social patterning (Galobardes *et al.* (2006a) and Galobardes *et al.* (2006b)).

Galobardes *et al.* (2007), Shavers (2007) and Cheng and Goodman (2015) conclude that of all the measures of SES; the best individual ones are education, occupation and income. They also mention that measuring SES over the life course seems theoretically the best way to monitor the impact of changing income/SES on health outcomes. However, this works best for chronic conditions and in large population-based cohort studies and may not be so valuable for cross-sectional studies or case-series. Composite indices are best for determining area-level SES and can stand as a proxy if individual SES measures are missing or unavailable. However, if this is the case, care must be taken in interpretation to avoid the ecological fallacy as every individual's SES is different (Braveman *et al.* (2005), Galobardes *et al.* (2007), Shavers (2007) and Cheng and Goodman (2015)). As this current research is on children, it is evident that children will not have their measures of SES, so parental socioeconomic status is often used to represent the child.

Eleven of the 29 papers measured SES using IMD scores or its country-specific equivalents, e.g. SEIFA in Australia., 5/29 papers each measured it via insurance and area deprivation, 2/29 papers measured by income only and 3/29 measured by area deprivation. 1/29 papers had three measures: living below poverty, unemployment and income. Each of the remaining seven papers measured it via a social index, area SES and insurance, income and insurance, area poverty, housing, job type and benefits.

It was interesting to note that older papers (2001-2004 and an exception in 2010 and 2 in 2015-2016) considered SES via individual measures like income, insurance while the papers that examined deprivation were more recent (2007-Jan 2018 and a 2003 exception). Seventeen of the 29 papers examined burns only while 12/29 papers examined burns along with other injuries. However, all the mixed injury papers used more inferential statistics to measure SES/deprivation (mostly logistic, but also Cox, binomial and Poisson regression). The burns only papers mostly used descriptive statistics (pictorials, percentages, Chi-square or T-test) then logistic or Poisson regression in some cases to report SES/deprivation. Twenty-eight of the 29 papers seem to point towards an association of increased burn risk and low SES irrespective of the different years of study, populations and if the data analyses were descriptive or inferential. Previous and current literature also seem to show the substantial effect of one's SES on other socio-demographic factors. Thus, the introduction and modification of standard measures common today like the Index of Multiple Deprivation (IMD) or the Townsend Index of Deprivation (TID) are used to measure the effect of deprivation from the least to the most significant quintiles. IMD is accepted as the best measure because it is routinely collected (derived via small area statistics from the census) and it is a composite measure that captures different aspects of social deprivation apart from SES alone. However, only 11 of the 29 studies mentioned using IMD as their standard measure of SES/deprivation, and it is not surprising that most of these studies (9) expressly mentioned exploring SES in their aims. Inferential statistics are also more reliable as they show the adjusted and or unadjusted results of SES/deprivation in their studies. Inferential statistics allow one to see the effect of SES/deprivation on other risk factors and vice versa. Again, all the non-cross-sectional studies and a few cross-sectional studies used inferential statistics.

Most studies higher in the hierarchy of evidence (cohorts and case-control studies) reported the association between higher disadvantage and burn risk with unadjusted odds ratios, hazard ratios or IRRs ranging from 1.57-1.98, while adjusted odds ratios ranged from 1.82-1.94. One retrospective cohort (Spady *et al.*, 2004) showed a reduced risk of burn injury among children from deprived backgrounds who had a partial premium subsidy on their insurance than those who did not. Overall, 8/29 papers reported the association between children from low SES/most deprived/assisted or no insurance families and burns via odds ratios, hazard ratios or incidence rate ratios. Only one paper with an OR less than 1 (Spady *et al.,* 2004) reported disadvantaged families assisted with insurance had children with less risk of burn injury OR=0.82 (95% CI: 0.79-0.86) while another (Emond *et al.*, 2017) showed no association between IMD and burns reported by parents. 12 of the 29 studies reported 19.4%-77% of their participants with burn injuries were from low SES/deprived backgrounds.

Overall, the association between SES and burn risk was consistent across 28 out of 29 studies (96.5%), irrespective of their setting or population. Studies published before 2007 seemed to report odds ratios of 2 and above for being at a significant disadvantage and having increased burn risk, but this seemed to drop for post-2007 studies. This change was not because of the adjustment of odds ratios as studies carried this out irrespective of the year published. Only Orton *et al.* (2014) makes a reasonable observation for this change. The authors mentioned a narrowing in the gap of burn risk between children from most deprived quintiles and those from the least deprived quintiles. Some interventions over the years may have taken effect, but still high reports of injuries from most deprived areas were common. As such these places need more specific interventions targeted to fit with issues they experience in their socioeconomic gradient. They also mention that health-seeking behaviour (HSB) may have played a role in the changes as they observed that injured children from lower SES families might be overrepresented in the hospital primarily if they are newly registered. However, adjusting for this injury ascertainment bias did not change the social gradient for those reporting burn injuries. Thus, the authors could not conclude if only HSB by socioeconomic quintiles was wholly responsible for observed differences.

#### ***2.6.3.1.5 <u>Bias due to missing data:</u>***

A few authors do mention that measuring deprivation was quite tricky as they could not get complete data in some cases. Others warned that even when such data were available, one should be cautious so as not to over-interpret findings, e.g. ecological fallacy. As SES is considered missing not at random, missing data lead to results that may be potentially biased

Twelve (41.4%) of the 29 studies did not mention how they handled any bias from missing data- six- of which purely gave descriptive analyses of SES measures. Five studies mention using complete case analysis namely Cronin *et al.* (1996), Kramer *et al.* (2010), Laursen and Nielson (2008), Brehaut *et al.* (2003) and Hughes *et al.* (2014). One of them, Kramer *et al.* (2010), justified using complete case analysis because only a minimal proportion of data (0.008-0.16%) were missing from critical variables. However, Kramer *et al.* (2010) state the insurance/payor status which was used to represent SES had about 30.6% missing. Four studies, namely Spady *et al.* (2004), Orton *et al.* (2014), Prasad *et al.* (2014) and Duke *et al.* (2015), used sensitivity analysis to control for bias from missing data. Two studies (Emond *et al.* (2017) and Shields *et al.*, 2007) used imputation to control for missing data bias. Three studies, Baker *et al.* (2016), Pratt *et al.* (2016) and Solemani *et al.* (2016) mention using all available data for analyses- the latter two studies compared their findings to carrying out complete case series analyses (CCS). They found that the results from both analyses were not affected by the minute differences observed. Alnababtah *et al.* (2011) and Zoni *et al.* (2017) mentioned checking for data completeness but did not specify the handling of missing data. However, it seems the authors just used those with complete data from hospital computer databases.  Hughes *et al.* (2014) mentioned using a complete case series for their dataset of interest (HES) excluding those with a missing area of residence or gender. They also mention the problem of weak coding categories for injuries.

All the papers that used sensitivity analysis were cohort studies and given a “good rating” on the CASP tools. All the papers that used complete case series were cross-sectional and had a “good rating” except for Kramer *et al.* (2010) which had a “fair rating”.  Studies that checked for data completeness and used imputation were cross-sectional studies and had a “fair rating” except Emond *et al.* (2017) that was a prospective cohort study with a “good rating”.  Irrespective of methods used in handling missing data, there was consistency in associating children from the most deprived/low SES/unemployed backgrounds with increased burn risk. However, one could argue that the estimate of the strength of this association may have improved if studies that failed to deal with bias via missing data adequately reported how they had done so. The association between increased burn risk and low SES for studies that used complete case series were in descriptive percentages ranging from 20.3%-77% except for Laursen and Nielsen (2008) who expressed this as incidence rates ratios, AIRR=1.9 (95% CI: 1.6-2.3). Two of the four studies that used sensitivity analysis expressed the association between low SES and increased burn risk as odds ratio ranging from 0.82-1.97 and as percentages for the other two studies ranging from 26-33%. The studies that used data completeness and one that used imputation (Emond *et al.* (2017)) reported the association by IMD score while the other paper using imputation reported it as a percentage (35.7% of burns were from those in second most deprived quintiles) respectively.

#### *2.6.3.1.6* ***<u>The confounding effect of ethnicity:</u>***

Ethnicity and socioeconomic status are closely inter-related, and the associations between burns and poor SES backgrounds may be confounded by different ethnic groups with different exposures to burn risk and different health-seeking behaviour in response to a burn injury. Overall, most papers mentioning race/ethnicity along with SES/deprivation data were from the USA (8 studies) and the UK (7 studies). Three were from Australia, two from Canada while one each was from Sweden and Germany. The authors all tried to show an association between burn injury, low SES or high deprivation and people from minority or indigenous ethnic groups. The inequality gaps in SES ties in with those of ethnicity.

An alternative interpretation is that "people from the ethnic majority do not have any deprivation issues and if present, may be very low". This statement is sometimes mentioned in research examining ethnic differences in socio-demographic factors and health as in Bajekal *et al.* (2004), Nazroo and Williams (2006), Becares *et al.* (2011) and Becares (2013). None of these authors conducted inferential analyses to investigate if there was an association between SES and burn risk independent of ethnicity except Lehna *et al.* (2016). These authors showed via multiple regression that children with the highest risk for home fires/burns came from high-risk areas with a large percentage of African American ethnicity; were children of non-high school graduates and lived in older houses. Thus, there is a need to study the interplay between socio-economic deprivation, ethnicity and burn injuries. Filling this research gap is one of the objectives of this thesis, and the relationship between ethnicity and economic deprivation will be further discussed in chapter 6

In conclusion, this review confirmed a general trend in the literature that children from more deprived families are at a higher risk of burn injuries. The strength of the evidence reporting the association between SES and increased burn risk was moderate. The reason was that 21 out of the 29 studies were rated as "good" via CASP, had good quality studies and included all those at the top of the hierarchy of evidence. Also, of the remaining 8/29 studies with a fair CASP rating, 4 had weak quality. They also had bias intrinsic in study design, the missing data and in different ways, SES was measured. Across most of the studies, children from more socio-economically deprived backgrounds often had more extensive and more in-depth burns, more severe burns or longer length of stay (LOS) if admitted. In countries where treatment is free at the point of access (e.g. the UK with the NHS), children from poor backgrounds get aid to full recovery. However, this may not be the case for those who cannot afford insurance or private healthcare like those in the USA (Stafford *et al.*, 2007). Thus, access to health care influences outcomes of burn injury and this, in turn, varies by setting, population and socioeconomic status.

The body of literature considering the relationship between burn injury and ethnicity is discussed in depth in chapter 6

### 2.6.3.2 <u>Inequalities by geographical variation</u>

#### ***2.6.3.2.1 <u>The strength of evidence:</u>***

Geographical variations refer to spatial differences based on the urban and rural divide. The body of evidence shows there is an association between geographical variations and many health outcomes. (Bangdinwala (2000), Flowers (2006), Nazroo and Williams (2006), Becares *et al*. (2010), Douglas *et al*. (2010), Graham (2010), Cheng and Goodman (2015) and Moller *et al.* (2015)).

This literature review found 18/124 studies (14.5%) investigating the association between geographical variation and burns (See Appendices for Table of Methods (AT 2.7) and Table of Results (AT 2.8)). Three (Poulos *et al.*, 2009, Goltsman *et al.* (2016) and Randall *et al.* (2017)) of the 18 papers (7.7%) had the specific aim to examine the association between geographical variations and burn injury. These studies were from Australia. The remaining 15 papers had geographical variations included as a covariate. Overall, they report inequality in geographical variation and burn risk, but this is ambiguous as there is an almost equal distribution of studies reporting children having burn injuries in urban or rural areas. Some studies high up the hierarchy of evidence (Duke *et al.* (2015) and Devodic *et al.* (1998)) show an increased risk for children living in urban areas. Studies reporting a higher prevalence of burns in rural areas were all cross-sectional studies apart from one prospective cohort study (Randall *et al.*, 2017). This inequality was also consistent irrespective of study quality, settings and populations (see Appendices for Table of Methods (AT 2.7) and Table of Results (AT 2.8)).

#### ***2.6.3.2.2 <u>Representativeness:</u>***

Nine of the 18 (38.9%) studies were on hospital derived data. Five of the 18 (27.8%) studies were on burn centre data only. Two of the 18 (11.1 %) studies used population surveys to obtain data. A study used a mixture of national representative registry data and one other used 14 burn centre and 18 hospital data. Based on these numbers, 2(6.9%) of these 18 studies may have questionable internal validity since the data were not originally intended for burn injury research.

Of the nine studies that used hospital data, three (42.9 %) were on data from a single hospital; six were from several hospitals in their region of interest. Four of the nine hospital-based studies carried out data linkage to other population-wide databases within the regions of study and these studies were also part of the six that used several hospitals' data. Eight of the 18 (44.4%) studies (were reported by their authors to be "representative" of their general population of interest, but do not show the true burden of burns in the community (see previous sections on representativeness). Thus, it may be safer to infer that 44.4% of these 18 studies exhibit external validity, but only for medically reported injuries.

Depending on the setting and population of interest, there is under-reporting for burn victims who reside in rural, remote or "hard to access" areas. This issue is complicated as some victims come from low socio-economic backgrounds and ethnic or indigenous minorities (Duke *et al.* (2015), Poulos *et al.* (2009), Quayle *et al.* (2000), Shavers (2007) and Karimi *et al.* (2015)). There is an inherent bias in studies investigating urban-rural divide and burns based on hospital–derived samples because of access issues. For example, several studies mention that proper healthcare facilities, workforce and infrastructure are limited if not absent in rural/remote areas (Fernandez-Morales *et al.* (1997) and Schmidt *et al.*, 2011). Children from families that reside in rural or remote areas may have to travel long distances to get treatment and as such may not present on time, or not at all, seeking self-care or alternative medicine to manage treatment thus underestimating reported burn incidence. Also, some families cannot afford the costs of the trips or the added discomfort of travelling with an injured child (Peden *et al.* (2008), Duke *et al.* (2015), Poulos *et al.* (2009) Karimi *et al.* (2015)).

No study reported findings of health-seeking behaviour, urban-rural divide and burn injury outcomes. Only 2 of the 18 studies (11.1 %) reported their findings on the use of first aid. Fernandez-Morales *et al.* (1997) observed that 21.9% of cases had applied the appropriate first aid, but there was no definition of what this first aid was. Goltsman *et al.* (2016) reported cool running water (CRW) as the appropriate first aid. They reported children with burns from high-risk areas (HRAs) had lower use of CRW first aid (52.27%) than low-risk areas, LRAs (64.77%).

#### *2.6.3.2.3 __Bias due to study design:__*

Regarding study designs, there were no systematic reviews, one prospective cohort study, one retrospective cohort study, 1 case-control and 15 cross-sectional studies. Thus, most of the studies were of designs low in the hierarchy of evidence.

The only prospective cohort study, Randall *et al.* (2017) reported that admission rate for burns per population was lowest in Perth (4.7 burns per 1000 people) despite having the most significant population and being the most developed urban city in Western Australia. The highest crude burn rate was in the Kimberley (19.2 burns per 1000 people), followed by the Goldfields, Pilbara, Midwest and the Wheatbelt, all with similar rates (12.1, 11.8, 11.2 and 11.1 per 1000 people, respectively). These latter areas were mostly rural and remote. The only retrospective cohort study, Duke *et al.* (2015) reports a higher burn injury prevalence of 52.6% in major cities (urban), and this was stronger than the burn prevalence of rural and remote areas. The only case-control study by Devodic *et al.* (1998) reported that the risk of being admitted to hospital with a burn increased in children living in urban areas compared to those from rural areas (OR= 1.97; 95%CI 1.48-2.62).

There was varied reporting of burn risk by urban/rural location for cross-sectional studies. Six cross-sectional studies (Mercier and Blond (1996), Fernandez-Morales *et al.* (1997), Quayle *et al.* (2000), Rajan *et al.* (2011) and Morrow *et al.* (2014) and Saridi *et al.* (2015)) reported a higher number of cases in urban areas than rural areas. Fernandez-Morales *et al.* (1997) particularly reported that the risk of burn injuries in urban areas was 1.3 times more than the risk in rural areas. Seven studies had more rural cases at risk. The studies were Duke *et al.* (2011), Hjern *et al.* (2001), Poulos *et al.* (2009), Martin *et al.* (2014), Patel *et al.* (2016), Roberts *et al.* (2002) and Soleimani *et al.* (2016). Two studies, Goltsman *et al.* (2016) and Lehna *et al.* (2016) utilise a “mixed” geographical measure of HRAs and LRAs. This measure is based on the authors using a combination of geographic information systems (GIS) mapping and derived statistical scores comprising of SEIFA, postcode of patient’s residence, number of burns in each area, level of urbanity, remoteness and “rurality”. Thus, these latter two studies examined social patterning of risk around their residence while accounting for “pockets of variation” among rural/urban areas.

For the studies with more urban victims, Quayle *et al.* (2000) reported that the ratio of metropolitan (urban) burns: non-metropolitan (rural and remote) burns in children was 363:296 per 100,000 children respectively. Morrow *et al.* (2014) reported the almost equal number of cases for urban (50.6%) and rural areas, but there were no substantial differences between both areas. This finding is similar to that of Rajan *et al.* (2011) where both areas had a difference of one for several cases and in Soleimani *et al.* (2016). For the studies with more rural cases, prevalence ranged from 30% to 74%. Duke *et al.* (2011) further observed that burns in urban areas were smaller (<10% TBSA) and less deep than those from rural areas. It is likely that the latter is due to lack of facilities to monitor and treat injuries (which may be severe than in urban areas) in rural areas. Hjern *et al.* (2001) also reported higher burn risk for children in rural areas, AOR=1.4 (95% C.I:1.2-1.6) and had the highest etiological factor for scald injuries (EF=6.8%). Roberts *et al.* (2002) and Poulos *et al.* (2009) also reported more cases or higher burn risk in rural areas than urban areas but did not give an apparent value of how much. Martin *et al.* (2014) reported 74% of cases were rural. However, it is likely this was due to the type of burns (hot ash) that are more common in rural areas. All the other studies have a mixture of burn types. However, two studies, one with an increased risk of burns in urban living children (Rajan *et al.*, 2011) and one with rural living children (Roberts *et al.*, 2002), focused on exhaust burns and another on sunburns (Saridi *et al.*, 2015). Patel *et al.* (2016) was the only study to describe the urban-rural distribution of burn type- 74% of flame injuries and 81% of scalds injuries were urban related

As a result, 7/18 studies show an increased risk for urban children (one retrospective cohort, 1 case-control, and five cross-sectional studies) while 8/18 studies show increased the risk for rural children (1 prospective cohort and seven cross-sectional studies). One cross-sectional study shows no difference between urban and rural while the last 2/18 studies used the high risk and low-risk areas measure in which they report increased risk of children having burns if living in high-risk areas. These findings suggest that the evidence is unclear whether there is an increased risk of burns for either urban or rural children.

Regarding quality of the study, all cohort studies and the case-control study were given a “good” CASP rating while 46.7% of cross-sectional studies were given a “good” rating via the CASP tool with the remainder scored as “fair”. The better-quality studies all reported an association between dwelling in urban areas and increased burn risk except in Randall *et al.* (2017) were it was those in rural areas. These findings were similar in a majority (60%) of the cross-sectional studies irrespective of the quality of the study.

#### *2.6.3.2.4 **Bias due to measurement:***

The definition and measurement of the urban-rural divide is often a cause for concern in geographical and demographical research on health inequalities (Hart *et al.* (2005), Hall *et al.* (2006), Hale *et al.* (2010) and Riva *et al.* (2009)). The reason is there is no universal definition of what is “rural” or “urban” (Hart *et al.*, 2005). Thus, different studies often use different factors to classify the urban-rural divide. Some of these factors are not the basis of valid or reliable definitions but stereotypes and personal views (Hart *et al.* (2005), Hall *et al.* (2006), Hale *et al.* (2010) and Riva *et al.*, (2009)). Nine out of 18 studies gave details of how the urban-rural divide was classified or measured. These studies were Duke *et al* (2015), Hjern *et al* (2001), Morrow *et al* (1996), Quayle *et al* (2000), Fernandez-Morales *et al* (1997), Patel *et al* (2016), Poulos *et al* (2009), Randall *et al* (2017) and Soleimani *et al* (2016). The remaining nine studies gave no precise definition of how the urban-rural divide was classified- two of which measured geographical variation by comparing high-risk areas (HRAs) to low-risk areas (LRAs). Of the nine studies with defined urban-rural classification, four were from the USA, three from Australia and one each from Spain and Sweden. Also, 2 of these nine studies were a prospective and retrospective cohort study respectively; the rest were cross-sectional studies. The studies from Australia used the Australian Standard Geographical Classification and the Access Remote Index of Australia (ARIA+). The studies from the USA each used the Missouri USDA county designation by population density and the Office of State Planning 1990 definitions to classify urban-rural divide. The Swedish paper used the Swedish Population, and Housing 1990 Census classify geographical differences while the study from Spain used a population greater than 10,000 people to define an urban area.

There were no distinguishing differences between the methods used to classify the urban-rural divide in the cohort studies compared to the cross-sectional studies. This literature review also shows that seven out of the nine studies that gave details on urban-rural divide classifications were on sound systems from well-defined country systems, censuses and vital statistics. Only two papers, Fernandez-Morales *et al.* (1997) and Patel *et al.* (2016) seemed not to explain the validity of the classification.

The process of distinguishing rural from urban areas often fails to consider demographic, cultural and economic variations within rural or urban areas that often mirror the opposing region of comparison, e.g. sections within already defined rural areas that may have developed to or have strong characteristics of urban areas and vice versa.  Hart *et al.* (2005) mention that the following criteria could be applied when deciding what factors to include when classifying rural and urban areas. The classification should be clear and detailed in measurement, be replicable, be practically valid, be quantifiable in an objective way and be derived from available, high-quality data (Hart *et al.*, 2005). Population density involves calculations by the researcher for their study of interest. It is a measure of urbanisation based on the distribution of the population of interest in an area. It is the total resident population of a land area (as defined by censuses) divided by the size of the land area. As human populations have an uneven distribution over a land mass, they may not be reliable for the county or regional measurements which may have a boundary or overlapping issues but rather for larger land masses like when comparing densities across different countries (Hall *et al.*, 2006 and Riva *et al.* (2009). Population density also does not account for proximity or remoteness to urbanised areas as this may influence specific health outcomes (Hart *et al.* (2005) and Hall *et al.* (2006)).

Censuses can also be used to define the rural-urban divide. These are more objective than population density. However, they are assumed valid in defining this divide if it is uniform across all regions of interest. Depending on the country where the census is undertaken, the definitions of rural-urban divide get updated with each new census (e.g. last UK census was in 2011) to reflect changes over the years (Hall *et al.*, 2006 and Riva *et al.* (2009). The limitations of census' definition for the urban-rural divide is that they fail to consider economic interdependence that may be related to health care services. This phenomenon occurs in some earlier versions. Also, some censuses do not consider variations within rural or urban areas that seem out of place (Hart *et al.*

(2005), Hall *et al.*, 2006 and Riva *et al.* (2009). Some authors' state using definitions based on one or two criteria may mean the natural use of urban/rural categorisation. However, such definitions will lack precision in measurement (Hart *et al.* (2005) and Hall *et al.* (2006)).

"County codes" have also been developed by several county systems within different countries. These collectively measure the agricultural landscape, town size, proximity to urbanisation, commutability to necessary services and economic strength (Hart *et al.* (2005) and Hall *et al.* (2006)). Researchers are often advised to test different measurement scales for county codes within the country of interest and comparing if the results are similar. The disadvantage of such is that they fail to account for heterogeneity in counties of interest. E.g. a mixture of urban and rural pockets within a largely define rural area or counties that may be borderline of "rurality" and urbanisation (Hart *et al.* (2005) and Hall *et al.* (2006)).

There was not much variation in the year of publication about the classification of the urban-rural divide within the nine studies. Surprisingly, papers published before the year 2000 along with a few after described the basis of the urban-rural classification. The nine studies that did not give any info were after the year 2000. One would expect recent papers to be more likely to report their methods. Also, studies published before 2001 seemed to rely on population density classifications while those after were based on geographical indices of access and remoteness. Seventeen of the 18 studies (94.4 %) reporting rural-urban divide focused on burn injury alone while only one focused on mixed injuries. This latter study was also part of the nine studies that reported their basis for classifying the urban-rural divide. Ten of the 18 (55.6%) papers examining the urban-rural divide used only descriptive statistics. The only mixed injuries paper (Hjern *et al.*, 2001) used inferential statistics to show the association between urban-rural divide and burns (logistic regression). Ten of the 17 (58.8%) burns-only papers used descriptive statistics (pictorials, percentages, Chi-square, Mann-Whitney Test or T-test). Three of the remaining seven studies used Poisson regression to report urban-rural divide and 1/7 each used a combination of both Poisson regression and Bayesian methods, binomial regression, multiple regression and logistic regression respectively.

There is an association between increased burn risk and where children live irrespective of the different years of study, populations and if the data analyses were descriptive or inferential. However, this was not clear-cut by the urban/rural divide across the 18 studies. Two of the 18 studies examined geographical variations as HRAs and LRAs. Children from HRAs were more at risk of burn injury whether these were in urban or rural areas. One of the 18 studies found no sharp differences between urban and rural risk for burns in children (Soleimani *et al.* (2016). As mentioned above in the section on deprivation and burns, inferential statistics are more reliable in showing the adjusted and or unadjusted results of the association between urban-rural divide and burns in their studies. All studies higher up the hierarchy of evidence and 6 of the remaining 15 studies (40%) at the bottom used descriptive and inferential statistics to show the association between geographical variation and burn injury

Studies higher up the hierarchy of evidence (the cohorts (except Randall *et al.* (2017) and case-control studies) reported the association between dwelling in an urban area and burn risk via percentages (Duke *et al.*, 2015) and odds ratios (Devdovic *et al.*, 1996) of 1.97 (95%C. I= 1.48 to 2.62) respectively. The findings from the cohort and case-control studies were similar in five of the 15 studies (33.3%) at the bottom of the hierarchy of evidence. Four of the five cross-sectional studies with more burns in the urban areas presented their results in percentages ranging from 28.6% to 72.9%. The other study (Quayle *et al.,* 2000) presented the association between geographical variation and burn injury in the form of a burn injury rate with children in urban areas having an injury rate of 363/100,000 children compared to their rural counterparts with 296/100,000 children. It was interesting to note that of the eight of 18 studies that reported more burn risk in rural areas than in urban areas, there was one prospective cohort study and seven cross-sectional studies. Two of these eight (25%) studies gave the prevalence of rural burns as percentages ranging from 30% to 74%. Four of these eight studies did not give an exact quantifiable measure of how rural burns outnumbered urban burns. The last two studies: Hjern *et al.*, (2001) presented results as adjusted odds ratios of 1.4 (95% C.I:1.2-1.6) while Soleimani *et al.* (2016) odds ratios showed no substantial differences between urban and rural burn risk. One cross-sectional study, Hjern *et al.*, (2001) gave a 95% CI interval with a narrow range, suggesting that it had better precision than the case-control because it had more power and covered a larger sample of the population studied with linkage done to complete missing information.

The year of study or publication did not show any striking findings regarding result presentation in studies over time.  In all, misclassification of urban or rural areas may be dangerous to the validity of a study, e.g. via ecological fallacy (Hart *et al.* (2005), Hall *et al.* (2006) and Riva *et al.* (2009)).

#### *2.6.3.2.5 **<u>Bias due to missing data:</u>***

Fourteen of the 18 (77.8 %) studies did not mention how they handled any bias from missing data. The remaining 4 used the following: Duke *et al.*, (2015) used sensitivity analysis to control for bias from missing data. Morrow *et al.*, (1996) mentions 36 cases failed to give an address or lived outside the study area and excluded (complete case series-CCS). Soleimani *et al.* (2016) used both CCS and all available data but found no difference in their analyses. Patel *et al.* (2016) mentioned dealing with missing data but did not its resolution.

Of the 14 studies that did not outline the handling of their missing data, the authors of 5 studies mentioned they had complete information to examine the association between urban-rural divide and burn risk in their study. The papers that used sensitivity analysis and complete case series were given a “good” and “fair” rating respectively using the CASP tool. Duke *et al.* (2015) is a retrospective cohort study while others were cross-sectional study.

Irrespective of the handling process of missing data, it was unclear if there was a higher risk for burns in children living in urban areas over rural areas and vice-versa across all 18 studies. The association between increased burn risk and living in urban areas for the study that used complete case series was 50.6%. The study that used sensitivity analysis also expressed the association between living in urban areas and increased burn risk as 52.6 % in Duke *et al.* (2015).

In all, the different findings on the importance of urban or rural living on burn risk are often dependent on socioeconomic status and or ethnic background (depending on the country of interest) rather than definitions of urban/rural divide as identified in this review. As mentioned, in Section 2.6.3.2.4, each country has a different demographic and physical profile which will influence which population ends up living where and why. For example, in Australia, most of the country is rural, with many people living in these rural regions being socioeconomically poor and likely to be of indigenous status. They are more at risk of burn injuries due to the increased exposure to open fires and the lack of safety equipment and have greater distances to travel to access healthcare in the event of a burn. This phenomenon is also likely to occur in many LMICs. In the UK, the reverse is the case as most of the population dwell in urban areas and there is also a movement to the city for better quality of life and access to services. This action may bring about the urbanisation of poverty, where those of low socioeconomic status have no choice but to live in deprived areas which are likely to have insufficient space or low-quality housing. This environment exposes their children to increased burn risk in the home. Thus, the inconclusive nature of the effect of the urban-rural divide on burn injury risk signifies that urban/rural divide cannot be considered a lone deciding factor for burn risk without considering ethnic/socioeconomic disparities.

#### *2.6.3.2.6* ***The confounding effect of socioeconomic status:***

Geographical variations in injury risk are affected by confounding from the SES and ethnic background of the victim's parents. These two factors thus present themselves as a challenge to separate regarding geographical variation. They may also confound attitudes and behaviours which may influence the different exposures to burn risk within each geographical location. For example, some studies have mentioned greater risk of open fire/flame burns in rural and remote areas than in urban areas. However residential fires are more common in urban areas in the UK than the rural areas like in Australia and Canada. They also show an increased association of burn risk with children of minority ethnic parents living in impoverished rural/remote areas. However, the reverse is the case in some countries like the UK or USA (Quayle *et al.* (2000), Nazroo and Williams (2006), Poulos *et al.* (2009) and Duke *et al.* (2015). Overall, most papers with urban-rural data were from Australasia (9 studies), then the USA (4 studies) and one study each from Czech Republic, France, Greece, Spain and Sweden.

Seven of the 18 papers (38.9%) seem to have adjusted for confounding that may result from SES and other covariates when analysing the relationship between urban-rural divide and burn risk. These were Duke *et al.* (2015), Hjern *et al.* (2001) Lehna *et al.* (2016), Soleimani *et al.* (2016), Goltsman *et al.* (2016), Randall *et al.* (2017) and Quayle *et al.* (2000). Only Hjern *et al.* (2001) and Randall *et al.* (2017) showed higher odds/incidence of staying in rural areas and increased burn risk after adjustment. Two studies showed a higher risk for children living in urban areas, but these were unadjusted results. Two more showed a higher risk for children in HRAs than LRAs and 1 showed differences in risk for children in rural compared to urban areas. Thus, there is a need to further examine the relationship between socio-economic deprivation, ethnicity, urban-rural divide and burn injuries. This research gap is an objective of this current research.

In conclusion, the strength of the evidence reporting the association between geographical variation and increased burn risk in this review was moderate. This statement was due to 10 out of the 18 studies (55.6%) been rated as "good" quality via CASP and included all those at the top of the hierarchy of evidence. The remaining 8/18 studies had a "fair" quality as rated via CASP. They also had bias intrinsic in study design, missing data and not defining how urban-rural divide was classified (in half of these studies). While some authors suggest children are at greater risk in an urban setting, others suggest it is rural children who are at greatest risk. Thus, a review of evidence is not clear on the level of burn risk associated with urban and rural living. This uncertainty may be due to different researchers defining urban and rural divide in different ways. Therefore, the studies compared in this review were not similar. Other reasons for this uncertainty may be complex confounding that occurs about poverty, SES, ethnicity and living in an urban or rural setting. For example, ease of transport advances in technology, economic development, migration and globalisation. These factors may influence the "urbanisation of poverty" that occurs when families from these rural/remote areas move to urban or semi-urban areas in search of better opportunities and quality of life (Schmidt *et al.*, 2011, Riva *et al.*, 2009). This migration may cause such families to dwell in deprived sectors within the "well developed" urban regions they have come to call home as some can't afford "city living" (Schmidt *et al.*, 2011, Riva *et al.*, 2009). This observation may also be responsible for increased numbers of urban victims than in previous years. The importance of knowing the geographical base of residence and its effect on burn risk in children is important to health research. This fact will help interventions and policies for those living in "most at risk" areas are to be effective (Cheng and Goodman (2015), Randhawa (2007), Bangdiwala (2000), Nazroo and Williams (2006)).

### 2.6.3.3 <u>Inequalities by additional needs</u>

#### ***2.6.3.3.1 <u>The strength of evidence:</u>***

Research evidence suggests that individuals with additional needs show associations with worse outcomes in health, wellbeing and disease (Cheak-Zamora and Farmer (2015), Ford *et al.* (2007), Jabrink and Knapp (2001), Wigelsworth *et al.* (2015), Sayal *et al.* (2015), Oldfield *et al.* 2015). This fact is in addition to other challenges they already may have with everyday activities of life (Cheak-Zamora and Farmer (2015), Wigelsworth *et al.* (2015) and Sayal *et al.* (2015)). For the rest of this section, additional needs will be used to describe any conditions that show "limiting" proper functioning of physical, mental, emotional, behavioural and developmental health in children and young people.

However, this current literature review on burns found few papers (8/124 studies (6.5%)) that attempted to quantify the impact of additional needs on burn injury risk (See Appendices for Table of Methods (AT 2.7) and Table of Results (AT 2.8). Seven of the eight papers (87.5 %) planned on investigating additional needs as stated in their aims. The 8th paper had additional needs included as a covariate. Four of these eight papers were from the UK; three were from the USA and one from Canada. Overall, children with additional needs had an increased risk of burns (See Appendices for Table of Results (AT 2.8). This finding is consistent in all eight studies irrespective of settings, populations; study design, position in the hierarchy of evidence and study quality.

In this review, two studies, Mangus *et al.* (2004) and Thomas *et al.* (2004) examined attention deficit hyperactivity disorder (ADHD). One study, Colin *et al.* (2006) reports two cases in their study of autism and cerebral palsy. The following needs were also investigated: epilepsy (Prasad *et al.,* 2014), cognitive difficulties (Nayeb-Hashemi *et al.*, 2009). Also, any childhood behavioural disorder (CBDs) treated with Ritalin (Brehaut *et al.,* 2003) and a mixture of "psychiatric disorders" (ADHD, oppositional defiant disorder (ODD), conduct disorder (CD), anxiety, depression) and intellectual functioning (low child IQ and poor reading ability). Emond *et al.* (2017) examine the relationship between motor development, coordination problems, tantrums and abnormal hyperactivity with burn injury risk. The volume of evidence relating to additional needs and burn risk is greatest for ADHD and hyperactivity. All studies except Colin *et al.* (2006) base their clinical diagnosis of additional needs using the

Diagnostic and Statistical Manual of Mental Disorders, $4^{th}$ Edition (DSM-IV) coded with ICD-10 classifications. In addition to DSM-IV, Emond *et al.* (2017) used the ALSPAC development scale to measure developmental progress and the Strengths and Difficulties Questionnaire (SDQ) to measure behaviour in children.

#### *2.6.3.3.2 __Representativeness:__*

Two of the eight papers were on data derived from burn centres followed by 2/8 studies from burn units within a hospital. One study used data from primary care, one using a population-based cohort study, one using population-based surveys and national mental health database and one using data statewide health database. Based on these numbers, 1 (12.5%) of the eight studies may have questionable internal validity since the data was not originally intended for burn injury research. Also, 1 of the eight studies (12.5%) involved the use of a mental health database, so this may have some internal validity for measuring additional psychological needs. In all, five of the eight studies (62.5%) were reported by their authors to have included a sample that was representative of their general population. Thus, it may be safer to infer that 62.5% of these eight studies exhibit external validity for medically reported injuries.

Bias is inherent in studies investigating additional needs and burns based on hospital–derived samples because of access issues, misdiagnosis and co-morbidities of conditions which will underestimate reported burn incidence. However, if such facilities and expertise were in specific regions, it could lead to over-reporting of burn incidence in children with additional needs in such areas. As such, there should be a consideration in emphasising the place of residence from a place of treatment as well as proper diagnosis.

There were no reports of health-seeking behaviour or first aid from the eight studies documenting the association between children with additional needs and burn injuries. Due to the lack of information from authors, one cannot comment on health-seeking behaviour or first aid.

#### *2.6.3.3.3 __Bias due to study design:__*

Of the eight studies, there were two cohort studies (1 prospective & 1 retrospective), and 6 were cross-sectional studies. The two cohort studies (Emond *et al* (2017) and Prasad *et al*, 2014) and five of the six cross-sectional studies (Brehaut *et al* (2003), Mangus *et al* (2004), Nayeb-Hashemi *et al* (2009), Rowe *et al* (2004) and Thomas *et* *al* (2004)) specifically tried to look for the relationship between additional needs and burn injury risk. Emond *et al.* (2017) reported that children with advanced gross motor developmental scores in the 6th month of life were more likely to sustain burns at age 0-2-years [AOR 95%C. I= 1.03 (1.02-1.03)]. There was a relationship between reported coordination problems at age 4.5 years and burn injuries at ages 5 -11 years [AOR 95%C. I= 1.69 (1.21-2.35)]. Reported tantrums in children at 42 months increased burn risk between ages 5 and 11 [AOR 95%C. I= 1.41 (1.04-1.92)] while abnormal hyperactivity at age 47 months hinted increased burn risk in children at age 5-11 years old [AOR 95%C. I= 1.24 (1.01-1.54)]. Prasad *et al.* (2014) mentioned that the hazard ratio (HR) for burn injury was 1.49 (95% CI: 1.27-1.75) in children with epilepsy and this was 50% more than the general population. This observation may be due to high injury risk epileptics are exposed to during seizures. Brehaut *et al.* (2003) reported that after adjusting for age, sex, SES and region, burns in children with childhood behavioural disorders (CBDs) had the 2nd highest injury AOR= 1.99 (95%CI: 1.31-3.02). Colin *et al.* (2006) reported two cases in their study of autism and cerebral palsy. Mangus *et al.* (2004) reported ADHD children had more burns than non-ADHD (83%:58%) ones. They also reported ADHD children had more kitchen/bath burns and less from playing with matches or house fires. This finding was quite interesting as ADHD has some relationship with playing with fire or “arson-like” behaviour. Nayeb-Hashemi *et al.* (2009) reported that the number of younger children with electrical burns and cognitive difficulties was thrice that of the older children. This finding implies that younger children with cognitive difficulties have higher burn risk than their older counterparts.

Regarding the quality of the study, the cohort studies and 50% of the cross-sectional studies were given a “good” rating using the CASP tool with the rest scored as “fair”. Based on these ratings, the results of the cohort study were less at risk of bias than the cross-sectional studies. The cohort and 83% of cross-sectional studies reported an association between children from with additional needs and increased burn risk.

#### ***2.6.3.3.4 <u>Bias due to measurement:</u>***

As this section is pooling together the different needs reported in children with burn injuries, it is quite difficult to describe an accurate measure for all. However, the studies that reported each further need mention that these were on records of clinical diagnosis, parental reports, prescriptions for treatment and psychology/psychiatric evaluations. Four of the eight papers (Colin *et al.* (2006), Mangus *et al.* (2004), Rowe *et al.* (2004) and Thomas *et al.* (2004)) measured inequality in burns and additional needs status using only clinical diagnosis/records. Two studies (Brehaut *et al.* (2003) and Prasad *et al.* (2014)) used prescription records only. One study used parent filled questionnaires (Emond *et al.*, 2017) and another used a combination of clinical records, parent information, psychology and psychiatric evaluations (Nayeb-Hashemi *et al.* (2009)).

Physical needs may be easier to detect or recognise if they can be viewed externally or show recognisable signs of poor wellbeing when symptoms occur, e.g. people who are have lost or reduced use of vision or hearing, the physically disabled, congenital abnormalities and so on. However, this may be more difficult to diagnose if needs are of a mental or learning nature. Thus, the measures outlined here as common to studies examining additional needs focus on mental and behavioural needs. Only Rowe *et al.* (2004) carried out parental interviews or researcher evaluations of victims' additional needs based on standardised descriptions outlined in the Development and Well-Being Assessment interview (DAWBA) by Goodman *et al.* (2000). These assessments were then confirmed (where applicable) with experienced clinicians' evaluations using the Diagnostic and Statistical Manual of Mental Disorders, 4$^{th}$ Edition (DSM-IV).

Some studies outline that while using the DAWBA to assess additional needs of the child; it may be necessary also to assess the status of parents, guardians, researchers and other independent observers doing the assessments (Sayal *et al.*, 2015, Rowe *et al.*, 2004). This template design helps the layman can be able to carry out evaluations, thus confirming with DSM-IV evaluations from experienced clinicians may assist in validating outputs (Sayal *et al.*, 2015).

The DSM-IV seems to have been the widely accepted valid template for confirming needs of a mental nature. However, over time, researchers called for an update to DSM-V (which occurred in 2013) as new diagnoses previously un-coded were identified. Good examples are co-morbidity of these needs in the same individual, a change from one to the other and conditions that share very close similarities such that misclassification occurs. (Jarbrink and Knapp (2001), Rowe *et al.*, 2004, Loeber *et al.*, 2009 and Sayal *et al.*, 2015).

The prescription of medications has been criticised as an adequate measure of additional needs status because they only help to deal with the symptoms of such needs and do not serve as a total "cure" for the needs or conditions themselves (Jarbrink and Knapp (2001), Brehaut *et al.* (2003)). Another reason is the variation in the rates of prescription which vary per individual and may not report status if the victim has not needed to use such for a long period compared to regular users. Thus, children that fall in the former category may get misdiagnosed as having "no additional needs" (Jarbrink and Knapp (2001), Prasad *et al.* (2014) and Sayal *et al.* (2015).

It was interesting to note that older papers (2004-2006) used only clinical records of diagnoses to classify those with additional needs while the oldest (published 2003) and a 2014 paper both relied on prescription records. The only paper published in 2009 seemed to use a combination of records of clinical diagnosis, prescriptions for treatment and psychology/psychiatric evaluations to assign additional needs status. This occurrence may suggest that the authors of this latter study had followed recommendations of earlier publications to ensure a valid classification of children with or without additional needs.

Five of the eight papers (62.5%) examined only burns while the remaining studies examined a mixture of injuries. All the mixed injury papers used inferential statistics to measure the association between additional needs status and burns (mostly logistic, then Cox regression) while most of the burns only papers used descriptive statistics (pictorials, percentages, Chi-square, Fisher's exact test and means with standard deviations). Seven out of the eight studies all point towards an association between increased burn risk and having additional needs irrespective of the different years of study, populations and if the data analyses were descriptive or inferential. As inferential statistics are more reliable in measuring associations, one can trust the results from the cohort studies and 33.3% of the cross-sectional studies that reported them than other studies that gave only descriptive measures.

The study highest in the hierarchy of evidence, i.e. the prospective cohort study (findings outlined in "Bias due to study design" section) and the retrospective cohort study reported the association between having additional needs and burn risk via hazard ratio of 1.49 (95% CI: 1.27-1.75) respectively. The findings from the cohort studies were reflected in weaker studies although, the cross-sectional studies had higher odds ratios ranging from 1.8-3.2 (unadjusted) and adjusted odds ratios ranged from 1.5 to 1.6. Overall, 4/8 papers reported the association between children with additional needs and burns via odds ratios/hazard ratios ranging from 0.01-3.2. Four of the eight studies that used descriptive methods reported a prevalence of children with additional needs ranging from 1.6% to 92.3% of their participants. The reason for the vast range of prevalence was that some studies (e.g. Thomas *et al.*, 2004) had explicitly aimed to quantify the proportion of children with additional needs on admission for burns compared to those with same needs but not admitted. Studies that gave a 95% CI interval along with their odds or hazard ratios had narrow ranges (i.e. the difference between the lower and upper confidence interval limits) with differences from between 0.48-3.4 suggesting some studies had a poor precision on the estimation of effect. These results are more likely for intervals that had a difference of more than 1. It is worth mentioning that the differences in confidence interval limits from the cohort studies and adjusted results were below 1.3 suggesting a fairer precision of estimating effect than other studies that were unadjusted and at the bottom of the hierarchy.

Overall, the association between additional needs and burn risk showed a consistently elevated risk across all eight studies irrespective of their setting or population. There were no noticeable trends between odds or hazard ratios reported and year of publication except for a reduction over time in the adjusted OR / HR. This observation may suggest better quality is being applied to studies in recent years or increasing commitment to improve the power of a study for more accurate results.

##### ***2.6.3.3.5 <u>Bias due to missing data:</u>***

Missing data occurred in 4 out of 8 (50%) studies. The other studies may not have had missing data or failed to account for dealing with missing data. However, given the "specific" nature of additional needs, it is likely that the above suggestion may hold more ground. Of those with information on missing data, two studies, Brehaut *et al.* (2003) and Rowe *et al.* (2004) reported using complete case series. Both authors mention that most additional needs of interest were complete and any few that were missing was not more than 1.3%. They, however, conclude that the association between additional needs and burn risk was not affected but may have reduced study power. Emond *et al.* (2017) used multiple imputations to control for 16-22% of missing data on predictors and confounders while 27% to 55% of participants had missing outcomes. The last study, Nayeb-Hashemi *et al.* (2009), mention that data were complete for additional needs of interest but few psychiatric observations that may have had more information were not collected at a previous place of treatment or lost during transit of patients to their centre. Thus, they advise caution in interpreting their findings. Two of the four studies with information on missing data were cohort studies while others were cross-sectional studies.

The papers that were assigned a "good rating" on the CASP tool include the cohort studies and the three cross-sectional studies that used complete case series and accounted for completeness in their study. Thus, one can say the quality was good for these papers. The three papers that had a "fair rating" on the CASP tool did not account for missing data in their study. The association between increased burn risk and having additional needs for studies that used complete case series was expressed as odds ratios ranging from 1.8 to 3.2 for unadjusted odds ratios and 1.0 to 1.3 for the adjusted odds ratio. The adjusted odds ratios for the paper that used multiple imputations ranged from 1.03-1.69. The study that checked for data completeness did not give a fixed number for the risk of burns in children with additional needs. However, they did state the risk of burns were three times more in younger children with cognitive difficulties and electrical burns than in older children.

##### ***2.6.3.3.6 <u>Confounding effects:</u>***

Factors that were considered confounders varied across the different studies with a few being consistent. The cohort studies, Emond *et al.* (2017) and Prasad *et al.* (2014) controlled for most socio-demographic factors present in their study and confounders that would affect their models. Also, three studies, Thomas e*t al.* (2004), Brehaut *et al.* (2003), Rowe *et al.* (2004) all mention being of younger age, i.e. below seven years could be a confounder for behavioural conditions like ADHD and ODD. The reason is these behavioural conditions are difficult to diagnose before age five years. However, only the two latter studies and the cohort studies controlled for age. However, the association between these conditions and burn risk existed afterwards. Mangus *et al.* (2004), Rowe *et al.* (2004) and Emond *et al.* (2017) explicitly mention that being of the male gender could confound the association between behavioural conditions like ADHD and ODD. However, only the latter two studies controlled for this. Emond *et al.* (2017) showed abnormal hyperactivity at age 47 months led to increased burn risk in children at age 5-11 years old**,** AOR 95% C. I= 1.24 (1.01-1.54) while Rowe *et al.* (2004) failed to show an association between ADHD and burn risk after controlling for gender. This finding could, however, be because Rowe *et al.* (2004) also controlled for other socio-demographic factors like Prasad *et al.* (2014). Nayeb-Hashemi *et al.* (2009) excluded patients that had cognitive difficulties after injury as that would have confounded the results. One of the eight studies (12.5%), Colin *et al.* (2006) failed to neither control for nor mention possible confounders.

All studies examining additional needs especially if they fell under some mental or behavioural conditions mention that misclassification of the condition of interest could be the most significant source of confounding. They state this will not only underestimate the real effect of children with additional needs and burn risk but will also lead to some genuine cases of additional needs being missed or coded for the wrong condition. However, Emond *et al.* (2017), Prasad *et al.* (2014) and Nayeb-Hashemi *et al.* (2009) seemed to have used more methods to classify additional needs. In all, the authors of the various studies warn it is still likely that misclassification can occur even with the most rigorous systems applied as some of these conditions mimic each other, occur as co-morbidities and are challenging to discover especially in the youngest of children.

The strength of the evidence reporting the association between additional needs and increased burn risk was moderate. This statement was because 5 out of 8 studies (62.5 %) were rated as "good" via CASP, had good quality studies and included the studies at the top of the hierarchy of evidence. Also, of the remaining 3/8 studies with a fair CASP rating, all had weak quality. They also had bias intrinsic in study design, missing data and misclassification. Having an additional need be it physical or behavioural reduces the quality of life of an individual no matter how small. This fact leaves such an individual with more vulnerability than they usually would especially in the case of children. Thus, more needs to be done in making the general population more aware of the different additional needs, identifying and distinguishing them (especially those of a mental or behavioural nature). Learning to develop coping mechanisms for those who have these needs is essential (especially around burn risk factors) if interventions and policies to reduce burn risk in this vulnerable group are to be successful.

### 2.6.3.4 <u>Inequalities in supervision levels</u>

Different parents choose to apply different levels of supervision to their children. Defining a threshold of ‘adequate’ or ‘inadequate’ supervision is difficult, and different schools of thought have different definitions (Ablewhite *et al.,* 2015). In the absence of a standard measure of supervision, a clinician’s judgement is often used to assess if parental supervision was good, moderate or inadequate when a child is injured. This judgement is made based on descriptions by witnesses and carers of the burn event. Carer reports of supervision will have some form of social desirability bias, i.e. parents/carers may give a socially desirable response rather than the true story. For the rest of this section and thesis, supervision levels refer to either parental presence or absence when the injury occurred or if the child was under observation during injury or not.

#### *2.6.3.4.1 <u>The strength of evidence:</u>*

Research evidence suggests a relationship between levels of parental supervision and children’s outcomes in health, wellbeing and disease (Bishai *et al.* (2008), Datubo-Brown and Gowar (1989), Dewar *et al.* (2004), Munro *et al.* (2006), and Sowemimo (1983)). Sufficient levels of supervision are particularly important if children are very young or have additional needs that require constant attention. (Cheak-Zamora and Farmer (2015), Morrongiello *et al.* (2006), Morrongiello *et al.* (2009), Wigelsworth *et al.* (2015) and Sayal *et al.* (2015)). However, this current literature review on burns found 13 papers (13/124 (10.5%) studies) that attempted to describe the impact of supervision levels on burn injury risk. The 13 papers identified that reported data on supervision levels and burns are in the Appendices for Chapter 2 (AS2.2).

None of the 13 papers investigated supervision levels as part of their aims. Thus, all measured supervision levels as a covariate. Five of the 13 papers were from Australia, 3/13 studies were from the USA while the remaining five papers were from each of the following countries: UK, Ireland, France, Switzerland and Germany. There seems to be inequality in burn risk, with most studies in this review reporting burned children having *more* parental presence or supervision at the time of injury. Only 4/13 studies (30.8 %) reporting supervision in this review report an association between lower supervision levels and higher burn risks (Colin *et al.* (2006), Henderson *et al.* (2003), Patel *et al.* (2016) and Street *et al.* (2002)). The remaining nine of 13 studies (69.2 %)

reported that most parental reports of burn events had indicated parental presence or supervision at the time the child was injured. This finding was irrespective of settings, populations; study design, position in the hierarchy of evidence and study quality.

For the rest of this section, supervision levels refer to either parental presence or absence when the injury occurred or if the child was under observation during injury or not. Morrongiello *et al.* (2006), Morrongiello *et al.* (2009), Munro *et al.* (2006), Petrass *et al.* (2009), Saluja *et al.* (2004) and Scwebel and Kendrick (2009) mention that parental presence and supervision are two independent factors that are often mistaken for each other. These authors stress that parental supervision should be the focus of measuring supervision levels rather than merely parental presence. Choo *et al.* (2002) also mention that sometimes the quality of supervision may be excellent with enough mature people around at the time of injury. However, some carers let their guard down if they are in places of relaxation or engaging in recreational activities such that they get distracted by supervision, e.g. looking at mobile phones or watching television. Thus, parental supervision is defined as the parent actively in charge of observation and care for a child at a point in time. This definition was used to describe parental supervision in 8/13 (61.5%) studies used in this review. These studies were Choo *et al.* (2002), Colin *et al.* (2006), Eich *et al.* (2009), Henderson *et al.* (2003), Patel *et al.* (2016), Shai and Lupinacci (2003), Street *et al.* (2002) and Wallis *et al.* (2008). Interestingly, these were all cross-sectional studies. Five of these eight studies also mentioned parental presence/absence in addition to parental supervision. These studies were: Colin *et al.* (2006), Eich *et al.* (2009), Henderson *et al.* (2003), Patel *et al.* (2016) and Street *et al.* (2002).

##### ***2.6.3.4.2 Representativeness:***

The 13 papers included data mostly derived from burn centres (6/13 (46.2%) studies), followed by 4/13 (30.8%) studies from general hospitals. 1/13 (7.7%) studies each used data from a state fire department; a combination of burn centre and hospital data and finally, a population-based community health centre database. Based on these numbers, all 13 studies may have enough internal validity since the hospital settings where the data were obtained will have enough assessments to evaluate for burn injury. In all, only 1/13 (7.7%) studies were reported by their authors to have included a sample that was representative of their general population. However, it may be safer to infer that only 1 (7.7%) of these 13 studies exhibits external validity, while the rest may do so but only for medically reported injuries.

Bias is inherent in studies investigating supervision and burns based on hospital–derived samples because of lack of proper data on supervision levels, the risk of misdiagnosis of what counts as proper supervision or neglect, and confusion between supervision and presence of parents or an elder. However, based on evidence of how supervision should be measured, parental/guardian presence is not enough to conclude that supervision was adequate. In this review, 8/13 (61.5%) studies mentioned if the children were being supervised or not at the time of injury. The studies were Choo *et al.* (2002), Colin *et al.* (2006), Eich *et al.* (2009), Henderson et al. (2003), Shai and Lupinacci (2003), Patel *et al.* (2016), Street *et al.* (2002) and Wallis *et al.* (2008).

Of the 13 studies, there were no reports of health seeking behaviour of the parents, although 4/13 (30.8%) studies gave some information on first aid measures. These were Cronin *et al.* (1996), Cheng *et al.* (2016), Stockton *et al.* (2015) and Street *et al.* (2002). Cronin *et al.* (1996) report that 30% of parents felt they had basic first aid knowledge while another 38% of parents mention using precautions to protect their children from sunburn. Stockton *et al.* (2015) provided a detailed report on first aid used- 79.8% of cases had cool running water (CRW) applied out of which 33.6% had this ongoing for 20 minutes. 26% of cases had first aid applied at the scene of injury apart from CRW though unspecified. The authors further reported that 66.5% of cases had a combination of CRW and other alternative therapies (like ice, cold cloth or submersion in water) and from this amount, 50.4% used the alternative therapies only. Street *et al.* (2002) reported that 81.8% of cases had cold water used as a first aid by carers. Cheng *et al.* (2016) was the only study to give inferential results of first aid knowledge. In their study, parents with low health literacy did not know what to do when a child had a burn injury [AOR 1.45; 95% CI: 1.29-1.63]. These findings highlight the importance of building awareness and knowledge of first aid for burn injuries among parents and families.

#### ***2.6.3.4.3 <u>Bias due to study design:</u>***

As mentioned above, all 13 studies here were cross-sectional studies. Regarding quality of the study, 38.4% of the cross-sectional studies were given a “good” rating using the CASP tool with the rest scored as “fair”.  Nine of the 13 (69.2 %) studies reported that most of the injured children (50% and above) had parents present or supervising at the time of injury. These findings were similar across the studies irrespective of study quality.

#### ***2.6.3.4.4 <u>Bias due to measurement:</u>***

Supervision level measures in these studies were parental presence/absence at the time of injury, carer supervising the child at the time of injury or if the carer is witnessing the injury. None of the authors reported supervision levels based on a valid or reliable definition or measurement. Of the 13 papers, 8 (61.5 %) used parental supervision to report their findings (see Strength of evidence section above). It was interesting to note that older papers (published before 2002) and the two most recent papers (published 2009 and 2015) used parental presence to account for supervision. This observation may suggest that the authors of papers published post-2002 to 2009 and 2016 followed recommendations of earlier publications to use parental supervision rather than parental presence.

All 13 studies reporting parental supervision or presence examined burn injuries only except Cheng *et al.* (2016) which examined a mixture of injuries. Also, all 13 papers used descriptive statistics (pictorials and percentages) to quantify cases with parental supervision or presence except Cheng *et al.* (2016) which used descriptive statistics and logistic regressions. All four papers that reported parental presence had a range of 50.8% to 87% of cases with parents present at the time of injury. These four studies reported high burn injury risks despite the range of percentages observed for parental presence at the injury. However, the authors of these papers did not explain if the children whose parents were present had supervision. The remaining 8 of 9 papers that reported parental supervision report that 33.3% to 98.7% of cases were supervised by parents when the injury happened with 5 of these studies reporting a percentage of 50% and above.

Only 1/13 (7.7%) studies, Cheng *et al.* (2016), gave inferential results on lack of precautions that classifies as inadequate supervision. In their study, parents with low health literacy did not keep matches and lighters away from children or provide a safe space when cooking [AOR 2.58; 95% CI: 1.23-5.39] and did not set water heaters to a safe temperature [AOR 1.34; 95% CI: 1.19-1.52]. The findings are more applicable to the less common causes for burns in children such as flame burns, not the most common which are scalds. Given the developmental stages of young children, their curiosity and change in architecture and technology over time, it is of paramount importance parents ensure their immediate surroundings are free of risk agents that put their children in harm's way. The issues outlined above may be reasons for the association between increased burn risk and receiving supervision at the time of injury irrespective of the different years each study was carried out, study population and country of study. It is also quite difficult to conclude on other reasons for this inequality as 12/13 (92.3%) studies reported these finds descriptively and without inferential analyses. Cheng *et al.* (2016) hint that having low-level health literacy regarding necessary health information, services and preventive measures needed to make healthier choices, were essential for families when it came to safely supervising children in the home environment.

As there were no systematic reviews, cohort studies or case-control studies reporting burn risk and parental presence or supervision, the studies next on the hierarchy of evidence (cross-sectional studies) all reported parental presence in burned children with percentages ranging from 50.8% to 87%. The findings from the cross-sectional studies were consistent- although the fewer studies reported parental supervision than parental presence. Five out of the 13 cross-sectional studies reported percentages of cases ranging from 75% to 98.78% having injuries while under supervision. Three studies reported lower percentages of cases ranging from 33.3% to 36.3% experiencing injury when under supervision. This observation shows that papers report different levels of injury and this is likely to reflect issues like different exposures or activities at the time of injury, different ages or developmental abilities, different degrees of supervision.

Three of the 13 (23.1%) studies report a lower percentage of cases (33.3% to 36.3%) experiencing an injury while being supervised. The discrepancy between injuries with and without supervision illustrate the need to understand the role and measures of supervision if one is to create prevention strategies that impact effectively. Further research appears needed to define and measure supervision levels to "quantify" a valid and reliable association with burn injury risk.

#### ***2.6.3.4.5 <u>Bias due to missing data:</u>***

Missing data reports were not in 12/13 (92.3%) studies. Patel *et al.* (2016) briefly mention missing data but do not state how it was resolved.

#### *2.6.3.4.6 **Confounding effects:***

None of the 13 studies reported analyses where the authors had adjusted for potential confounders on the association between parental supervision or presence and burn injuries. Thus, it is not possible to comment on the facts regarding confounding on this association. However, one may suggest that some authors mentioned potential confounders in their discussion of lower health literacy as reported by Cheng *et al.* (2016). Also, family factors have a role to play, e.g. parental marital status, number of older children, family coherence. These results are similar to reports by Natterer *et al.* (2009) and Shai and Lupinacci (2003). Henderson *et al.* (2003) tried to measure the impact of other carers outside the family circle like teachers, neighbours on burn risk in children. However, this seems to be an area for further research, possibly to see differences in burn risk while supervised by family and non-family members.

Choo *et al.* (2002), Street *et al.* (2002) and Wallis *et al.* (2008) all mention in their discussion that age plays a huge role in injury risk and supervision. Parents have a responsibility to give" adequate" supervision to children especially below five years. This may seem to contradict research evidence that suggests increased supervision is associated with increased risk of injuries. However, as mentioned in the "bias due to measurement" section above, the definition of "supervision" is often contested, and most papers seen in this review were referring to parents/carers "being present on witnessing" the injury rather than "actively" monitoring their children under their care. Also, given the current generation, it may be that risk of injury increases while parents are around because of multitasking, e.g. trying to take care of their children while engaging (or being distracted) with mobile devices, television and their intake of hot drinks at the same time. Parents/carers should ensure that while carrying out "adequate supervision," they are always actively monitoring their child, and not distracted by their phones, and do not have any risk factors/agents, e.g. hot drinks nearby that may harm the child in the process. However, there is the need to adjust the degree of supervision as the child grows older and achieves more independence, and this may vary per child depending on other needs they require, e.g. those with additional needs or more reduced rate of development.

The strength of the evidence reporting the association between supervision and increased burn risk was weak. This statement was because 5 out of 13 studies (38.5 %) had a "good" rating via CASP, i.e. had good quality studies though with a cross-sectional design. Also, the remaining 8/13 studies with a fair CASP rating all had weak quality. They also had bias intrinsic in study design and no inferential statistics. Thus, more needs to be done to define supervision measures accurately and how these measures affect burn risk if interventions and policies to reduce burn risk in this vulnerable group are to be successful.

#### 2.6.3.5 Inequalities in vulnerable families

In this section, 'vulnerable families' includes include families with more impoverished or no parental education, lifestyle, parental marital status, parental age, number of siblings, number of children, parental employment status; the number of step-parents, birth order and home layout.

##### *2.6.3.5.1 The strength of evidence:*

Research evidence suggests that individuals from vulnerable families tend to be associated with poorer outcomes of health, wellbeing and disease (Wardsworth *et al* (1983), Jordan *et al.* (1993), Forjouh *et al.* (1995), Joseph *et al.* (2002), Reis *et al.* (2009), Hong *et al.* (2010) and DiGuiseppi *et al.* (2012)). However, this current literature review on burns found very few papers (12/124 studies (9.7%)) that attempted to quantify the impact of vulnerable families on burn injury risk.

The 12 papers identified that reported data on vulnerable families and burns are listed in Appendices (AS 2.2).

None of these 12 studies explicitly mention investigating vulnerable families and burn risk in their aims. All measured vulnerable families as a covariate. Four of the 12 studies were from the UK; 2 were from Australia and the USA respectively while one each from Greece, Switzerland, Sweden and Denmark (See Appendices for Table of Methods (AT 2.7) and Table of Results (AT 2.8)). There is inequality in burn risk, with the association between children from vulnerable families and increased risk of burns (See Appendices for Table of Methods (AT 2.7) and Table of Results (AT 2.8)).

This finding is consistent in all 12 studies irrespective of settings, populations; study design, position in the hierarchy of evidence and study quality.

In this review, seven studies examined marital status of parents: Williams *et al.* (2003), Laursen and Nielsen (2008), Shai and Lupinacci (2003), Hjern *et al.* (2001), Andronicus *et al* (1998), Shah *et al* (2013) and Emond *et al* (2017). Three studies examined the effect of the number of siblings in a family: Hutchings *et al.* (2010), Petridou *et al.* (1998) and Hjern *et al.* (2001). Another three studies looked at maternal education: Emond *et al.* (2017), Laursen and Nielsen (2008) and Hjern *et al.* (2001). Two papers each investigated the effect of birth order: Petridou *et al.* (1998) and Shah *et al.* (2013). Then, maternal age: Petridou *et al.* (1998) and Laursen and Nielsen (2008). There was also two studies each for the number of rooms in home: Petridou *et al.* (1998) and Natterer *et al.* (2009) and living in crowded condition: Laursen and Nielsen (2008) and Natterer *et al.* (2009). Lastly, two studies for the number of children in the home: Shai and Lupinacci (2003) and Laursen and Nielsen (2008). One paper each investigated the effect of maternal employment status: Petridou *et al.* (1998), having step-parent: Rowe *et al.* (2004), and homeownership: Shai and Lupinacci (2003).

***2.6.3.5.2 <u>Representativeness:</u>***

The 12 papers used data from variable sources; hospital records (3 of the 12 studies), 2/12 studies from hospital burn units another 2/12 from population-based databases linked to hospital records. The remaining five studies each used data from state fire department database, population-based GP database, a population-based cohort study, a population-based survey combined with a national mental health database, and national injury registry. Based on these numbers, 1 (8.3%) of the 12 studies may have questionable internal validity since the data were not originally intended for burn injury research. Also, many of these data sources would not routinely collect information on a range of vulnerable families.

In all, seven of the 12 studies (58.3%) were reported by their authors to have included a sample that was representative of their general population. Thus, it may be safer to infer that 58.3% of these 12 studies exhibit external validity but only for medically reported injuries.

There were no reports of first aid from the 12 studies. Due to the lack of information from authors, one cannot comment on first aid application. However, 2 of the 12 studies documenting the association between children from vulnerable families and burn injuries, Laursen and Nielsen (2008) and Hutchings *et al.* (2010) reported health-seeking behaviour. Hutchings *et al.* (2010) report no significant differences in non-urgent care-seeking behaviour in families with children admitted for burns or other conditions (which formed the control group of their study). The authors were trying to understand why more admissions were in the control group. Their conclusion was different conditions some children may have is a heavy burden family are unwilling to bear. The additional stress of a sick or injured child along with challenges they may face in the home or around lowers quality of life. Laursen and Nielsen (2008) reported social differences in care-seeking behaviour with high numbers of families from low SES backgrounds reporting with injured children to either ED or for admissions. This phenomenon may also be due to the reason outlined above by Hutchings *et al.* (2010).

#### ***2.6.3.5.3 <u>Bias due to study design:</u>***

Of the 12 studies, there were two cohort studies (one prospective and retrospective each), 2 case-control studies and eight cross-sectional studies. Given the numbers of different vulnerable families' characteristics observed, the following subheadings and where they appear within the different designs will describe findings:

<u>1.) Maternal education:</u> Four of 12 (33.3%) studies had information on this variable- 1 prospective cohort study and three cross-sectional studies. All four studies had a "good" rating via the CASP tool. The prospective cohort study, Emond *et al.* (2017) observed that higher maternal education is associating with increased burn injury risk in infancy and pre-school children. This finding may be because the dataset used, ALSPAC, has retained the more educated parents than, the less educated parents. Thus, more educated parents may be more confident to report burn injuries than less educated parents (i.e. less influenced by social desirability bias). Emond *et al.* (2017) also report that higher maternal education associating with increased burn risk in children aged 5-11 years old. However, the opposite of this finding occurs in the three retrospective studies with the lesser educated mothers having a higher risk of burn injury in children. Hjern *et al.* (2001) report that children with mothers educated at primary level (AOR=1.3: 95%CI: 1.03-1.5) had higher burn risk for their children than those with secondary and tertiary education. Laursen and Nielsen (2008) also mention the incidence rate ratios (IRR) of children having burns whose maternal education level was primary, 1.6(95% CI: 1.4-1.9) or secondary, 1.2(95% CI: 1.0-1.3). Lehna *et al.* (2016) observed via multiple regressions that children with parents that were non-high school graduates had higher burn risks. The findings of six cross-sectional studies, though with inherent bias, report that poor education may lead to poor outcomes.

2.) Maternal occupation: Two of the 12 (16.6%) studies had information on this variable- 1 case-control and one cross-sectional study. Both studies had a “good” rating via the CASP tool. The case-control study, Petridou *et al.* (1998) reported that mothers of 41.4% of cases were involved in housekeeping and schooling for more than six years. However, the odds ratio for a burn victim with some mum working/schooling for < 6 years when compared to other years was 2.6 (95% CI 0.7-9.4). Natterer *et al.* (2009) stated that 30% had career homemakers for mothers. Thus, it is likely that the findings in these studies are due to parenting experience.

3. Maternal age: Five of 12 (41.7%) studies had information on this variable- 1 retrospective cohort, 2 case controls and two cross-sectional studies. All five studies had a “good” rating via the CASP tool. The retrospective cohort study, Hutchings *et al.* (2010) observed that the mean number of injuries was 1.83 (range:0-6) and that younger mothers (below 30 years) had more risk of having burned children (youngest maternal age in this study= 25.9 yrs).

For the two case-control studies, Petridou *et al.* (1998) reported that mothers of most burn victims (30.1%) were aged 25-29 years. Shah *et al.* (2013) reported that the children of mothers aged 40 years and above had lowest odds of scald injury compared to the children of teenage mothers (OR 0.32, 95% CI 0.16-0.64). The two cross-sectional studies further confirmed the risk of burn injury in children of younger mothers. Laursen and Nielsen (2008) reported that having mothers < 25 years led to child burn incidence rate (IR) of 2.9 per 1000 and incidence rate ratios (IRR) of 1.6 (95% CI: 1.4-1.9). Lehna *et al.* (2016) further report most burn cases to occur with teenage parents, but this did not persist after multiple regression.

In conclusion, one can surmise that there is a higher risk of burns in children with younger mothers (usually below 30 years) irrespective of study design or quality. Some of the studies highlight that this may be due to lack of experience (i.e. for 1$^{st}$-time mothers) or family stability (e.g. unmarried, teenage mothers that lack extra support in child rearing)

4. The number of children in home and birth order: Six of 12 (50%) studies had information on this variable- 1 retrospective cohort, 2 case controls and three cross-sectional studies. All six studies had a “good” rating via the CASP tool. The

retrospective cohort study, Hutchings *et al.* (2010) observed that 86% of cases had siblings around at the time of injury.

As for the two case-control studies, Petridou *et al.* (1998) report that cases were more likely to be children with two siblings (45.6%) and first-born children (46.4%). Shah *et al.* (2013) however showed an opposite trend with cases born later having higher OR's for burns than those born first especially 3/4th born (OR 2.17, 95% CI 1.60-2.94). The studies report that higher risk in first-born children is due to their parents of having less experience of child rearing. For children born later, the increased risk is due to being of younger ages and developmental stages than older children, non-adult supervision by older siblings (which may not be as effective as adult supervision) and the increased number of children needing parental supervision as the family grows.

One of 3 cross-sectional studies further confirms findings from the studies high up in the hierarchy of evidence. Hjern *et al.* (2001) observed that having 2 or more siblings had high odds of burns (AOR= 1.2, 95%CI: 1.02-1.4). The remaining two showed no increased risk for larger families. Laursen and Nielsen (2008) reported the IRR of having a burn in a 2-child home was 0.8 (0.7-1.0). Shai and Lupinacci (2003) observed no association between burn occurrence and a high number of < 15-year-old children (OR=1.001, 95%CI: 1.0009-1.0018).

In all, four of the six studies irrespective of quality and design indicate that households with a higher number of children had increased child burn injury risk.

<u>5. The number of residents in home and rooms:</u> Three of 12 (25%) studies had information on this variable- one case-control and two cross-sectional studies. All three studies had a “good” rating via the CASP tool. The case-control study, Petridou *et al.* (1998) reports that increased burn risks were common where there were four residents in a home (43.9%) and 2-bedroom homes (61.1%). However, odds ratios were stronger for burn victims in 1-bedroom houses 3.6 (95% C.I 1.1-12.2) and 3+ bedroom houses 2.7 (95% C.I 1.5-4.8) compared to 2-bed houses.

The first cross-sectional study, Natterer *et al.* (2009) stated that 50.6% of cases lived in 2-3.5-bedroom apartments, and 5.6% of cases lived in crowded conditions. The other cross-sectional study, Laursen and Nielsen (2008) observed that the IRR of children having a burn-in crowded dwelling was 1.2 (95% CI: 1.1-1.4).

In all, the three studies, irrespective of design and quality suggest that overcrowding is a risk factor for burns in children. The case-control study shows that smaller and larger numbers of rooms in the home may increase burn risk; this is due to overcrowding and poor supervision quality respectively.

6. Parental lifestyle: Two of the 12 (16.6%) studies had information on this variable-1 prospective cohort study and 1 case-control study. Both studies had a "good" rating via the CASP tool. The prospective cohort study, Emond *et al.* (2017) mention that families with higher family adversity index (FAI)- a composite measure used in ALSPAC data (made of 18 factors reflecting family socioeconomic status) showed association with increased burn injury risk in infancy and pre-school children. Family adversity was great in families with higher FAI scores. They also report that mothers with higher parenting scores at child age six months, had children with fewer burns at 0-2 years old but no apparent protective effect by 2-4.5 years.

The case-control study, Shah *et al.* (2013) reported that parents who were current/ex-smokers had OR=1.18 for having a child with a scald (95% C.I 1.08-1.38). Also, having perinatal depression increased the odds of having a child with a scald by 34%(OR=1.34, 95% C.I 1.06-1.70).

7. Marital status: Eight of 12 (66.7%) studies had information on this variable- one prospective cohort, 1 case-control study, and six cross-sectional studies. All eight studies had "good" rating via the CASP tool except two cross-sectional studies (Andronicus *et al.* (1998) and Williams *et al.* (2003)) that had "fair" rating. The prospective cohort study, Emond *et al.* (2017) reported that never being married was associated with increased burn injury risk in infancy and pre-school children. This finding is like that of the case-control study, Shah *et al.* (2013) where children in single adult homes had high odds for scald injuries (OR 1.26, 95% CI 1.08-1.46).

Only Natterer *et al.* (2009) however stated that 79% of cases had parents who were married. This finding was descriptive.

The other cross-sectional studies agreed with findings from the cohort and case-control studies except for Andronicus *et al.* (1998) that agreed with findings in Natterer *et al.* (2009). Andronicus *et al.* (1998) reported accidental burns were 9-10 times less likely to be from single-parent homes. Hjern *et al.* (2001) report that living in single-parent homes had higher burn risk (AOR=1.2, 95%CI: 1.03-1.5). Laursen and Nielsen

(2008) also mention the IRR of having a burn in a single-parent home = 1.3 (95% CI: 1.1-1.5). Shai and Lupinacci (2003) observed a strong association between burn occurrence and single-parent households (OR=2.80, 95%CI: 1.38-5.69) while Williams *et al.* (2003) reported that 48.6% of burns in St Louis census tracts (1995) were from children with single parents.

Irrespective of study design and quality, six of the eight studies here agree that there is an increased risk for burn injuries among children from a single home. The two exceptions may be due to the studies being descriptive (Natterer *et al.*, 2009) or having a different comparison group to others- accidental burns to non-accidental burns (Andronicus *et al.*, 1998).

<u>8. Type/Age of accommodation</u>: Three of 12 (25%) studies had information on this variable, and these were cross-sectional studies. All studies had a “good” rating via the CASP tool. Laursen and Nielsen (2008) report an increased IRR for burns in children whose family were flat dwellers= 1.7 (95% CI: 1.5-1.9). Shai and Lupinacci (2003) observed that residential fires had a strong association with dwelling in houses built before 1939 (OR=2.84, 95%CI: 1.50-5.37). These findings are like that of Lehna *et al.* (2016) where most children with burns were more likely to live in older houses.

The quality of these three cross-sectional studies was rated as excellent. The findings all agree that the use of accommodation designed for a small number of people, or staying in older generation houses, put children at higher risk of burn injuries.

##### ***2.6.3.5.4 <u>Bias due to measurement:</u>***

Measuring vulnerable families’ characteristics may not need complex tools or templates to obtain the necessary information as these are often a straightforward question, e.g. number of children, marital status. These factors are obtained by asking parents of the affected children directly (if they are not able to speak clearly for themselves or via data linkage (where available)). Thus, it all comes down to researchers’ questions of interest, the manner of questions within questionnaire or interview template and most importantly how sensitive the questions will be to the individual or their families (Joseph *et al.*, 2002). Some authors have mentioned this latter point as the primary key to success in getting family-based responses or characteristics (Dempsey and Orr (2006), Kramer *et al.* (2010) and DiGuiseppi *et al.* (2012)). In other cases, the method of obtaining family information is too complicated to understand or is not comprehensible to the participant/patient and their families due to literacy levels or language barriers. This barrier may also reduce chances of getting complete or good quality information to accurately quantify the association between family factors and burn risk (Joseph *et al.* (2002), Dempsey and Orr (2006), DiGuiseppi *et al.* (2012)). Thus, self-reporting information (with interpreters where applicable) has been used by some researchers to collect family information and burn history. However, these methods have the potential of introducing recall bias if the injury is not recent. E.g. overestimation of safety practices (so the parents mention every precaution they have in the home to prevent an accident to show they are "careful" in their roles). Also, not reporting the true state of home for fear of judgement for having specific hazards in their family/home life may occur (Joseph *et al.* (2002), Forjuoh *et al.* (1995), Reis *et al.* (2009) DiGuiseppi *et al.* (2012)).

Nine of the 12 papers (75%) examined only burns, while the remainder examined a mixture of injuries including burns. All the mixed injury papers used inferential statistics to measure the association between family factors and burns (mostly logistic, then Poisson regression). Three of the nine burns only papers used descriptive statistics (pictorials, percentages, Chi-square and means with standard deviations) while the remaining six burns-only papers used inferential statistics (2 papers used conditional logistic regression, two used logistic regression, one each used multiple regression and Bayesian statistics). As inferential statistics are more reliable in measuring associations via adjusted and or unadjusted results, one can trust the results from the prospective cohort study, the case-control studies and 75% of the cross-sectional studies that reported them than other studies that only reported descriptive measures (including the only retrospective cohort study).

The variables measured, and their findings reported by all 12 papers are presented in "Bias by study design of this discourse or Table of Results in Appendices (AT2.8).

The literature shows that there are associations between certain vulnerable families' characteristics and increased risk of child burn injuries, which are consistent across study designs, populations and settings. These characteristics include low maternal age, low maternal education, being unmarried, having high numbers of siblings or being a first-born child, and living in overcrowded or older accommodation. Understanding the impact of such vulnerable families is complex since these factors are not independent of each other, or with factors relating to parenting and supervision.

#### *2.6.3.5.5* ***Bias due to missing data:***

Missing data were in two studies: Emond *et al.* (2017) and Rowe *et al.* (2004). Rowe *et al.* (2004), a cross-sectional study, reported that few data were missing (not more than 1.3%) and these were excluded resulting in complete case analyses. They, however, conclude that the association between family factors and burn risk was not affected by missing data but may have reduced study power. Emond *et al.* (2017), a prospective cohort study used multiple imputations to control for missing data ranging from 16-22% on predictors and confounders.

Both studies were observed to be of good quality and had a "good" rating on the CASP tool. The association between increased burn risk and children from vulnerable families in these two studies occur via the following variables: having step-parents, higher maternal education, single status and high family diversity (see bias due to study design section for more details)

#### *2.6.3.5.6* ***Confounding effects:***

Of the 12 studies, 6 (50%) adjusted for confounding. The cohort studies adjusted their models for maternal and socioeconomic factors, age, sex and matching by enumeration district. One cross-sectional study, Rowe *et al.* (2004) adjusted their models for age and gender. Hjern *et al.* (2001) and Lehna *et al.* (2016), both cross-sectional studies, both controlled for socio-demographic factors while another cross-sectional study, Laursen and Nielsen (2008) did the same in addition to excluding children not living with any of their parents. After adjustment, Lehna *et al.* (2016) only showed ethnicity, parental education and year home were built as influencing burn risk. Laursen and Nielsen (2008) reported that living with single parents and stepfamily showed no effect on burn risk.

These findings suggest that a likely confounder for measuring vulnerable families' characteristics may be socio-demographic factors, e.g. literacy levels, socioeconomic status. This opinion is similar to findings in Joseph *et al.* (2002) and DiGuiseppi *et al.* (2012).

In all, there is limited evidence on the impact of confounders on vulnerable families. This observation calls for further investigation of the direct impact of vulnerable families on burn risk in children. Thus, an objective of this thesis is to examine such (where applicable). The strength of the evidence reporting the association between vulnerable families and increased burn risk was moderate. The reason was that 10 out of 12 studies (83.3 %) had a “good” rating via CASP. Also, most studies were of good quality studies and included those higher up the hierarchy of evidence. The remaining 2/12 studies had a fair CASP rating and weak quality. There was no information on the impact of parental influence on burn risk or knowledge/application of adequate first aid.

## 2.7 Critique of Literature Review

### 2.7.1 Strengths

This work has been a comprehensive review of literature rather than a systematic review as described using Cochrane guidelines. The review used pre-specified inclusion and exclusion criteria; electronic databases searches and critical appraisal of included studies by one observer, with moderation by two others. Findings from these studies were pooled together under different themes, and a narrative review undertaken in a transparent fashion which is potentially reproducible.

Quality appraisal of studies was done using the Critical Appraisal Skills Programme (CASP) checklist tool. This tool was used was because it has templates for different study designs. Also, the tool has essential sub-questions that enable the user to appraise a study against the included questions consistently.

Data were extracted and pooled using a narrative synthesis method under different themes to describe the inequalities reported. Also, there was a comparison of studies regarding their study quality, where they appeared in the hierarchy of evidence and by how statistics were presented, i.e. descriptive or inferential. Furthermore, “missingness” within the studies was highlighted and how its biases and other confounding factors were resolved.

In all, this is the first review of inequalities in paediatric burns in high-income countries in the past 23 years (1995-2018), and it will guide future research in paediatric burns.

### 2.7.2 Limitations

Although the principles of a systematic review process were followed as much as possible, some limitations of this review remain.

The studies selected by different authors carrying out literature reviews on the same topic will vary, based on the choice of keywords used when trying to design their search strategy. This weakness was minimised by looking through published literature with similar scope to this research for keywords used; consulting a University Librarian skilled in systematic reviews and an academic expert in injury research for common keywords used in this area. It is still possible that some keywords relevant to this current research are missing, or synonyms that would have brought forth sensitive and specific hits mistakenly mischosen for their counterparts which carry less precision.

Date limitations were applied to limit the number of potentially eligible studies to a likely number and to focus on evidence more likely to reflect the lived experience of children today.

Another issue to consider is if all the right electronic databases that could have had the necessary studies were searched. The author to the best of his ability did screen a long list of electronic databases that could not have been exhaustive but was able to select 22 which could bring forth the needed papers. Seven of these were deemed to be within the scope of this research and able to provide functional quality studies used in this review. Therefore, it is entirely possible that the inclusion of all necessary papers was not complete, e.g. those that required extra payment to access. Also, the databases used the English Language. Thus, it is likely that relevant evidence written in languages other than English are missing. Fortunately, most of the studies retrieved published in English, and if they came in other languages, they tended to be available with English translations. As such, there was no exclusion of papers because of language barriers. Also, the journals from the selected regions of study used for this review publish mostly in English.

Grey literature was not included in this review. The reason is there were many hits retrieved from the 7 electronic databases. Also, the limited grey literature (PhD or MSc theses) obtained from one of the excluded databases was published in peer-reviewed journals. Thus, including such theses in this current review could have led to double counting or inclusion of duplicated research. However, it is more likely that some theses that met the inclusion criteria never got written up for publication (at the time the searches were done) and had been missed.  Also, a higher number of grey literature had to a “pay for access” portal restricting the information therein. It is possible that relevant evidence from grey literature is missing the review.

Most of the appraisal and extraction of the evidence has been carried out by one author, with support from his supervisors. However, having two independent assessors to examine studies with ambiguous quality may have helped reduce bias. A meta-analysis could not be carried out given the heterogeneity of the study designs from the included papers. Therefore, a narrative synthesis was deemed more appropriate to present the findings from this review.

The "generalisability" of the findings of this review is limited to medically reported burn injuries as most of the information reported in the studies included in this review were derived from the hospital or burn centre records. Furthermore, the findings apply to high-income countries especially those with similarities to the United Kingdom and not the low or middle-income countries. There is also the issue of "intentionality" of the injury. Though this review focused on studies reporting burn injuries classed as "accidental", it is very likely that some studies have cases have been erroneously coded as such when they are in fact "neglectful or intentional" cases.

## 2.8 Conclusion of Chapter

The findings from the review suggest that burns and scalds in children are associated with multiple risk factors. The narrative synthesis focused on the factors related to inequalities in burn incidence. There was clear evidence on issues of deprivation, ethnicity, geographical variation, additional needs, and parental/carer supervision. There is need to understand the contribution of each of these factors to the overall risk of burn injuries (Baker (2000), Bangdiwala (2000), Flowers (2006), Nazroo and Williams (2006) and Norton *et al.* (2006)).

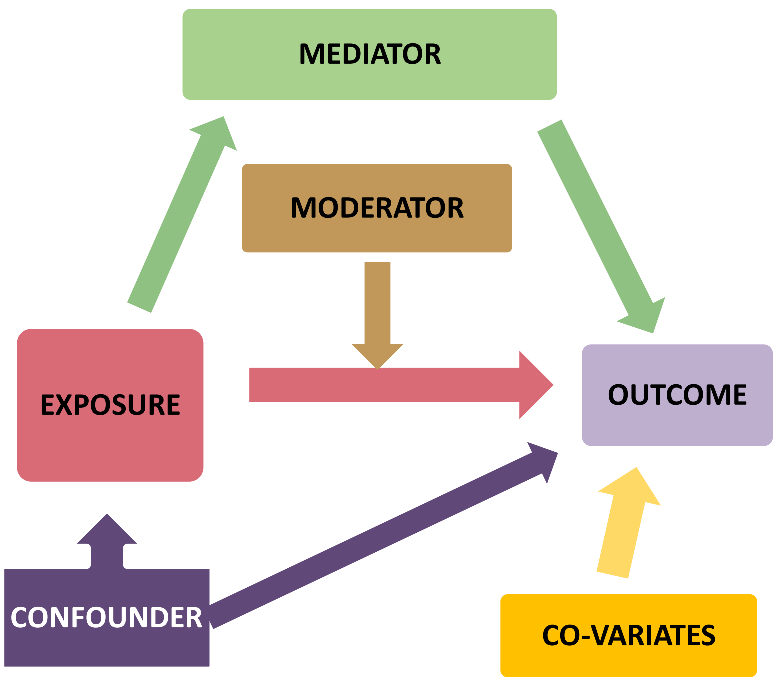
The next phase of the research will be to improve the evidence relating to the association of these factors and children's burn injuries through analyses of secondary datasets using hypotheses generated from this review. These hypotheses and research questions are in detail in Chapter 3.

# CHAPTER 3 : VARIABLES INFLUENCING BURN RISK

This chapter will show all the possible variables at play in the relationship between the key variables of interest (deprivation, ethnicity, urban/rural divide, pre-injury impairment and supervision levels) and burn outcomes in children. Associations are depicted using conceptual diagrams.

Conceptual diagrams are diagrams that help researchers illustrate relationships between their key exposure and outcome variables (Paradies and Stevens (2005), Field-Fote (2019)). These variables are then classified as confounders, covariates, effect modifiers and mediators. Given the complexities in how variables intertwine in a model, it can be tricky to understand these associations and how they affect (or do not) the main relationship between an exposure and outcome of interest. Below is a figure which gives a basic layout of how variables may interact within a model according to Field-Fote (2019)

**Figure 3-1 Basic Conceptual Diagram (adapted from Field-Fote, 2019)**



Confounders are variables in an epidemiological model that have an independent association with both the exposure and the outcome variable of interest (Paradies and Stevens (2005), Field-Fote (2019)). However, they do not lie on the causal pathway of the association one wishes to examine (as seen in Fig. 3.1 above). For example, in the model examining the relationship between additional needs in children and burns in children (Fig. 3.4), maternal age is a confounder. Published literature reports that older mothers (e.g. 40 years and above) are at risk of having children with conditions like Down's syndrome. Young mothers are also more likely to have children with burn injuries. Thus, maternal age is associated with both the exposure (additional needs) and the outcome (childhood burn injury) of interest.

Mediators are considered "intervening" variables in an epidemiological model as they lie on the causal pathway between the exposure and outcome of interest (Field-Fote, 2019). E.g. in the additional needs model (Fig 3.4), supervision from parents and carers can be a mediator since this may be heightened for children with additional needs. Heightened supervision, in turn, may reduce exposure to burn risks in children thereby reducing burn incidence.

Effect modifiers/moderators are variables in an epidemiological model that may change the size of the relationship between an exposure and the outcome. They interact with the exposure in a way that influences the relationship between the exposure and the outcome (Field-Fote, 2019). E.g. in Fig 3.6, ethnicity can be considered a moderator in the relationship between supervision and burn outcomes in children. Published literature reports that supervision styles vary across different individuals, families and this may have some cultural influence.

Covariates in an epidemiological model often have a relationship with the outcome of interest. Recognising the categories under which these key variables fall can help researchers from the early onset to know how each variable should be included in the model or adjusted for, so the effect of bias and confounding is reduced (Jager *et al*, (2008), Paradies and Stevens (2005)).

However, it is also important to note that not all confounding may be completely removed from epidemiological models. This issue is called residual confounding and is due to many factors, e.g. the lack of some of the key variables of interests in a dataset (if its secondary data) or the lack of ability in collecting such information due to ethical or logistic issues (i.e. if its primary data). Also, the study design used in collating data in the first place may introduce residual confounding. This issue is common in observational studies (e.g. cohort, cross-sectional studies) and almost non-existent in experimental studies) (Jager *et al*, 2008).

The conceptual diagrams presented below depict the important variables of interest that may apply to the research in this thesis. Some of these are not available in the secondary datasets or have not been collected during primary data collection.

The resulting conceptual diagrams below have been constructed based on the results from the comprehensive review in Chapter 2. The conceptual diagrams specific to each dataset are presented in their respective chapters: Chapter 4 (HES) and Chapter 5 (BaSAT).

Socio-demographic factors like deprivation and ethnicity strongly influence the risk of burn injury in children. Because of this, a separate chapter 6 is dedicated to examining in more depth the effect of ethnicity on child health and child injury.

## 3.1 The multivariable conceptual diagrams and burn outcomes in children

The conceptual diagrams below attempt to provide a pictorial description of the complex and intertwined relationships between the five main exposures of interests and burn outcomes. One clear thing is that even the main exposures of interest are themselves at some point within the model either covariates, moderators, mediators or confounders. This complexity is challenging to unravel, but where available, the secondary data analyses in this thesis will attempt to control for their effects

Below is a brief table (Table 3.1) listing the kind of variables used in the models and how they are classified under the socio-ecological model of health. In the inferential analyses in chapter 4 and 5, the models of interest will be plotted such that one can see the combined effect of other environmental, family and individual factors on the associations between the key exposure and outcome variables.

**Table 3-1 Grouping of the key variables from literature review within the concept of the socioecological model of health**

| Category of predictor variables | Variables |
| --- | --- |
| **Individual factors (child)** | Sex of the child, age of the child, any additional needs, |
| **Individual factors of parent/carer influencing family structure** | Maternal/teenage parental age, parental health literacy, parental education, parental income, and lone parent |
| **Family factors** | Ethnicity, number of siblings, supervision levels and chaotic/vulnerable families (i.e. marred with domestic violence, substance abuse and so on.) |
| **Environmental factors** | IMD score, overcrowding, urban/rural divide and housing type |

The conceptual diagrams for this thesis described below are as follows:

1. Deprivation (IMD) and burn outcomes in children.
2. Ethnicity and burn outcomes in children.
3. Additional needs and burn outcomes in children.
4. Urban/rural divide and burn outcomes in children.
5. Supervision levels and burn outcomes in children.

## 3.2 IMD and burn outcomes in children

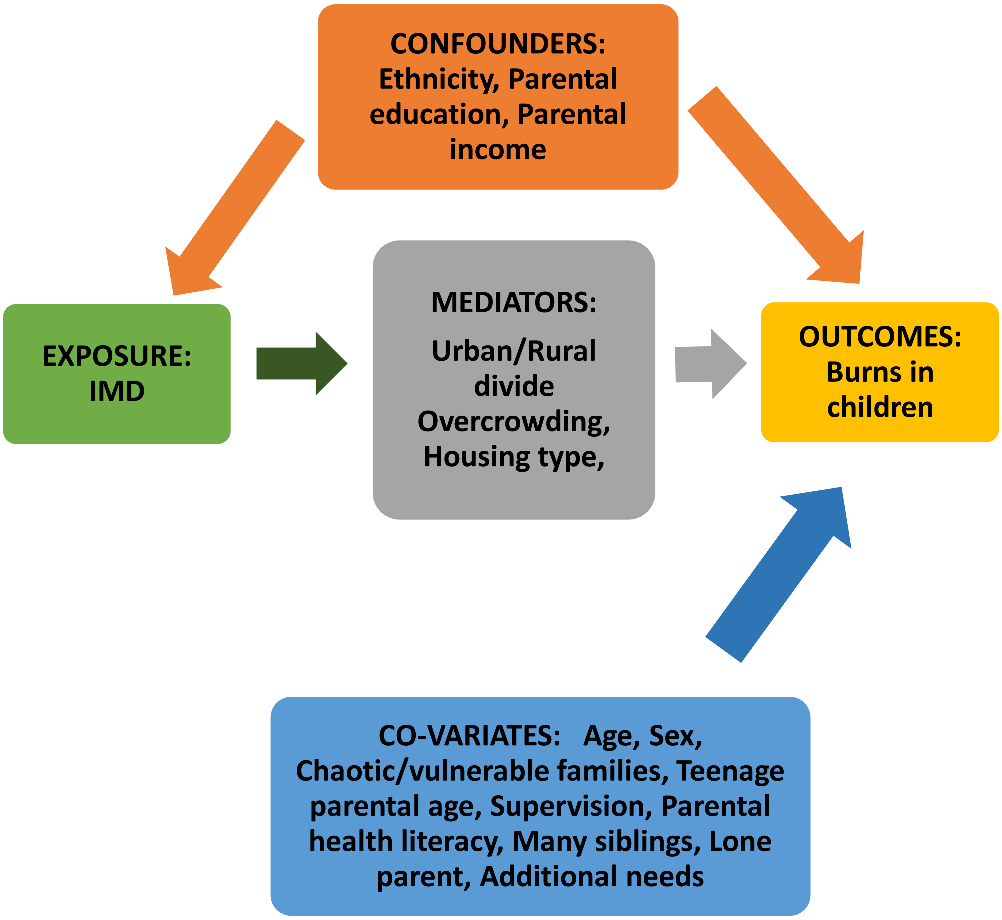
As highlighted in the comprehensive review in chapter 2, several factors affect the relationship between a family's deprivation status and burn outcomes in children. The conceptual diagram below shows which of the variables are possible confounders, mediators, moderators or covariates. However, the relationship between some of the variables in the IMD model is complex. For example, some literature seems to associate ethnicity as a confounding factor in the relationship between deprivation and burn outcomes in children (Alaghehbandan *et al.* (2012) and Nazroo and Williams (2006)). Alaghehbandan *et al.* (2012) mention that children from Aboriginal backgrounds have a higher rate of unintentional injury than children from non-Aboriginal backgrounds due to several factors most of which are linked to living in areas with higher deprivation. In addition to the conceptual diagram for the IMD model, the following table highlights where each variable is classified in this model with some reasons:

**Table 3-2 Table showing role of variables in the IMD model**

| |
|---|
| **Confounders: Ethnicity, Parental education, Parental income** |
| These variables are not on the causal pathway between IMD and burn outcomes in children. They precede the exposure of interest. E.g. one's ethnicity could be associated with deprivation as described above. However, IMD doesn't cause one's ethnicity. Also, parental education and income could determine if one ends up in elevated deprivation or not. In turn, these variables are known to also influence in burn outcomes as seen in the review in Chapter 2. |
| **Mediators: Urban/Rural divide, Overcrowding, Housing type** |
| These variables can be seen to be on the causal pathway between IMD and burn outcomes in children. If a child comes from a very deprived background, this could influence the kind of housing their family can afford. If the quality of the house is poor and is not "child-safe", they could in turn have elevated risk for injury. As seen in the chapter 2 review, such houses often occur in urban deprived areas in HICs than in rural areas. Overcrowding may also result if the house is not spacious enough for the family who may have extended members co-sharing to save costs beyond the capacity of a house e.g. A family of 5 staying in a studio. |
| **Co-variates: Age, Sex, Chaotic/vulnerable families, Teenage parental age, Supervision, Parental health literacy, Many siblings, Lone parent, Additional needs** |
| The literature review in chapter 2 shows that these variables have a relationship with burn outcomes. However, they do not "cause" the exposure (IMD), neither are they a direct result of deprivation. |

The secondary data analyses from HES and BaSAT data will control for these factors (where available) in Chapter 4 and 5.

**Figure 3-2 Conceptual diagrams of the relationships influencing the association between family deprivation (IMD score) and burns in children**



## 3.3 Ethnicity and burn outcomes in children

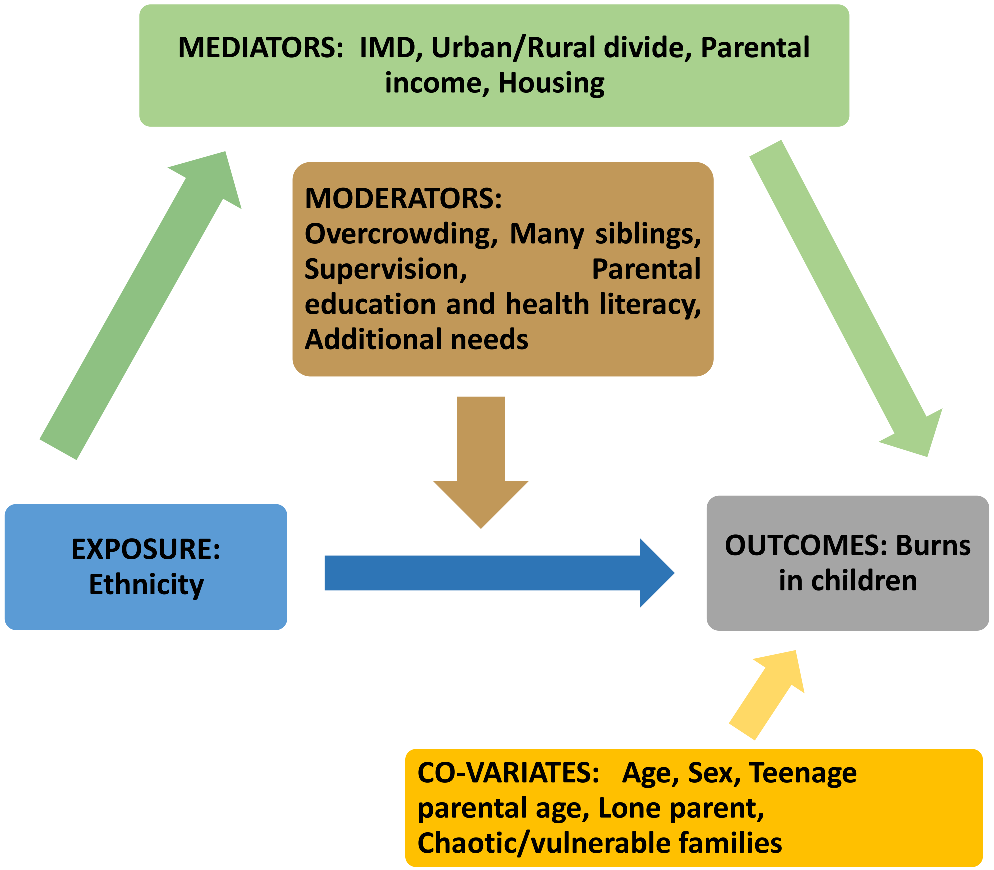
The conceptual diagram below shows which of the variables are possible confounders, moderators, mediators or covariates in the model for ethnicity and burn outcomes. For instance, different ethnic groups may have different cultural norms for raising children, including supervision. In some cultures, it may be normal for older siblings or extended family to provide supervision to young children (Allport *et al*, 2019). Thus, supervision acts as a moderator in the relationship between ethnicity and burn outcomes in children. If the supervision is inadequate, then children are at elevated risk of injury. The secondary data analyses from HES, and BaSAT data in Chapter 4 and 5 will control for these factors (if applicable). The relationship between ethnicity, deprivation and burn risk will be discussed in greater depth in Chapter 6. In addition to the conceptual diagram for the ethnicity model, the following table highlights where each variable is classified in this model with some reasons:

**Table 3-3 Table showing role of variables in the Ethnicity model**

| |
|---|
| **Moderators: Overcrowding, Many siblings, Supervision, Parental education and health literacy, Additional needs** |
| These variables are not on the causal pathway between ethnicity and burn outcomes in children. However, they may affect the relationship between these two variables. The example with supervision has been described above. Also, Cheng *et al.* (2016) report that parents with lower health literacy had children with increased risk of burn injuries. Such parents are found in any ethnicity and so parental health literacy moderates the relationship between ethnicity and burn outcomes in children. |
| **Mediators: IMD, Urban/Rural divide, Parental income, Housing** |
| These variables can be seen lying on the causal pathway between ethnicity and burn outcomes in children. The literature review in Chapter 2 shows that some children from ethnic minority backgrounds may also be surrounded by elevated deprivation depending on their family background. This reflects their parental/household income and where these families can afford to live as well as the type of housing. If the quality of the house is poor and is not "child-safe", they could in turn have elevated risk for injury. As seen in the chapter 2 review, such houses often occur in urban deprived areas in HICs than in rural areas. |

| **Co-variates: Age, Sex, Teenage parental age, Lone parent, Chaotic/vulnerable families** |
| --- |
| The literature review in chapter 2 shows that these variables have a relationship with burn outcomes. However, they do not “cause” a child’s ethnicity, neither are they a direct result of ethnicity. |

**Figure 3-3 Conceptual diagrams of the relationships influencing the association between ethnicity and burns in children**



## 3.4 Additional needs and burn outcomes in children

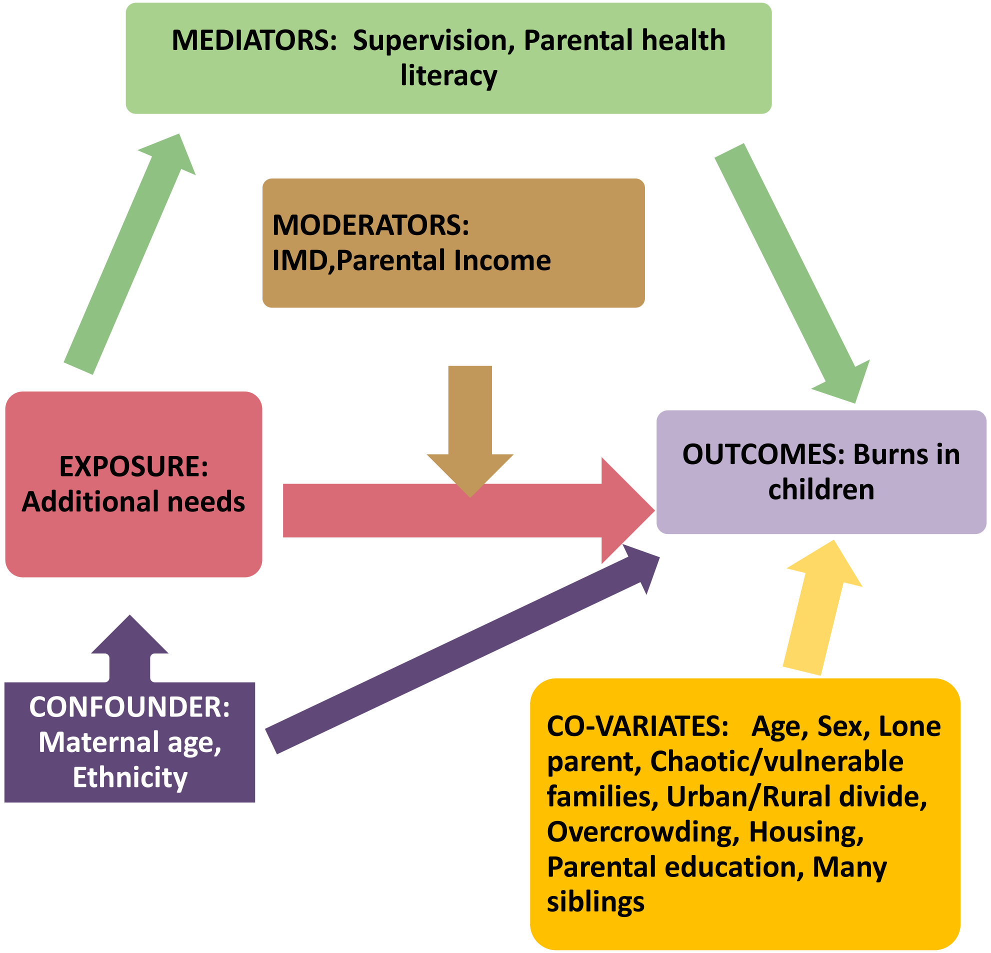
The additional needs model shows that parental health literacy and adult supervision levels of children are mediators that influence health outcomes in children (Saluja *et al.* (2004) and Thomas *et al.* (2004)). This pathway seems plausible from the literature given that parents/carers have a heightened sense of the importance of supervision for children with additional needs (Papworth Trust (2016) and Wiglesworth *et al.* (2015)). However, this depends on how health literate parents/carers of such children are. The relationship of the confounders, mediators, moderators or covariates in this model have been described in the "inequalities by additional needs" subsection of Chapter 2 of this thesis. In addition to the conceptual diagram for the additional needs model, the following table highlights where each variable is classified in this model with some reasons:

**Table 3-4 Table showing role of variables in the additional needs model**

| **Moderators: IMD, Parental Income** |
|---|
| These variables are not on the causal pathway between additional needs and burn outcomes in children. However, they may affect the relationship between these two variables. For example, if children with additional needs live in areas with the least deprivation or live in households with good parental income, they may be provided with top quality care and support that may help reduce injury risks (Papworth Trust, 2016). Also, if a child is from a family background that has strong cultural values to support those with additional needs rather than stigmatise, it helps the care process which in turn reduces chances of injury. |
| **Confounders: Maternal age, Ethnicity** |
| This variable is associated with additional needs as it is well known in literature that some additional needs have maternal age as a known risk factor. Also, some cases of injury outcomes have been linked to maternal age. Some ethnicities have been shown to be at increased risk of behavioural and neurodevelopmental disorders especially if they are not in their country of origin (Allport *et al*, 2019). Some children |

| |
|---|
| are also exposed to mental health issues that their parents have had to endure if they were refugees. These issues may predispose them to burn risk. |
| **Mediators: Supervision, Parental health literacy** |
| These variables can be seen lying on the causal pathway between ethnicity and burn outcomes in children. This has been described in the preamble before this table |
| **Co-variates: Child Age, Sex of child, Lone parent, Chaotic/vulnerable families, Urban/Rural divide, Overcrowding, Housing, Parental education, Many siblings** |
| The literature review in chapter 2 shows that these variables have a relationship with burn outcomes. However, they do not “cause” a child’s additional needs, neither are they a direct result of a child’s additional needs. |

**Figure 3-4 Conceptual diagrams of the relationships influencing the association between additional needs and burns in children**



## 3.5 Urban/Rural divide and burn outcomes in children

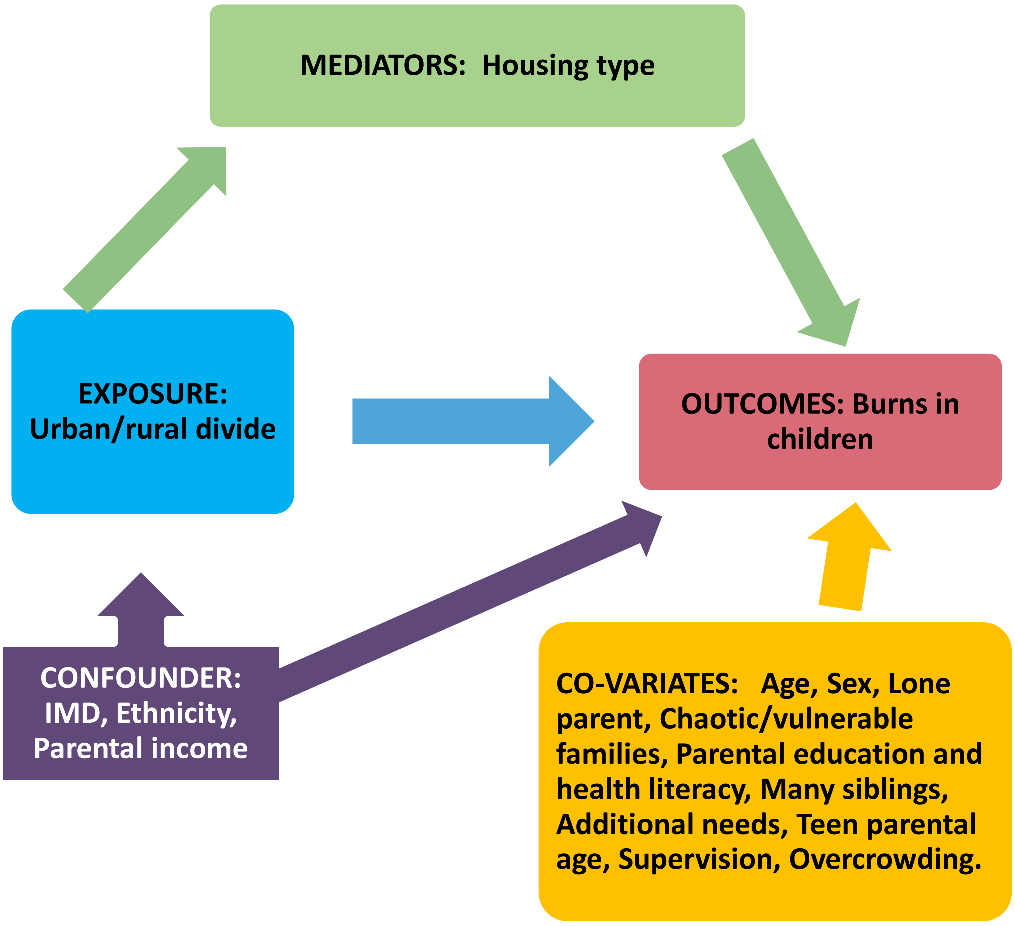
The conceptual diagram for this model shows that ethnicity, IMD and parental income are confounders in this model, and their effect is described below. These relationships are derived from the literature by Shai and Lupinacci (2003), Dempsey and Orr (2006) and DiGuiseppi et al. (2002). For instance, Shai and Lupinacci (2003) reported that houses that were built before 1939 (older houses) had higher levels of thermal injuries in children, due to the lack of proper modern fire safety equipment or regulations. This risk further intensified if such houses were within urban or rural areas with higher levels of deprivation. Dempsey and Orr (2006) reported higher thermal injury levels among children of asylum seekers who were often housed in inappropriate homes. Most of these houses were either too small for some families, old or in deprived areas of urban areas of Ireland. Also, environmental risk differs by urban-rural divide, e.g. some individuals may be more exposed to open fires in rural areas used for agricultural, camping or entertainment purposes and so on. These differences have been reflected in the "inequalities by geographical variation" subsection of Chapter 2 of this thesis. In addition to the conceptual diagram for the urban/rural divide model, the following table highlights where each variable is classified in this model with some reasons. The secondary data analyses from HES and BaSAT data will control for these factors (if available) in Chapter 4 and 5.

**Table 3-5 Table showing role of variables in the urban/rural divide model**

| **Confounders: IMD, Ethnicity, Parental income** |
|---|
| These variables and how they associated with urban/rural divide and burn outcomes have been described in the preamble above. |
| **Mediators: Housing type** |
| This variable can be seen lying on the causal pathway between urban/rural divide and burn outcomes in children. This has been described in the Shai and Lupinacci (2003) example above. |
| **Co-variates: Age, Sex, Lone parent, Chaotic/vulnerable families, Parental education and health literacy, many siblings, Additional needs, Teen parental age, Supervision, Overcrowding** |

The literature review in chapter 2 shows that these variables have a relationship with burn outcomes. However, they do not “cause” a child’s urban/rural divide, neither are they a direct result of a child’s urban/rural divide location.

**Figure 3-5 Conceptual diagrams of the relationships influencing the association between urban/rural living and burns in children**




## 3.6 Supervision levels and burn outcomes in children

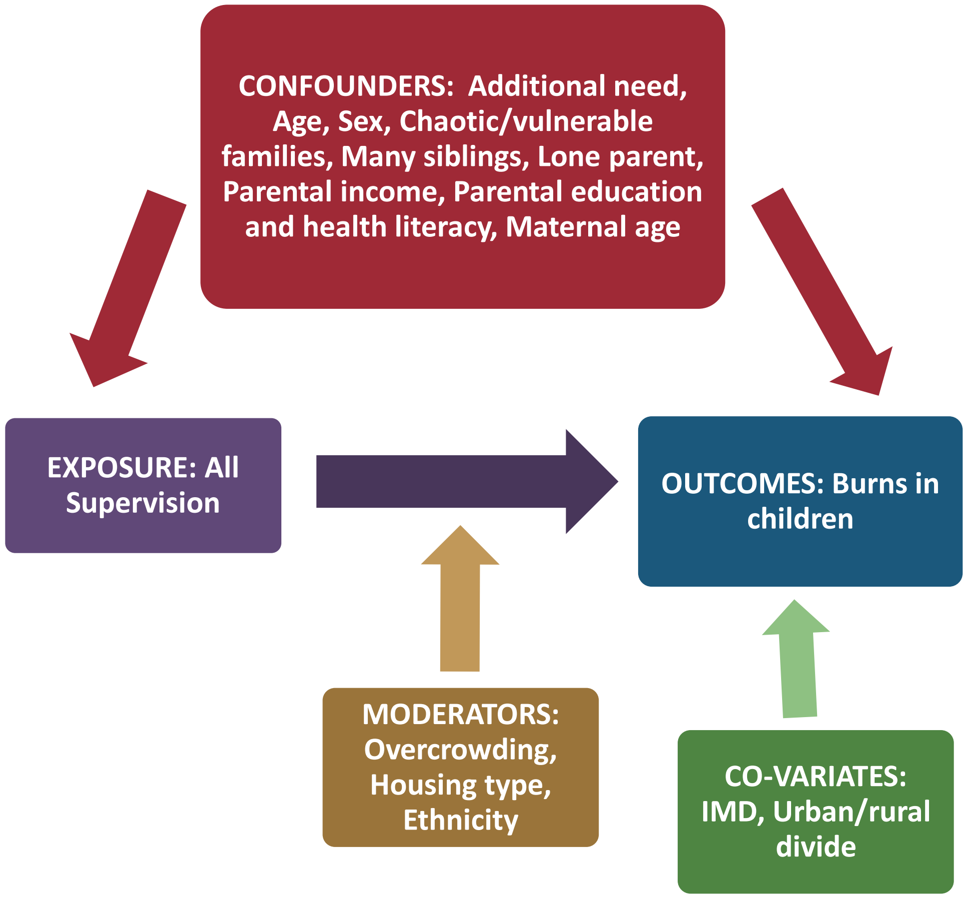
This conceptual diagram presented below shows that urban/rural divide and IMD are covariates in this relationship. The remaining variables are confounders except overcrowding, housing type and ethnicity which were classed as moderators. For example, Ingram and Emond (2009) reported in the differences in parental attitudes towards supervision and how this may reduce or increase of burn injuries in children. Parents/carers from backgrounds that were more deprived, less educated or from a minority ethnicity may be less likely to apply adequate supervision for their children to avoid burn injuries.  Other issues have been described in the "inequalities by supervision levels" subsection in Chapter 2 and will be tested in the secondary data analyses with HES and BaSAT data in Chapters 4 and 5 (where applicable). In addition to the conceptual diagram for the supervision model, the following table highlights where each variable is classified in this model with some reasons.

**Table 3-6 Table showing role of variables in the supervision model**

| |
|---|
| **Confounders: Additional need, Age, Sex, Chaotic/vulnerable families, Many siblings, Lone parent, Parental income, Parental education and health literacy, Maternal age** |
| These variables have been reported in the Chapter 2 review has having some association with supervision and burn outcomes but are not on the causal pathway. For example, in section 3.7.11, one can see how being a male child affords them less supervision than female children in some communities. As such, boys tend to engage in behaviours that lead to injury if left unsupervised. Section 2.6.3.4 and 2.6.3.5 also show the contributions with examples of other variables mentioned here. |
| **Moderators: Overcrowding, Housing type, Ethnicity** |
| These variables are not on the causal pathway and may have some effect on the relationship between supervision and burn outcomes in children. Allport *et al* (2019) outlines how family and cultural make-up in some ethnicities contribute to supervision styles. If these are present, coherent and adequate, then the risk of injuries is reduced. However, if overcrowding and poor housing quality abounds, the risk of injury is elevated. |
| **Co-variates: IMD, Urban/rural divide** |

The literature review in chapter 2 shows that these variables have a relationship with burn outcomes. However, they do not “cause” a child’s supervision, neither are they a direct result of a child’s supervision’s level.

**Figure 3-6 Conceptual diagrams of the relationships influencing the association between supervision and burns in children**




## 3.7 Mechanisms of association between the confounders, moderators and mediators across the conceptual diagrams

The following relationships explain the connections between some of the confounders, covariates and mediators across all five models depicted above.

The interplay co-exists with the associations between the main predictors of interest and burns in children.

### 3.7.1 Urban/rural divide and overcrowding

Some published literature report that overcrowding is quite common with large families or among deprived families in areas that lack good quality housing or space (Natterer *et al.* 2009). Other times, this is as a result of affordability in urban areas. Thus, these individuals are having no choice but to share accommodation beyond the capacity of the habitation. This association is more likely to occur when there are high levels of migration to urban areas from rural areas and increasing numbers of people living in poverty in urban areas, E.g. asylum/refugee seekers/recent migrants that find themselves in large numbers in old or low-quality housing in urban areas (Dempsey and Orr, 2006).

### 3.7.2 Housing type and overcrowding

The dynamic here is like that of 3.7.1. However, this association may be heavily influenced by affordability. If the families have low income irrespective of their family size, the parents may have no choice but to rent/ what they can afford. This situation may occur among families on benefits, asylum seekers/refugees and other families with low income. As a result, the tight space may lead to increased exposure to hazards, and more difficulty in supervising young children, resulting in elevated risks of burn injuries for the children of such households. Living in private rented accommodation is associated with increased burn risk and private landlords may allow overcrowding within the properties they rent (Kendrick *et al.*, (2005) and Cemlyn *et al.* 2009).

### 3.7.3 Parental income and housing type

This association ties in with 3.7.2. Families that can afford high-quality housing with the space required for their needs should be able to provide a home environment that has reduced the risk of injury for their children. However, those who can’t afford adequate housing may only be able to purchase housing with small space, e.g. one room for a family of 5. Also, if the housing is dilapidated and lacks updated thermal injury prevention or safety equipment (such as smoke alarms and thermostatic mixer valves), then all members of the family are at risk of burn injuries (Pearson *et al.*, (2010)).

### 3.7.4 Overcrowding and supervision

Adequate supervision is difficult to administer when there is an uneven ratio of parents/carers to the number of children that require such in the household. In some extended families, the ratio is in favour of the adult carers who may be able to lend a hand in raising the young (Allport *et al.*, 2019). However, this is dependent on family dynamics. If the ratio of children are more than the adults can handle in the household, they may not be able to provide equitable supervision to all children, or appropriate supervision relative to the developmental age of the children. The latter leads to an elevated risk of injury for such children especially if there is a lack of space (Laursen and Nielsen (2008).

### 3.7.5 Housing type and supervision

Some literature report that this association is an issue around the number of rooms in a house; the risk of injury is elevated if the houses have little or too much room to explore. If it is the former, then there may be an elevated risk of injury from surrounding agents/mechanism that may lead to injury. If there is too much space, then the parent/carer may not be able to actively supervise the children when they are not within view (Petridou *et al.* (1998) and Shah *et al.* (2013)). Children in the latter scenario may be those that are exploring their new-found curiosity, e.g. below ages five years or those seeking independence, i.e. older children/teenagers. If the house isn’t structured in such a way that injury prevention is possible (e.g. the use of safety gates to restrict children from accessing areas in the house with increased burn risks like kitchen/bathroom) or to allow then the parents/carers monitor their wards while engaging with other activities (e.g. semi open plan kitchen and living area with secure prevention tools while cooking etc.); then it becomes quite difficult to give adequate supervision which in turn leads to elevated risk for the children in having thermal and other injuries (Cheng *et al.* (2016)).

### 3.7.6 Many siblings/lone parent and supervision

This association ties briefly to 3.7.4 when looking at the concept of many siblings. Larger families with large numbers of children may find supervision difficult if there are not enough adult carers. Parents may assume that older children will supervise younger siblings (Shah *et al.* (2013)). Often younger children copy the activities of their older siblings and may not be developmentally able to manage the burn risks that they are consequently exposed to (e.g. cooking, ironing, using hair straighteners, lighting fires etc.). Lone parents find it more difficult if they have no partner or family to assist with supervision and upbringing especially when such children are highly mobile/independent (Navarette *et al.*, (2018)). As such, there is an elevated risk of injury for both groups if supervision is inadequate.

### 3.7.7 Parental education and health literacy and supervision

It is expected that the more educated a parent is, the more likely they are to be aware of hazards and the need to keep their children safe. However, the literature suggests that this isn't necessarily true. Nowadays, most parents expect to get proper health literacy information during antenatal and prenatal care, especially when the child is their first one. The information is often translated or broken down into infographics or pamphlets for easy assimilation by members of the community. There are also /health visitors who can better inform such parents in their communities. Thus, parents that may have the time to commit and execute prevention strategies show better health literacy even though they are not highly educated.

For parents who are highly educated, it may be an issue of work-family conflict. Thus, they may not have the time to commit to adequate child upbringing and may commit childcare to grandparents or external professionals, e.g. childminders or nannies (Mallonee *et al. (*2003). However, if such alternative caregivers can't cater to the needs of the child, then the child may still be at the risk of injury. For those with lower educational attainment and lower income, they may not be able to afford to employ professional childcare while trying to make ends meet (Lehna *et al.* (2016)), Allport *et al,* (2019)). If they have no family members to assist with such care, then the child is still at elevated risk of injury due to lack of proper supervision.

### 3.7.8 Age of child and additional needs

The literature suggests that some additional needs (especially behavioural ones) may not manifest themselves early in life (i.e. < 5 years), and they may not be clinically diagnosed until the child is older (Brehaut *et al.*, 2003). This issue poses a challenge for burn injuries as the literature shows children under five years are most at risk especially age 1-2 years when they are prone to scalds. Thus, it may be difficult for parents/carers to administer supervision if they are not aware of the additional needs their children have and the increased risk of burn injuries that occur with this group. As children grow older and become more independent, they are likely to be exposed to new burn risks, for example, playing with fire, using matches, cooking, using hair straighteners etc.

### 3.7.9 Teenage parental age and parental education and health literacy

Given the extra requirement of care having a child will bring, if teenagers end up becoming parents early in life without set plans and goals or structure, this can truncate their educational pathway which in turn affects their prospects re income. Some may return to education at some point in life, but this may not be for much of this group.

Regarding parental health literacy, it may be down to the attitude to know and engage with the prevention of poor health outcomes (including injury in their children), especially among young mothers. The literature report that older mothers especially those with higher parity may have better health literacy that can be handed down to younger mothers. Such “rites of passage” are common among ethnic minority communities but still depends on the individual receiving such advice to change their behaviour (Mallonee *et al. (*2003), Allport et al, 2019).

Although fathers traditionally undertake less childcare than mothers, the literature (though descriptive) report better health and wellbeing outcomes for children when both fathers and mothers contribute towards their upbringing and development rather than the mother alone. There is emerging qualitative literature that fathers perceive injury risks differently to mothers and consequently parent differently (Brussoni and Olsen, 2011). Brussoni and Olsen (2011) found that fathers were more likely to encourage their children to experience new environments or activities which might expose them to different or greater injury risks.

### 3.7.10 Ethnicity and teenage parental/maternal age.

This association is common in families from cultures that believe in early marriage or cohabitation. Thus, one may observe younger mothers/parents where such culture is prevalent. Such cultures also tend to have extended family living close to young parents, providing them with support and advice (Ensor and Cooper, 2004). If such parents aren't mature or prepared for the responsibilities of childcare/family life, or do not have access to extended family support, this may lead to an environment where the children born to such parents are at elevated risk of poor health outcomes (including injury).

### 3.7.11 Sex of the child and additional needs

The literature report that the sex of a child may predispose them to some additional needs than others. For example, males are predisposed to have some behavioural conditions like ADHD than females (Thomas *et al.*, 2004). Societal stereotypes assigned to boys give them more opportunity to be "free and independent" in most communities (O'Brien *et al.*, 2009). Thus, there may be an elevated risk for male children (given such leeway) with additional needs to then be predisposed to thermal injury.

### 3.7.12 Chaotic/vulnerable families and supervision

The literature report that chaotic/vulnerable families, e.g. those in which parents engage in substance misuse, unhealthy lifestyles and domestic violence etc.

have unstable family dynamics which affect how parents interact with their children. Thus, children suffering such adverse childhood experiences are at elevated risk of neglect since supervision/care may be less than adequate. These issues may lead to an elevated risk of thermal injuries. In some rare cases, intentional episodes of thermal injury may occur, e.g. snuffing out cigarettes in some children thereby burning them (Andronicus *et al*, (1998), Kemp et al (2014)).

### 3.7.13 Parental education and health literacy on parental income

As highlighted in several sections above having an increased educational level may provide parents with a greater level of income. This ability enables parents to provide the best they can afford for their children (Laursen and Nielsen (2008). However, there are exceptions to this norm, e.g. self-employed parents not having higher education or white-collar jobs and still doing well. Thus, it is expected that education should enhance the mind of one who engages with it such that they can cater to their needs and that of their families.

For parental health literacy, the higher this is among parents, the better they can protect themselves and their children from preventable poor health outcome/injury (Cheng *et al* (2016). This ability, in turn, can help parental income by reducing the amount of money spent on illness, the need to take some days off from work due to their child’s illness/injury and treatment.

# CHAPTER 4 : HOSPITAL EPISODES STATISTICS

## 4.1 Introduction

In this chapter, three of the four thesis research questions will be tested using the Hospital Episodes Statistics (HES) database. It will give a brief description of HES, and details of the data extraction process, the cleaning process and the analyses carried out while investigating the dataset of interest.

## 4.2 Background of the Hospital Episodes Statistics (HES) Database

According to the HES website (2016) http://content.digital.nhs.uk/hes HES was developed in 1987 after a steering group led by Dame Edith Korner produced a report of the importance of collecting hospital data and activity information around England (HES, 2016). This development aimed to contribute to understanding how health providers work in healthcare delivery. Also, how much of the population seek treatment and what the priority conditions were per year. These details ensure that proper strategies and interventions are created to ensure spending on health was maximised to the fullest while providing as much top-quality care as possible (HES, 2016). In its early stages, the focus was admitted patient care only, with 10% coverage nationwide. However, this grew to be nationwide coverage from 1989, followed by detailed collecting of outpatient care information in 2003 and emergency department (ED) data from 2007. Thus, one can see that the data collected on admitted patient care are the oldest and most detailed compared to outpatient data and accident and emergency data (HES, 2016). The government established a system whereby the National Health Service (NHS) trusts that collated and delivered this information properly get paid a service fee for contributing to health information development (HES, 2016). Those who do not deliver the necessary information do not get paid. This system aimed to ensure complete data collection over the years. It is for these reasons that this chapter will be analysing burn admissions data which are complete, rather than data from burn outpatient treatment or ED attendance/treatment which are not as complete.

## 4.3 Methods for Extracting and Cleaning HES Inpatient Variables of Interest

### 4.3.1 Data Codes, Extraction and Cleaning for Analyses

HES admissions are coded using ICD 10 codes. These diagnoses codes are in two broad groups “DIAG_01” which represents primary diagnosis as at the time of admission while “DIAG_02 to DIAG_20” represent secondary diagnoses which may number from 2 to 20 in a single episode.

The HES dataset contains information on exposures, outcomes and possible confounders/mediators/moderators of interest for the burns analyses, and these are contained in five separate tables. These tables include selected codes from the HES Admitted Patient Care (APC) Dictionary (See Appendix tables AT 4.1, AT 4.3, AT4.4 and AT 4.5) and HES Outpatient Data Dictionary (See Appendices AT 4.2).

The exposures, in this case, refer to the socio-demographic variables mentioned in the research questions listed in section 1.7 of this thesis, specifically questions 1-3 (i.e. social disadvantage, ethnicity and urban-rural divide). In the HES data, these variables were easily identifiable after searching for their codenames in the HES data dictionary. These codenames are in Appendix table AT 4.2. Also, section 4.4 of the main theses describes these variables, how they were obtained in HES and their numbers.

The codes required for this study were submitted to the HES team, in the Health Economics Centre in the School of Population Health Sciences at the University of Bristol. To conform to HES data access rules and regulations, all intending researchers submit a data access form with their proposal to the HES team to decide if the project is suitable to answer the research question of interest (this form is attached in the appendices). Thus, permissions to use the data are required for any individual project using the HES data. Once this is approved, a member of the HES team extracts the requested data using the codes that have been submitted.

For the dataset used in this thesis, Dr Tim Jones extracted the requested data using structured query language (SQL). The data were then handed over to the author of this thesis in their raw format. The thesis author cleaned, re-coded and analysed the dataset to investigate better the research questions of interest with statistical training gained from the Population Health Sciences short courses at the University of Bristol. The analyses and resulting outputs were examined by the supervisory team to ensure that all was correct.

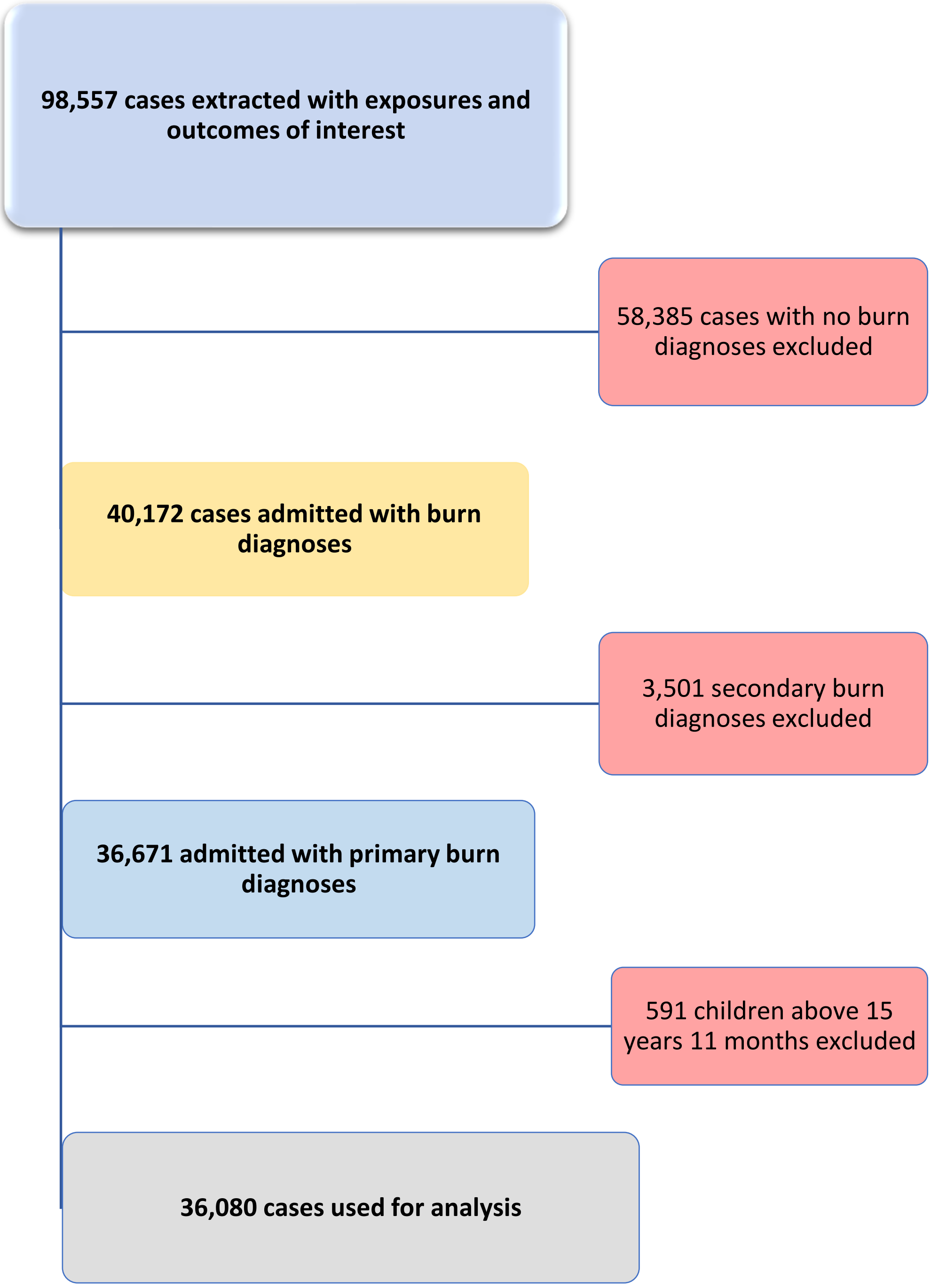
Based on observation from previous work on burn research, expert recommendations from supporting researchers and HES website (HES, 2016); the strength of the HES dataset is in its recorded inpatient information across England. Thus, inpatients rather than the outpatients' data was the basis for analyses.

Below is a flowchart showing the numbers with exposures/outcomes of interest cascading during the extraction process (Fig. 4.1).

The HES dataset contained 40132 children who were admitted with burn injuries between financial years 2009/2010 to 2014/2015. Three thousand five hundred and one children had their data excluded because they did not have burns as the primary reason for admission to hospital. In the classification of the HES dataset regarding diagnoses, only one field is assigned for the primary reason for admission. The remaining two to twenty fields are for secondary diagnoses. There was ambiguity on whether these secondary diagnoses were minor reasons requiring medical care at the time of admission, or previous reasons for admission to hospital, or a mixture of both. This issue is common for anyone who uses the HES dataset, and so it was decided to exclude the secondary diagnoses of burns.

Therefore, the final dataset used for analysis contained only the 36,080 children with primary burn diagnosis as a reason for their admission. The cleaning process involved re-coding, relabelling, encoding, generating new variables from existing variables and changing string variables to digital versions where necessary. Most of the variables of interest had complete numbers. At this stage, the decision was taken to use all available data on children under 16 with a primary burn diagnosis for statistical analyses.

**Figure 4-1 Flowchart of Extraction of Cases aged up to 15 years 11 months with Burn Diagnoses from HES Dataset 2009/2010 to 2014/2015**



### 4.3.2 Methods for Statistical Analysis

The methods and software used for the descriptive analysis of the predictor variables of interest involved the use of graphs, charts and tables generated via Microsoft Word and Excel 2013. Proportions from HES data and their confidence intervals were calculated using STATA 14 while those for 2011 Census data were calculated using the Physiotherapy Evidence Database (PEDRO) CI Confidence Interval calculator http://www.pedro.org.au/english/downloads/confidence-interval-calculator

The odds ratios (OR) and 95% confidence intervals (CI) for the comparisons between proportions from HES data and the 2011 Census data were also produced using the PEDRO CI Confidence Interval calculator. For the inferential analyses, multivariable logistic regression was used to obtain the unadjusted and adjusted odds ratios and 95% CI via STATA 14.

Furthermore, complete case series analyses (CCS) was done to see if missing data influenced the resulting OR. However, these yielded minute changes which did not affect the resulting output of the all available data (AAD) analyses. Thus, given that CCS analyses have a bias due to a reduction in sample size and loss of statistical power, it was decided that the resulting outputs from the AAD analyses are used given missing data were quite small in HES. This issue is in the discussion details of Chapter 6 in the subsection on missing data.

As there were no differences in data by financial years, all data from the six years of interest (i.e. 2009-2015) were pooled for analyses. For more details on this issue, please refer to the Appendix for Chapter 4.

## 4.4 Descriptive Analysis of HES Inpatient Data with Primary Burn Diagnoses only

### 4.4.1 Age

Of the 36,080 individuals, most fell into the age of 0 to 4 years old category, as shown below. None of the children admitted had their age data missing. This variable in HES collates from hospital records detailing the child's age at the end of admission. Table 4.1 shows primary burn admissions by age categories in

HES, their proportions and the proportion of the general population aged 0-15 years from the UK 2011 Census:

**Table 4-1 Proportions by the age of HES burn cases and the general population of children in England using the 2011 U.K. Census**

| AGE | HES SAMPLE | HES PROP. | 95% CI | 2011 CENSUS DATA | CENSUS PROP. | OR FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|---|
| 0 to 4 years | **27,444** | **0.76** | **0.76-0.77** | **3,318,449** | **0.33** | **6.42** | **6.27-6.58** |
| 5 to 9 years | **4,384** | **0.12** | **0.12-0.12** | **2,972,632** | **0.30** | **0.33** | **0.32-0.34** |
| 10 to 15 years | **4,252** | **0.12** | **0.11-0.12** | **3,731,755** | **0.37** | **0.23** | **0.22-0.23** |
| Total | **36,080** | | | **10,022,836** | | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. | | | | | | | |

The table shows that children below five years of age accounted for most of the children admitted, and suggests that the proportion of burns admissions decreased with increasing age.

Children aged 0-4 years old were 6.4 times more likely to be admitted primarily for burns compared to children aged 5-15 years old.

### 4.4.2 Sex

The number of individuals that had complete information on their sex was 36,073 (99.98%) out of 36,080. Males accounted for 57.2% of the sample.

Below is a table (Table 4.2) showing the proportions by sex of burn cases compared with the proportions of the general population in England aged 0-15 years from the UK 2011 Census:

**Table 4-2: Proportions by sex of burn cases and the general population of children using the 2011 U.K. Census**

| SEX | HES SAMPLE | HES PROP. | 95% CI | 2011 CENSUS DATA | CENSUS PROP. | OR FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|---|
| Male | **20,618** | **0.57** | **0.57-0.58** | **5,131,675** | **0.52** | **1.27** | **1.24-1.30** |
| Female | **15,455** | **0.43** | **0.42-0.43** | **4,891,161** | **0.49** | **0.79** | **0.77-0.80** |
| Total | **36,073** | | | **10,022,836** | | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. | | | | | | | |

The odds of male children admitted primarily for burns compared to the general population were 1.3. This ratio was lower for females when compared to the general population (0.8). Below is a table (Table 4.3) showing results when age was cross-tabulated with sex.

**Table 4-3: Proportions by age and sex of burn cases and the general population using the 2011 U.K. Census**

| SEX/AGE GROUP | HES SAMPLE | HES PROP. | 95% CI | 2011 CENSUS DATA | CENSUS PROP. | OR FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|---|
| Males 0-4 years | 15,930 | 0.77 | 0.77-0.78 | 1,698,171 | 0.33 | 6.87 | 6.65-7.10 |
| Males 5-9 years | 2,226 | 0.11 | 0.10-0.11 | 1,521,271 | 0.30 | 0.29 | 0.27-0.30 |
| Males 10-15 years | 2,462 | 0.12 | 0.12-0.12 | 1,912,233 | 0.37 | 0.23 | 0.22-0.24 |
| Total for Males | 20,618 | 0.57 | 0.57-0.58 | 5,131,675 | 0.52 | 1.27 | 1.24-1.30 |
| Females 0-4 years | 11,507 | 0.74 | 0.74-0.75 | 1,620,278 | 0.33 | 5.88 | 5.67-6.10 |
| Females 5-9 years | 2,158 | 0.14 | 0.13-0.15 | 1,451,361 | 0.30 | 0.38 | 0.37-0.40 |
| Females 10-15 years | 1,790 | 0.11 | 0.11-0.12 | 1,819,522 | 0.37 | 0.22 | 0.21-0.23 |
| Total for Females | 15,455 | 0.43 | 0.42-0.43 | 4,891,161 | 0.49 | 0.79 | 0.77-0.80 |
| GRAND TOTAL | 36,073 | | | 10,022,836 | | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. | | | | | | | |

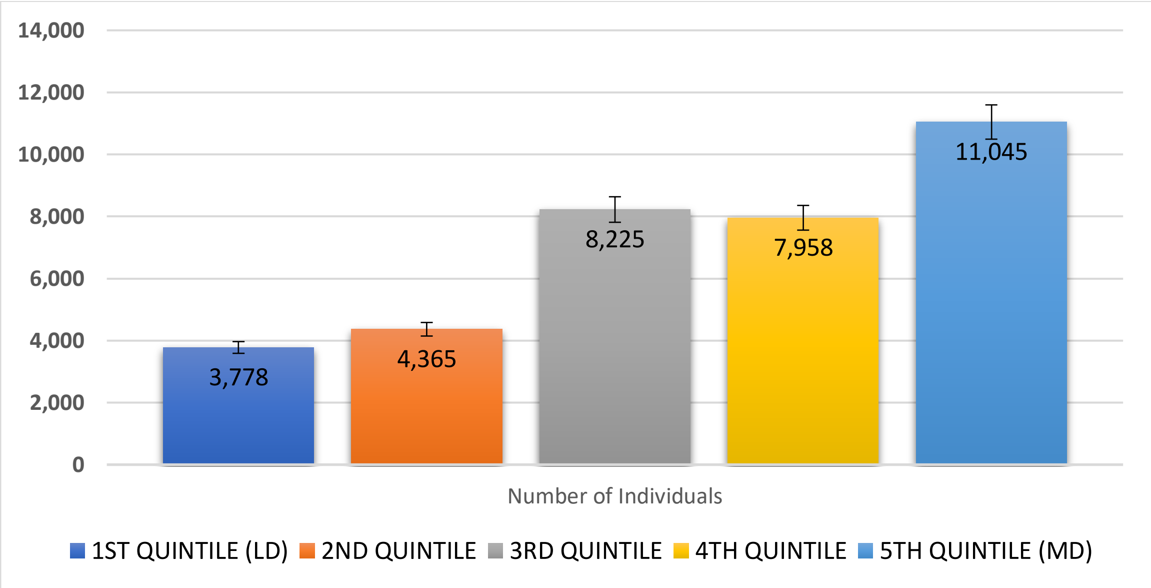
The proportions for admissions by age and sex shows there is an over-representation of 0-4-year olds when compared to their counterparts in the general population aged 0-15 years of age. The two ratios depicting these numbers are in males aged 0-4 years (6.9 times likely to be admitted) and females aged 0-4 years (5.9 times likely to be admitted).

### 4.4.3 Deprivation

Index of Multiple Deprivation (IMD) is in the form of deciles in the HES dataset**.** This variable collates from the overall IMD ranking scored on the Super Output Area, i.e. the residence of the child on admission. The scoring is from the guidelines from the 2004 English Indices of Deprivation http://webarchive.nationalarchives.gov.uk/20120919132719/http://www.communities.gov.uk/documents/communities/pdf/131206.pdf. These have been re-categorised into new variables by halves and quintiles. IMD information was only complete for 35,371 out of 36,080 (98.03%) individuals.

The graph below in Fig. 4.2 show the distribution of primary burn admissions by IMD quintiles, with LD representing the least deprived quintile and MD representing most deprived quintile:

**Figure 4-2: Under 16-year-olds' Primary Burn Admissions by IMD quintiles in HES 2009-2016**




The below table (Table 4.4) shows the proportions for the IMD quintiles compared to the general population data for England by IMD and age group 0-14 years (15-year olds were combined with older youth hence it could not be extracted for the comparison):

**Table 4-4: Proportions by IMD quintiles of burn cases and the general population using the 2011 U.K. Census**

| IMD QUINTILES | HES SAMPLE | HES PROP. | 95% CI | 2011 CENSUS DATA | CENSUS PROP. | OR FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|---|
| 1st quintile-least deprived | **3,778** | **0.11** | **0.10-0.11** | **1,769,652** | **0.19** | **0.51** | **0.50-0.53** |
| 2nd quintile-less deprived | **4,365** | **0.12** | **0.12-0.13** | **1,703,551** | **0.18** | **0.63** | **0.62-0.66** |
| 3rd quintile-more deprived | **8,225** | **0.23** | **0.23-0.24** | **1,745,064** | **0.19** | **1.33** | **1.30-1.36** |
| 4th quintile-most deprived | **7,958** | **0.23** | **0.22-0.23** | **1,910,238** | **0.20** | **1.14** | **1.11-1.16** |
| 5th quintile-most deprived | **11,045** | **0.31** | **0.31-0.32** | **2,257,787** | **0.24** | **1.43** | **1.40-1.47** |
| TOTAL | **35,371** | | | **9,386,292** | | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. | | | | | | | |

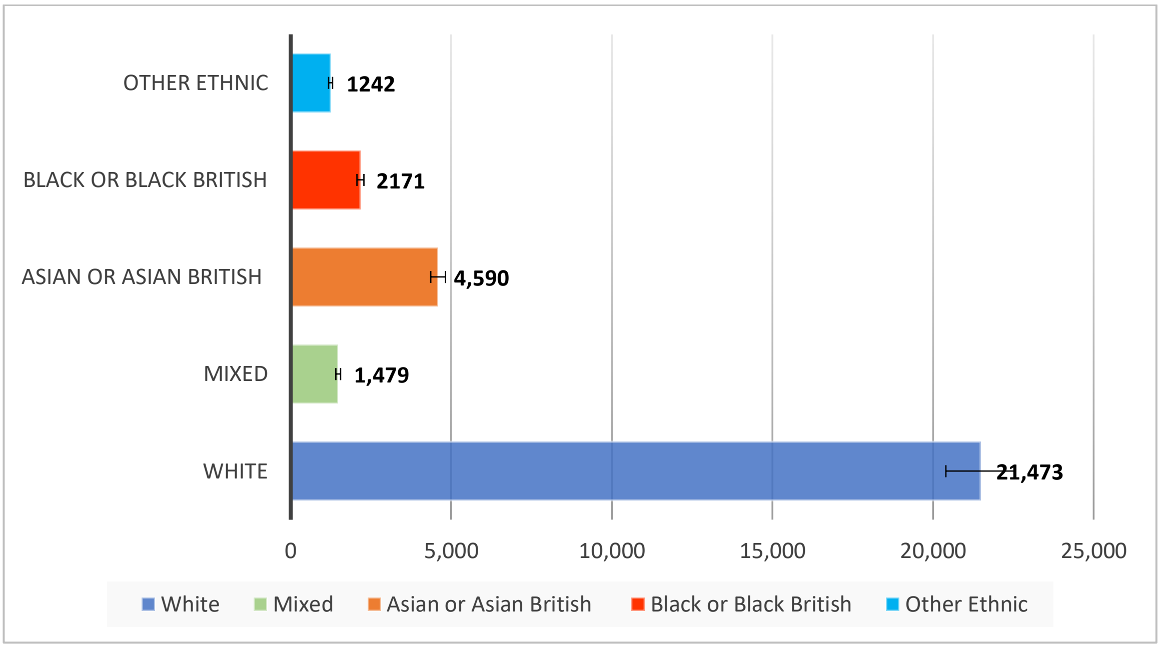
Children from the most deprived quintile (5th quintile) were most likely to be admitted for burns. The table suggests that the proportion of burns admissions increased with increasing deprivation. Also, the general population data shows that as one moved up the deprivation quintiles, the larger the proportion of individuals living in increased deprivation. The test for linear trend is described in section 4.5.3.1.

### 4.4.4 Ethnicity

Ethnicity was coded in HES with 19 different labels and values to signify what ethnic group each patient self-identified with. This variable was then re-coded for analysis. The process outline is in the Appendix section for Chapter 4.

The number of primary burn admissions according to the U.K Census classification of ethnicity is in the bar chart (Fig. 4.3) below:

**Figure 4-3: Under 16-year-olds' Primary Burn Admissions by Ethnicity in HES 2009-2016**




Proportions for this variable are in the table below along with proportions of the ethnic groups in the general population aged 0-15 years, as seen in the UK 2011 Census (Table 4.5):

**Table 4-5: Proportions by ethnicity of burn cases and the general population using the 2011 U.K. Census**

| ETHNIC GROUP | HES PROP. | 95% CI | 2011 CENSUS DATA | CENSUS PROP. | O.R FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|
| White | **0.69** | **0.69-0.70** | **7,829,032** | **0.78** | **0.64** | **0.63-0.66** |
| Mixed | **0.05** | **0.05-0.05** | **538,750** | **0.05** | **0.88** | **0.83-0.92** |
| Asian or Asian British | **0.15** | **0.14-0.15** | **1,020,154** | **0.10** | **1.52** | **1.48-1.57** |
| Black or Black British | **0.07** | **0.07-0.07** | **504,581** | **0.06** | **1.41** | **1.35-1.47** |
| Other Ethnic | **0.04** | **0.04-0.04** | **130,319** | **0.01** | **3.17** | **3.00-3.36** |
| TOTAL | | | **10,022,836** | **1.000** | | |

KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. *HES sample numbers are depicted in figure 4.3 above

The admissions odds for burns were very different per ethnic group. These were higher for ethnic minorities, especially among the Asian/Asian British and Black/ Black British ethnic group, which were 1.52 and 1.41 respectively. These results may suggest that there is an over-representation of these ethnic groups admitted for burn injuries compared to the white majority ethnic group. However, the interpretation of the “Other Ethnic” group should be taken with caution as it does not represent a “defined ethnicity” for the random individuals that constitute the group. Compared to their general population, the burn admission odds from the White and “Mixed” ethnic group was less than 1. This result may suggest an under-representation of these groups. Below are tables showing the ethnic distribution by sex, first for males (table 4.6), followed by females (table 4.7):

**Table 4-6: Proportions of ethnicity by male gender of burn cases and the general population using the 2011 U.K. Census**

| ETHNIC GROUP (MALES ONLY) | HES PROP. | 95% CI | 2011 CENSUS DATA | CENSUS PROP. | O.R FOR C.O. P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|
| White | **0.70** | **0.70-0.71** | **4,013,716** | **0.78** | **0.66** | **0.64-0.68** |
| Mixed | **0.05** | **0.04-0.05** | **274,097** | **0.05** | **0.87** | **0.81-0.93** |
| Asian or Asian British | **0.14** | **0.14-0.15** | **521,669** | **0.10** | **1.46** | **1.40-1.52** |
| Black or Black British | **0.07** | **0.06-0.07** | **255,022** | **0.06** | **1.40** | **1.32-1.48** |
| Other Ethnic | **0.04** | **0.04-0.04** | **67,171** | **0.01** | **3.09** | **2.86-3.33** |
| TOTAL | | | **5,131,675** | **1.00** | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. *HES sample numbers are depicted in figure 4.3 above | | | | | | |

The relationship between ethnicity and the male sex seems to be like that of the proportions of ethnicity and the total population (i.e. without splitting by gender). In other words, there is an over-representation of Black and Asian males admitted to hospital compared to their respective categories in the general population who are male and aged 0-15 years old.

**Table 4-7: Proportions of ethnicity by female gender of burn cases and the general population using the 2011 U.K. Census**

| ETHNIC GROUP (FEMALES ONLY) | HES PROP. | 95% CI | 2011 CENSUS DATA | CENSUS PROP. | OR FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|
| White | **0.68** | **0.67-0.69** | **3,815,316** | **0.78** | **0.60** | **0.58-0.62** |
| Mixed | **0.05** | **0.05-0.05** | **264,653** | **0.05** | **0.90** | **0.84-0.98** |
| Asian or Asian British | **0.15** | **0.15-0.16** | **498,485** | **0.10** | **1.64** | **1.57-1.72** |
| Black or Black British | **0.07** | **0.07-0.08** | **249,559** | **0.05** | **1.46** | **1.37-1.56** |
| Other Ethnic | **0.04** | **0.04-0.04** | **63,148** | **0.01** | **3.28** | **3.01-3.58** |
| TOTAL | | | **4,891,161** | **1.000** | | |

KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. *HES sample numbers are depicted in figure 4.3 above

The relationship between ethnicity and the female sex also had similar output to that of the males and the total sample (i.e. not split by gender).

In all, splitting by sex did not seem to influence the proportions of children admitted by ethnicity when compared to their counterparts in the general population aged 0-15 years old.

### 4.4.5 Rural/Urban Divide

This variable in HES was derived using the UK classification of Output Areas regarding their morphology and context. This classification was used to define the area a patient lives in before admission. Information was available for 35,870 of the 36, 080 (99.4%) individuals with a primary burn admission. Further details of the proportions of the rural/urban category are in the Appendix section of Chapter 4.

As the categories were quite broad with few numbers in some, it was decided to create a new variable that would fuse all urban and rural classes (i.e. town, fringe, village, hamlet and isolated dwelling) into a broad group representing each description respectively. This new variable classed all individuals staying in urban areas were labelled anew as “urban dwellers” while their rural counterparts were labelled “rural dwellers”.

The table below (Table 4.8) shows the proportions of primary burn admissions by the urban/rural divide and the proportions of the general population aged 0-15 years:

**Table 4-8: Proportions of the urban/rural divide of burn cases and the general population using the 2011 U.K. Census**

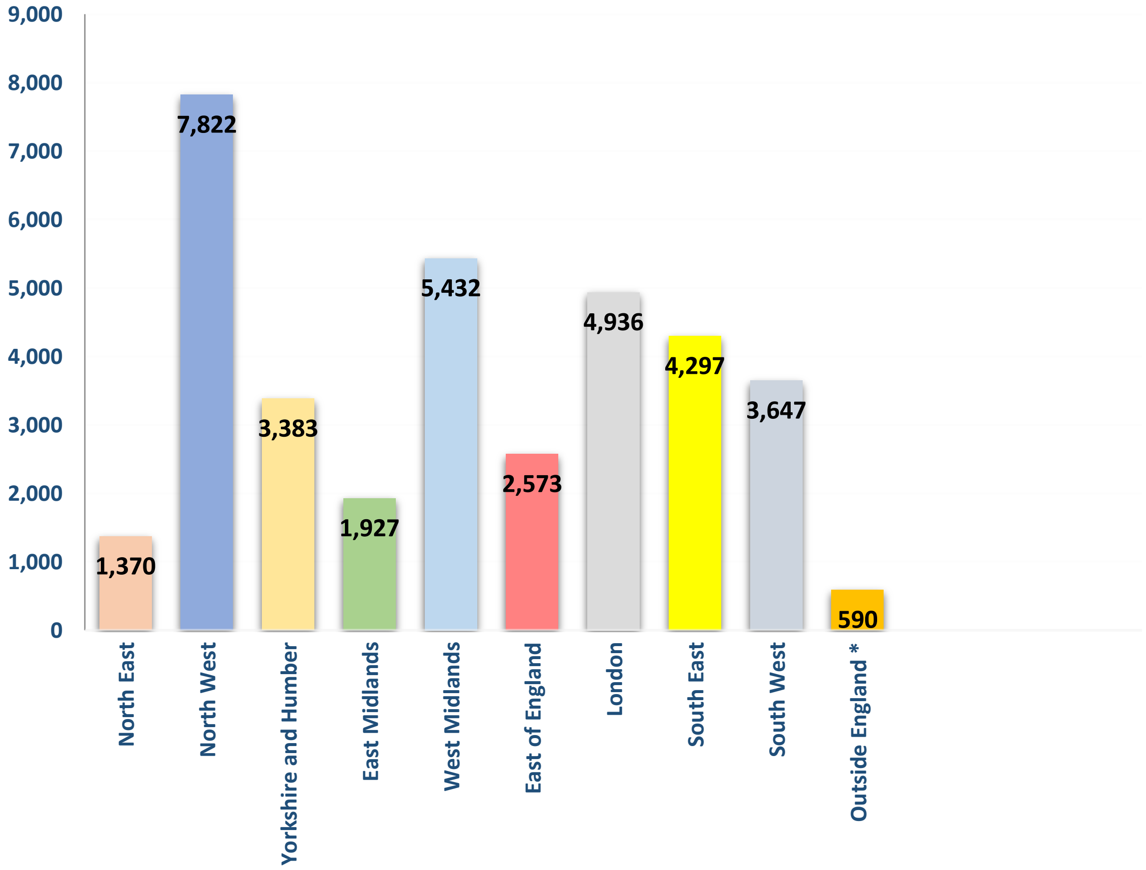
| URBAN/ RURAL DIVIDE | HES SAMPLE | HES PROP. | 95% CI | 2011 CENSUS DATA | HES PROP. | O.R FOR C.O.P | 95% CI FOR C.O. P |
|---|---|---|---|---|---|---|---|
| Urban Dwellers | **31,394** | **0.88** | **0.88-0.88** | **8,392,722** | **0.84** | **1.40** | **1.36-1.45** |
| Rural Dwellers | **4,334** | **0.12** | **0.12-0.12** | **1,630,114** | **0.16** | **0.71** | **0.69-0.73** |
| TOTAL | **35,728** | **1.000** | | **10,022,836** | **1.000** | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. | | | | | | | |

The odds of admission for burns among children dwelling in urban areas compared to the general population were 1.40. This result suggests a slight overrepresentation of urban victims. The odds were lower in rural populations which suggest an under-representation of children dwelling in rural areas with burn admissions.

### 4.4.6 Region of Residence

This variable in HES was designed to show the region of residence patients reside in across the United Kingdom. The variable comes from the UK census classification of the government office region of residence a patient’s town or city of residence. However, as this variable was in string (text) code, it was re-coded into a new variable so one could obtain the data for each region in a numerical fashion. Of the 36,080 individuals, 35,977 children had complete information about the region of residence (99.7%). There were 590 children permanently based outside England in Scotland, Wales, and Northern Ireland. These children were possibly injured while visiting or on holiday in England. These numbers were merged into a category called “Outside England*”. It is also worth mentioning that the proportions of children living outside England were not calculated from the general population of the 2011 Census as the data for admissions in HES is complete for only those in residing in England alone. Thus, they are not in the table of proportions. Below is a bar chart (Fig. 4.4) showing the distribution of individuals aged 0-15 years admitted primarily for burns across each region of England:

**Figure 4-4: Under 16-year-olds' Primary Burn Admissions by Region of Residence in HES 2009-2016**



Also, Table 4.9 below shows the proportions of primary burn admissions by regions of residence:

**Table 4-9: Proportions of the region of residence of burn cases and the general population using the 2011 U.K. Census**

| GOV. REGION OF RESIDENCE | HES PROP. | 95% CI | 2011 CENSUS | CENSUS PROP. | O.R FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|
| North East | **0.04** | **0.04-0.04** | **462,437** | **0.05** | **0.83** | **0.78-0.87** |
| North West | **0.22** | **0.21-0.22** | **1,324,548** | **0.13** | **1.82** | **1.77-1.86** |
| Yorkshire and Humber | **0.09** | **0.09-0.1** | **997,792** | **0.10** | **0.94** | **0.91-0.97** |
| East Midlands | **0.05** | **0.05-0.06** | **838,455** | **0.08** | **0.62** | **0.60-0.65** |
| West Midlands | **0.15** | **0.15-0.15** | **1,094,442** | **0.11** | **1.44** | **1.40-1.49** |
| East of England | **0.07** | **0.07-0.07** | **1,108,632** | **0.11** | **0.62** | **0.60-0.65** |
| London | **0.14** | **0.13-0.14** | **1,624,768** | **0.16** | **0.82** | **0.79-0.84** |
| South East | **0.12** | **0.12-0.12** | **1,642,084** | **0.16** | **0.70** | **0.68-0.72** |
| South West | **0.10** | **0.10-0.11** | **929,678** | **0.09** | **1.10** | **1.07-1.14** |
| TOTAL | | | **10,022,836** | **1.000** | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions, *= proportion not calculated for Census data as the sample is not representative. *HES sample numbers are depicted in figure 4.4 above | | | | | | |

The odds of children admitted primarily for burn injuries varied across regions but were high in the North West, West Midlands and South West. This result suggests that there may be an over-representation of children being admitted for burn injuries in these regions compared to other regions.

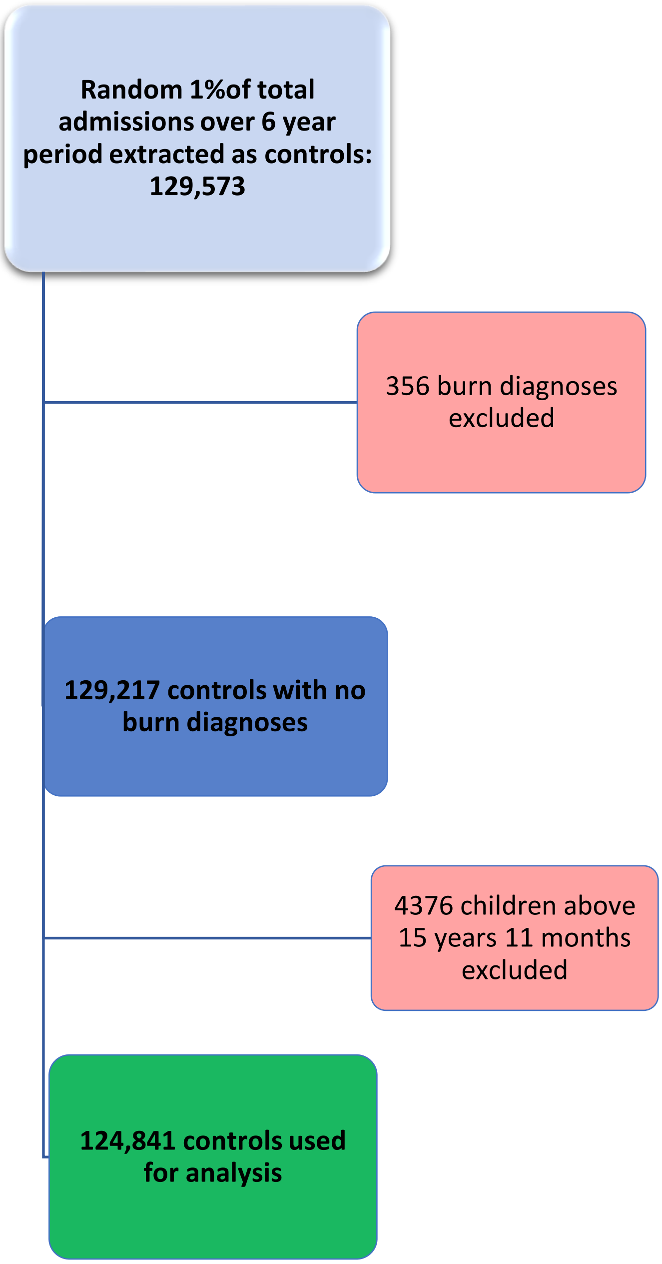
## 4.5 Multivariable Analyses of HES Data for Primary Burn Admissions from 2009-2016

### 4.5.1 Description of Comparator Group

For the multivariable analysis, logistic regression was used to compare the 36,080 children primarily admitted for burn injuries from 2009-2014 in England to a comparator group. To reduce bias or errors, e.g. due to social patterning, insufficient numbers; it was decided to use a comparator group consisting of a random 1% sample of the total number of children admitted primarily for any other diagnoses (except burns) between 2009-2015. This group was extracted in the same manner as the primary dataset used to obtain the cases used for analyses in this thesis.

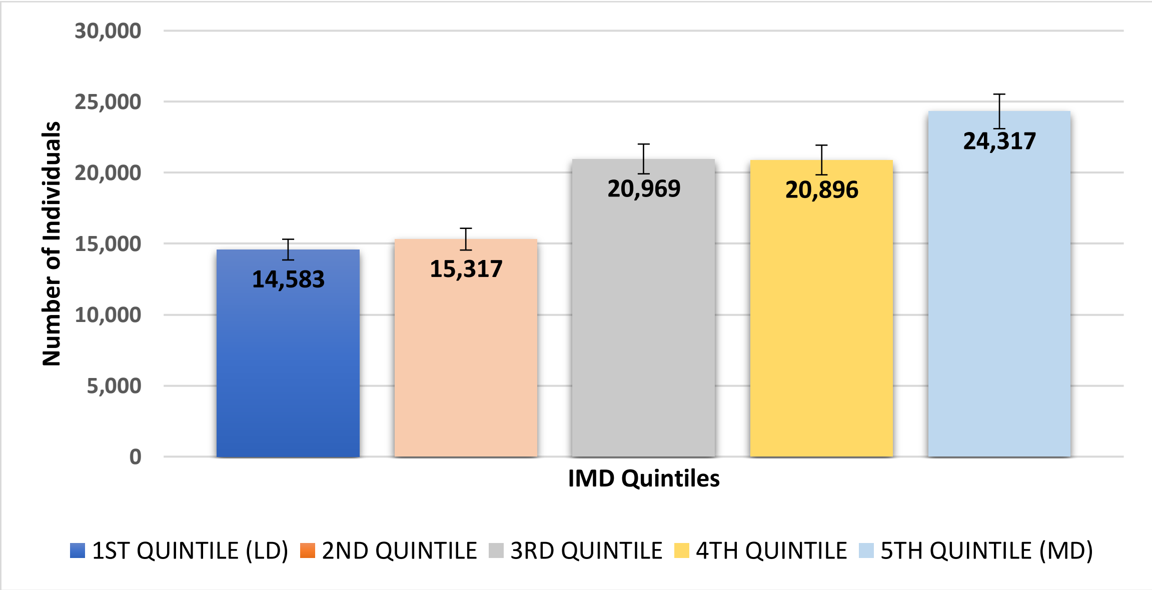
A total of 129,573 “controls” were extracted from a total number of admissions in England (i.e. 12,957,300) over the six years- providing a 1% sample of the total number of children primarily admitted for anything else apart from burns. This comparator group was randomly extracted by the HES team in the Health Economics Unit, the University of Bristol via structured query language (SQL). The extracted comparator group data were then subject to cleaning, description and analysis by the author of this thesis in the same manner as the primary dataset used to obtain the cases of interest. It was necessary also to exclude any control that had any burn diagnosis to avoid data output errors and misinterpretation. Below is a figure (fig.4.5) depicting the flowchart of numbers while cleaning the data of the comparator group:

**Figure 4-5: Flowchart showing Comparator Group (under 16 Years) from HES Datasets 2009 to 2015 after Cleaning**



The next step involved plotting a bar chart to check for social patterning among the comparator group. The numbers are in Fig 4.6 below:

**Figure 4-6: Under 16-year-olds' Comparator group by IMD quintiles in HES 2009-2016**




The above figure does show social patterning in the control group, but it is not as distinct as the trend for IMD observed from the burn cases. This figure further confirms that most diseases or conditions have an element of social patterning. Table 4.10 shows the distribution of each variable of interest in cases versus the comparator group. The MEDCALC online statistical software was used to calculate chi-squares and obtain the p values when the case and comparator groups were compared.

**Table 4-10: Percentage of Burn Cases and "Other Admissions" within each Variable of Interest**

| VARIABLES | NUMBERS OF BURN CASES (%) | NUMBERS OF OTHER ADMISSIONS (%) | P VALUES FROM CHI-SQUARE TESTS COMPARING BOTH GROUPS |
|---|---|---|---|
| AGE | | | |
| 0-4 Years | **27444 (76%)** | **87585 (70%)** | **P < 0.0001** |
| 5-9 Years | **4384 (12%)** | **17442 (14%)** | **P < 0.0001** |
| 10-15 Years | **4252 (12%)** | **19811 (16%)** | **P < 0.0001** |
| SEX | | | |
| Male | **20618 (57%)** | **67491 (54%)** | **P < 0.0001** |
| Females | **15455 (43%)** | **57316 (46%)** | **P < 0.0001** |
| ETHNICITY | | | |
| White | **21473 (69%)** | **87471 (77%)** | **P < 0.0001** |
| Mixed | **1479 (5%)** | **4436 (4%)** | **P < 0.0001** |
| Asian/Asian British | **4590 (15%)** | **13128 (12%)** | **P < 0.0001** |
| Black/Black British | **2171 (7%)** | **5571 (5%)** | **P < 0.0001** |
| Other Ethnic | **1242 (4%)** | **3267 (2%)** | **P < 0.0001** |
| URBAN/RURAL DIVIDE | | | |
| Urban | **31394 (88%)** | **81815 (85%)** | **P < 0.0001** |
| Rural | **4334 (12%)** | **14730 (15%)** | **P < 0.0001** |
| IMD QUINTILES | | | |
| 1st Quintile (Least Deprived) | **3778 (11%)** | **14583 (15%)** | **P < 0.0001** |
| 2nd Quintile | **4365 (12%)** | **15317 (16%)** | **P < 0.0001** |
| 3rd Quintile | **8225 (23%)** | **20969 (22%)** | **P < 0.0001** |
| 4th Quintile | **7958 (23%)** | **20896 (22%)** | **P < 0.0001** |
| 5th Quintile (Most Deprived) | **11045 (31%)** | **24317 (25%)** | **P < 0.0001** |
| REGION OF RESIDENCE | | | |
| North East | **1370 (4%)** | **5923 (6%)** | **P < 0.0001** |
| North West | **7822 (22%)** | **16245 (15%)** | **P < 0.0001** |
| Yorkshire and Humber | **3383 (9%)** | **11054 (10%)** | **P < 0.0001** |
| East Midlands | **1927 (5%)** | **7639 (7%)** | **P < 0.0001** |
| West Midlands | **5432 (15%)** | **11975 (11%)** | **P < 0.0001** |
| East of England | **2573 (7%)** | **9893 (9%)** | **P < 0.0001** |
| London | **4936 (14%)** | **16901 (16%)** | **P < 0.0001** |
| South East | **4297 (12%)** | **16231 (15%)** | **P < 0.0001** |
| South West | **3647 (10%)** | **9600 (9%)** | **P < 0.0001** |

### 4.5.2 Conceptual Diagrams for HES Analyses

This section describes the conceptual diagrams that will inform the models used in the multivariable analyses of the HES data. The diagrams only include variables which were available in the HES dataset. As the focus of the HES data is on the effect of IMD, ethnicity and urban/rural divide on having a burn admission; the conceptual diagrams below (fig. 4.7 to fig. 4.9) describe in detail within each diagram which other variables are confounders, mediators, moderators and covariates.

**Figure 4-7: IMD and Burn Admissions model**

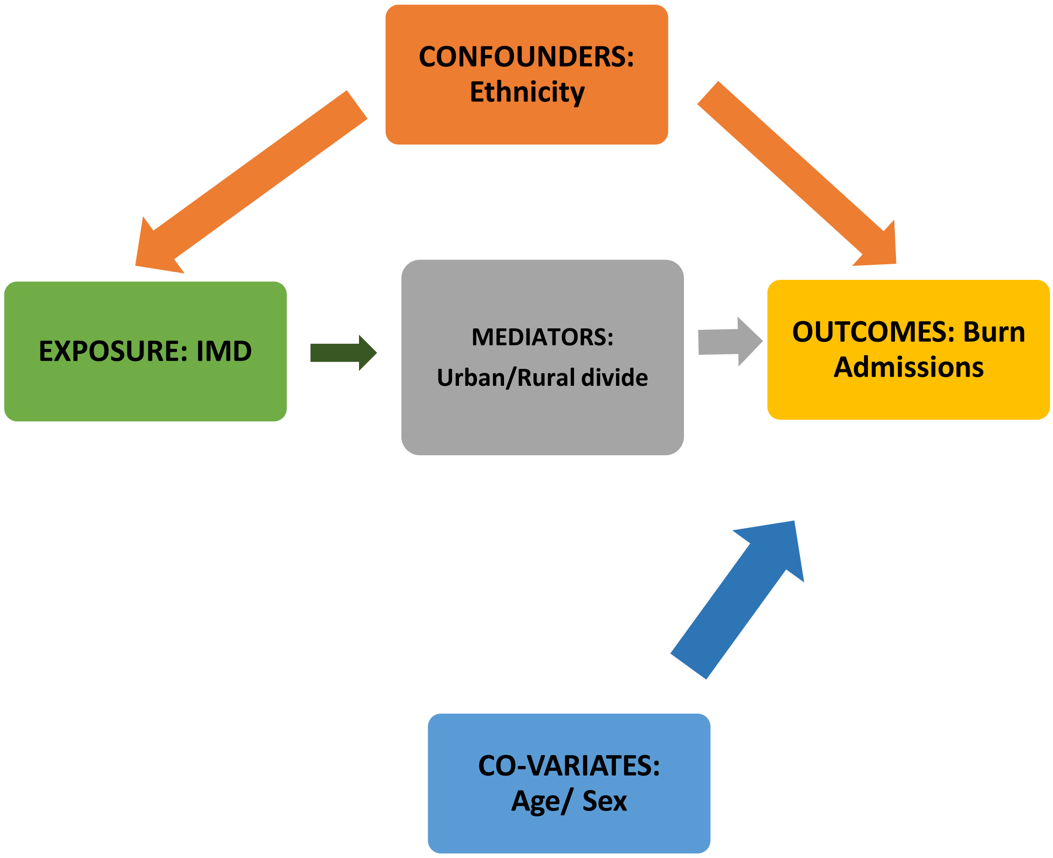
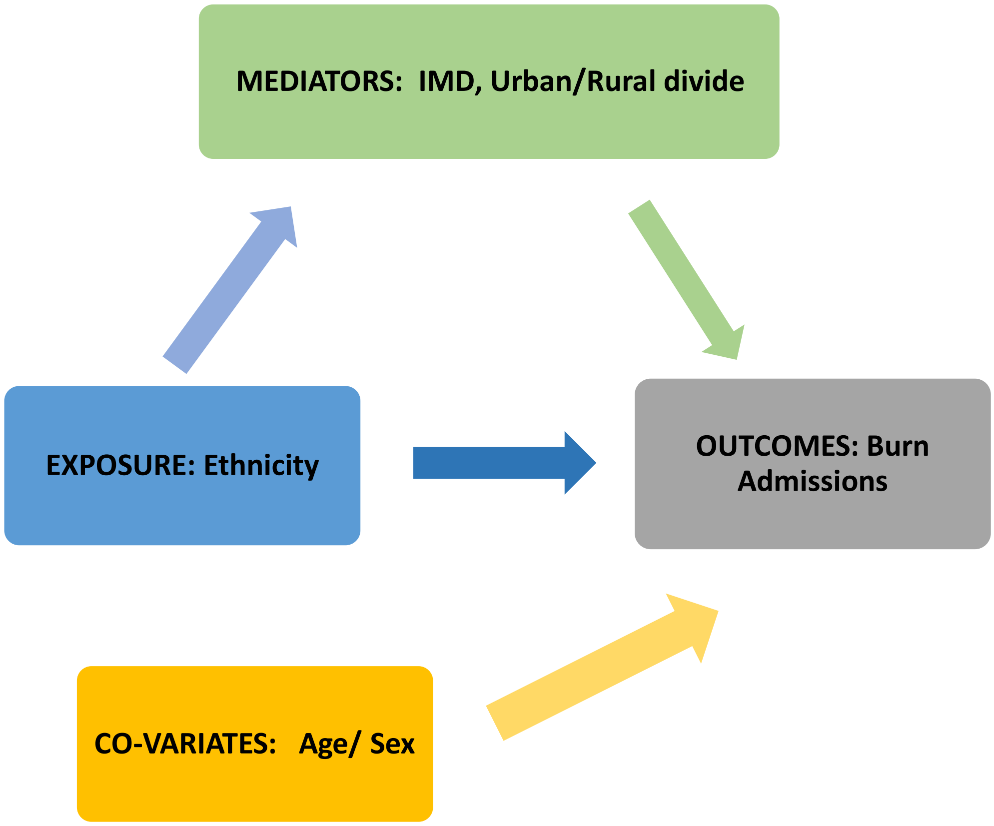
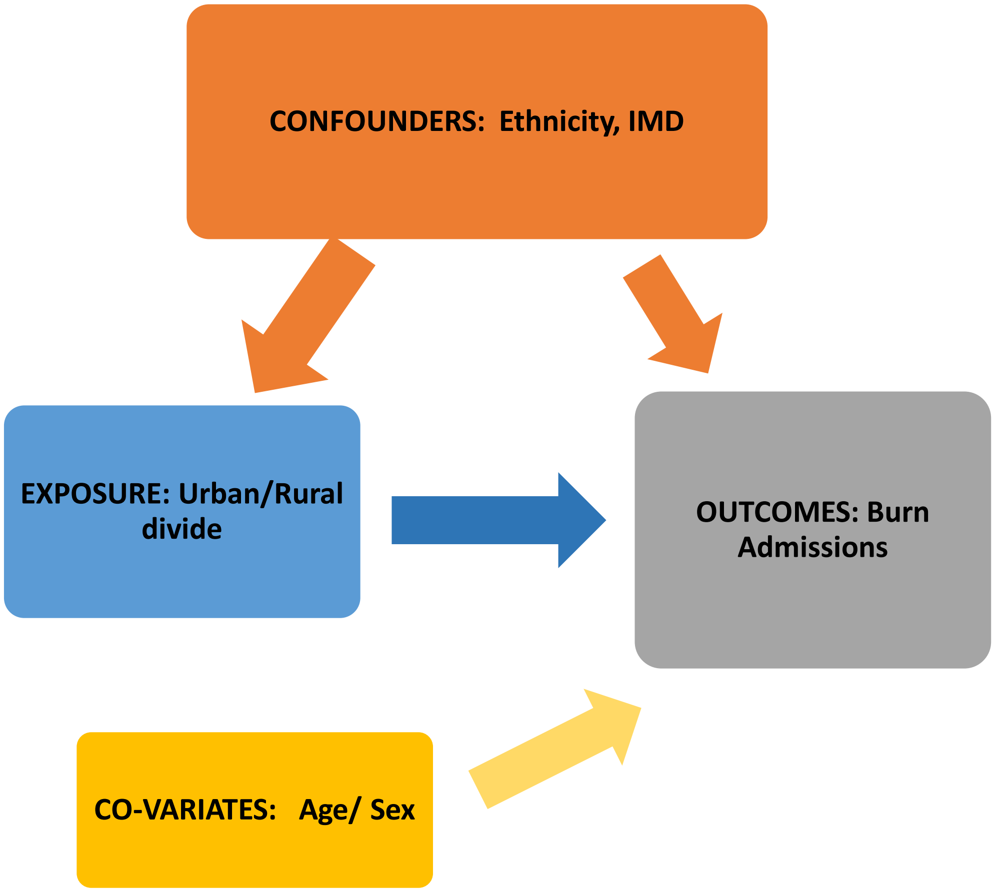


**Figure 4-8: Ethnicity and Burn Admissions model**




NB: Please note that the variables used in each model may vary in position depending on how they interact with the exposure and outcome variable. E.g. for this model on ethnicity and burn admissions, IMD and urban/rural are mediators.

**Figure 4-9: Urban/Rural Divide and Burn Admissions Model**



### 4.5.3 Regression Analyses of HES Data

The results of logistic regression analyses shown below compare the cases to the "other admission" group and have been split into three main sections to represent the three main predictor variables of interest for this thesis available in HES: namely Index of Multiple Deprivation (IMD), Ethnicity and Urban/Rural Divide. Within each section, tables have been constructed showing the unadjusted odds ratios and three adjusted models. These three adjusted models are:

Model 1: Unadjusted Odds Ratio (OR) + Individual Characteristics (Age, Sex);

Model 2: Model 1 + Family Characteristics (Ethnicity);

Model 3: Model 2 + Environmental Characteristics (IMD, Region and Urban/Rural Divide).

#### 4.5.3.1 Index of Multiple Deprivation (IMD) analyses

IMD was 82% complete in the full dataset of burn cases and the "other admissions" group, i.e. 131,453 out of 160,921 individual data available. For the logistic regression, the reference category was the 1$^{st}$ quintile, which is the quintile with the lowest deprivation scores.

Children belonging to the 5$^{th}$ (most deprived) quintile had the highest odds of being admitted for a burn injury compared to those from the 1$^{st}$ quintile (least deprived). The unadjusted model shows that children dwelling in the most deprived settings are associated with a 75% (95% CI= 68% to 83%) increase in burn admissions compared with children dwelling in the least deprived settings.

The 3rd quintile was second after this rank. The reason for the latter phenomenon could be that there is little difference between both the 3$^{rd}$ and 4$^{th}$ quintile in terms of deprivation (as seen in Table 4.10, where burns and other admissions had similar amounts of deprivation for these quintiles). Below is Table 4.11, which shows the unadjusted and adjusted results for IMD.

**Table 4-11: Multivariable Analyses Showing Relationship between Index of Multiple Deprivation (IMD) and Paediatric Burns Admissions in England from 2009-2015 (n=131453).**

| | Outcome Variable: Burn Admissions (1), Other Admissions (0) | | | |
|---|---|---|---|---|
| Predictor Variable: IMD | **UNADJUSTED OR (95% CI) (n=131,453)** | **MODEL 1* OR (95% CI) (n=131,421)** | **MODEL 2* OR (95% CI) (n=118,236)** | **MODEL 3* OR (95% CI) (n=118,236)** |
| 1st Quintile – Reference category | **1** | **1** | **1** | **1** |
| 2nd Quintile | **1.10 (1.05-1.16)** | **1.09 (1.04-1.14)** | **1.07 (1.02-1.13)** | **1.07 (1.02-1.13)** |
| 3rd Quintile | **1.51 (1.45-1.58)** | **1.47 (1.41-1.54)** | **1.36 (1.29-1.42)** | **1.34 (1.27-1.40)** |
| 4th Quintile | **1.47 (1.40-1.53)** | **1.42 (1.36-1.49)** | **1.32 (1.26-1.38)** | **1.30 (1.23-1.36)** |
| 5th Quintile | **1.75 (1.68-1.83)** | **1.71 (1.64-1.78)** | **1.58 (1.51-1.65)** | **1.55 (1.48-1.63)** |

***Model 1 controls for individual factors (Age and Sex), Model 2 controls for family factors (Ethnicity) and Model 3 controls for environmental factors (Urban/rural divide).**

A test for linear trend (using the “nptrend” command for ordered variables) conducted in STATA 15 for the IMD and burns admissions gave a z score of 29.40 (P <0.001) suggesting that a dose-response relationship occurs between increasing deprivation and burn admissions to hospital. This trend for increased risk of burn injury with increasing IMD scores carried through the unadjusted and adjusted models. Adjustment for the individual, family and environmental characteristics (Model 3) resulted in the most substantial attenuation on the odds of being admitted for burns in the 5$^{th}$ quintile i.e. The odds ratio was reduced by 20% after adjusting for individual, family and environmental factors. The adjusted model shows that children dwelling in the most deprived settings are associated with a 55% (95% CI= 48% to 63%) increase in burn admissions compared with children dwelling in the least deprived settings.

The confidence intervals of the odds ratios were narrow and confirmed a statistically significant relationship between IMD and burn admissions. These findings suggest that the most potent influence on the relationship between burn admission and IMD comes from family factors.

#### 4.5.3.2 Ethnicity analyses

There were 144,829 (90%) complete cases out of 160,921 available. The reference category for the ethnic analyses was the White ethnic group. Table 4.12 shows the unadjusted and adjusted models for ethnicity.

**Table 4-12: Multivariable Analyses Showing Relationship between Ethnicity and Paediatric Burns Admissions in England from 2009-2015 (n=144829).**

| | Outcome Variable: Burn Admissions (1), Other Admissions (0) | | | |
|---|---|---|---|---|
| Predictor Variable: Ethnicity | **UNADJUSTED OR (95% CI) (n=144829)** | **MODEL 1* OR (95% CI) (n=144807)** | **MODEL 2* OR (95% CI)** | **MODEL 3* OR (95% CI) (n=118236)** |
| White | **1** | **1** | **n/a** | **1** |
| Mixed | **1.36 (1.28-1.44)** | **1.33 (1.25-1.41)** | **n/a** | **1.30 (1.22-1.39)** |
| Asian/Asian British | **1.42 (1.37-1.48)** | **1.40 (1.35-1.46)** | **n/a** | **1.30 (1.25-1.35)** |
| Black/Black British | **1.59 (1.51-1.67)** | **1.58 (1.50-1.67)** | **n/a** | **1.50 (1.42-1.59)** |
| Other Ethnic | **1.55 (1.45-1.66)** | **1.53 (1.43-1.64)** | **n/a** | **1.45 (1.34-1.54)** |

***Model 1 controls for individual factors (Age and Sex). Model 3 controls for environmental factors (Urban/rural divide and IMD).**

There was no model 2 for the ethnicity analyses as the only family factor was the predictor variable in this case. Only model 1 and model 3 were run for ethnicity analyses. The highest odds for burn admissions were in the Black/Black British and "Other" Ethnic group, respectively. For example, the unadjusted model shows that Black/Black British children are associated with a 59% (95% CI= 45% to 66%) increase in burn admissions compared with White British children. This trend persisted after adjusting for all other variables. Like IMD, the odds of burn admissions attenuated across all ethnic groups after controlling for both individual and environmental factors. This result was most pronounced in Model 3 with the largest attenuations of odds ratios seen after controlling for environmental factors in the Asian group and the Black and "Other" Ethnic groups. E.g. the adjusted model shows that the odds for burn admissions in Black/Black British children reduced by 9%. However, Black/Black British children were still associated with a 50% (95% CI= 42% to 59%) increase in burn admissions compared with White British children. The confidence intervals of the odds ratios were narrow and confirmed a statistically significant relationship between IMD and burn admissions. These findings show the strongest influence on the relationship between burn admission and ethnicity comes from environmental factors. Regarding the effect of environmental factors, this was mainly due to IMD rather than urban/rural. It was interesting to note that the adjusted odds for ethnic burn admissions were the highest in the Black ethnic group.

#### 4.5.3.3 Urban/Rural Divide Analyses

There were 133,277 (82.2%) complete cases out of 160,921 available. The reference category for urban/rural analyses was children living in rural areas. Below is table 4.13, showing the unadjusted and adjusted models for the place of residence.

**Table 4-13: Multivariable Analyses showing Relationship between Urban/Rural divide and Paediatric Burns Admissions in England from 2009-2015 (n=133277).**

| | Outcome Variable: Burn Admissions (1), Other Admissions (0) | | | |
|---|---|---|---|---|
| Predictor Variable: Urban/Rural Divide | **UNADJUSTED OR (95% CI) (n=133277)** | **MODEL 1* OR (95% CI) (n=132241)** | **MODEL 2* OR (95% CI) (n=118942)** | **MODEL 3* OR (95% CI) (n=118236)** |
| Rural Dweller | **1** | **1** | **1** | **1** |
| Urban Dweller | **1.30 (1.26-1.35)** | **1.26 (1.21-1.31)** | **1.18 (1.14-1.23)** | **1.11 (1.06-1.15)** |

***Model 1 controls for individual factors (Age and Sex), Model 2 controls for family factors (Ethnicity) and Model 3 controls for environmental factors (IMD).**

The unadjusted odds ratio showed that children living in urban areas were more likely to be admitted with a burn compared to those living in rural areas. The unadjusted model shows that urban dwelling is associated with a 30% (95% CI= 26% to 35%) increase in burn admissions in urban dwellers compared with rural dwellers. However, like IMD, there was a gradual attenuation of odds after controlling for all individual, family and environmental factors. The magnitude of the odds ratios was attenuated by a small amount after controlling for individual factors and a moderate amount after family and environmental factors i.e. 19%

reduction in the odds ratio. The confidence intervals of the odds ratios were narrow and confirmed a statistically significant relationship between urban/rural divide and burn admissions. These findings show the strongest effects on the relationship between burn admission and urban/rural divide comes from the family factors and IMD. However, the fully adjusted results from model 3 show the odds of being admitted for a burn injury than other conditions are still higher if one dwells in an urban area than a rural area. The final adjusted model shows that urban dwelling is associated with a 11% (95% CI= 6% to 15%) increase in burn admissions in urban dwellers compared with rural dwellers. Also, the confidence interval in Model 3 (i.e. after adjusting for environmental variables) was outside the that of the unadjusted and model 1 results but still showed an association between urban/rural divide and burn admissions.

#### 4.5.3.4 <u>Results of the effects of age and sex</u>

The table below (Table 4.14) outlines the effects of age and sex in the fully adjusted model 3 (for all family and environmental factors) alongside the unadjusted results.

**Table 4-14: Table showing Age and Sex Effects from All Models**

| VARIABLES | UNADJUSTED<br>O.R (95% CI) | MODEL 3<br>O.R (95% CI) |
|---|---|---|
| AGE | | |
| 10-15 years old (reference category) | **1** | **1** |
| 0-4 years old | **1.46 (1.41-1.51)** | **2.00 (1.92-2.07)** |
| 5-9 years old | **1.17 (1.12-1.23)** | **1.11 (1.05-1.16)** |
| SEX | | |
| Female (reference category) | **1** | **1** |
| Male | **1.13 (1.11-1.16)** | **1.09 (1.06-1.12)** |

With age, the 0-4-year olds have the highest odds (unadjusted and adjusted) for being admitted for a burn injury than for other conditions. These results suggest that there is a substantial effect of age on the models plotted above, especially if the child falls within the 0-4-year-old group.

For sex, males had higher odds of being admitted for burns than for other conditions. There was attenuation in odds for admission by gender after controlling for other predictors. However, it was weak. This result implies that the sex of the child may not have had much effect on the models executed above. However, overall, there is still a male preponderance among children admitted for burns compared to the other conditions.

## 4.6 Summary

The results from the HES analyses demonstrate the relationship between some socio-demographical factors and burns admissions in England from 2009 to 2015. The main findings were as follows:

1. Children from the most deprived quintiles (5th quintile) had the highest odds ratios for burns admissions (unadjusted and adjusted) when compared to those from the least deprived children (1st quintile). Thus, they were shown to be at increased risk of burn admissions.
2. All children from ethnic minority groups had higher odds of burn admissions than the White ethnic majority. Children from the Black/Black British minority ethnic group had the largest odds ratios for burns admissions (unadjusted and adjusted) when compared to those from the White ethnic majority. Thus, they were shown to be at increased risk of burn admissions.
3. Children living in urban areas had increased odds ratios for burns admissions (unadjusted and adjusted) when compared to those living in rural areas. Thus, they were shown to be most at increased risk of burn admissions.
4. Family (ethnicity) and environmental factors (IMD and urban/rural divide) seem to have the most effect on all models run in these

analyses. Thus, it is likely that these factors play a significant role in burn risk in and out of the home. Future research is needed to understand further why this is so.

5. Further research is also needed to understand differences in ethnic minority groups and why these put them at risk of burn injuries compared to the ethnic majority.

# CHAPTER 5 : BURNS AND SCALDS ASSESSMENT TEMPLATE (BaSAT) DATASET

## 5.1 Research Questions for BaSAT Data Analyses

BaSAT analyses utilised data collected from Emergency Departments (EDs) to answer research questions that could not be investigated using HES data. These are divided into primary research questions which will focus on inequalities (by pre-injury impairment and supervision) among children with thermal injuries and then secondary questions that examine this relationship with burn depth and use of first aid (a proxy for health-seeking behaviour). Below are these research questions:

### 5.1.1 BaSAT primary research question on impairment

- Are children with pre-injury impairments at higher risk of non-scald/scald injuries than children with no such impairments?

### 5.1.2 BaSAT secondary research questions on impairment

- Do children with pre-injury impairments receive different first aid (explicitly cooling with running water) for non-scald/scald injuries than children with no such impairments?
- Do children with pre-injury impairments get more profound non-scald/scald injuries than children with no such impairments?

### 5.1.3 BaSAT primary research question on supervision

- Are children with no adult supervision at the time of injury at more risk of having non-scald/scald injuries than those with reported adult supervision?

### 5.1.4 BaSAT secondary research questions on supervision

- Do children with no adult supervision get adequate first aid for non-scald/scald injuries (explicitly cooling with running water) compared with children with reported adult supervision?

- Are children with no adult supervision at the time of injury at more risk of having more profound non-scald/scald injuries than those with reported adult supervision?

### 5.1.5 BaSAT secondary research questions on deprivation

- Are children from backgrounds of greater social disadvantage less likely to have adequate first aid (explicitly cooling with running water) than those from backgrounds with a lesser social disadvantage?
- Do children from backgrounds of greater social disadvantage have more profound burn injuries than those from backgrounds with a lesser social disadvantage?

### 5.1.6 BaSAT secondary research questions on ethnicity

- Are children from minority ethnic groups less likely to have adequate first aid (explicitly cooling with running water) than those from the majority ethnic group?
- Do children from minority ethnic groups have more severe thermal injuries than those from the majority ethnic group?

## 5.2 BaSAT Methods

### 5.2.1 History and Development

Thermal Injury in young children may result from inadequate supervision, ranging from “split seconds” of distraction, careless and inadequate parenting, chaotic households to neglect and physical abuse (Ojo *et al* ., 2007). However, although the literature suggests increasing incidence with parental supervision, the problem may be with defining supervision. For instance, some studies may use parental/carer/adult presence or witnessing the burn injury in children as “supervision”, when what is needed is close adult monitoring of a child’s behaviour.

Chester *et al.,* (2006) suggested that 10% of burns arise from child maltreatment, with an estimated ratio of neglect: physical abuse of 9:1. It is also said that some

30-40% of children may warrant further assessment to exclude early signs of neglect or potential child abuse (James-Ellison *et al*., 2009). An initial assessment of burns presented to emergency departments (EDs) provides an opportunity to identify risk factors for neglect and abuse, and to make the critical referrals to local safeguarding teams. To facilitate this, the Children's Burns Research Centre designed a clinical tool- the Burns and Scalds Assessment template (BaSAT)

The design of the BaSAT was based on the existing literature on maltreatment associated with burns, and a prospective study of children presenting to hospitals in England, Wales and Ireland with burn injuries (Kemp *et al.*, 2014a).

Kemp *et al.*, (2014b) and Maguire *et al.,* (2008) carried out systematic reviews defining the features which may distinguish intentional from unintentional thermal injuries. The findings from these reviews along with data from an extensive epidemiological study (Kemp *et al.*, 2014a) carried out in 2008-2010 informed the design of the data collection template which became the Burns and Scalds Assessment Template (BaSAT).

The multi-centre study of the epidemiology of thermal injury by Kemp *et al.,* (2014a) collected detailed information on 1215 children under the age of sixteen years. The following key results further presented a picture of the gravity of the problems surrounding thermal injury in children within the UK:

- Ninety per cent of children seeking medical treatment for thermal injury were attended to in the emergency department (ED) while the remaining 10% got treatment as inpatients in burns and plastic surgery units.
- Seventy per cent of the children were less than three years old with peak prevalence between the ages of 6-18 months.
- There were patterns of common factors that predisposed the injured children to thermal injury risk in the first instance. These were found to be related to the developmental age of the child.
- Infants who were becoming independently mobile (starting to crawl and walk) were at increasing risk from scalds (58%) primarily from

hot cups of beverages left in their reach or contact burns (32%) from household items such as hot oven doors, irons, hair straighteners.

- Ten per cent of children (112) had a child protection assessment while a further 30-40% of the child had features and risk factors that should have alerted professionals to a potential “child in need”. Unfortunately, these features missed recognition at presentation, and the children were not referred on to a paediatrician or health visitor for further assessment.
- The data collection proforma used in this study was simple to use, accepted and appreciated by the staff that assessed these children. They stated that it helped them to collect the essential clinical information to assess the child for both clinical and preventative intervention.
- Univariate and multivariable logistic regression analyses identified socio-demographical factors associated with accidental and intentional burns based on the resulting injuries assessed. This multi-centre study also helped in the creation of an algorithm to identify low, medium and high-risk groups for safeguarding concerns. The algorithm formed the basis of the clinical prediction tool (BuRN-Tool) used alongside BaSAT in some EDs.

### 5.2.2 Collecting and Cleaning BaSAT Data

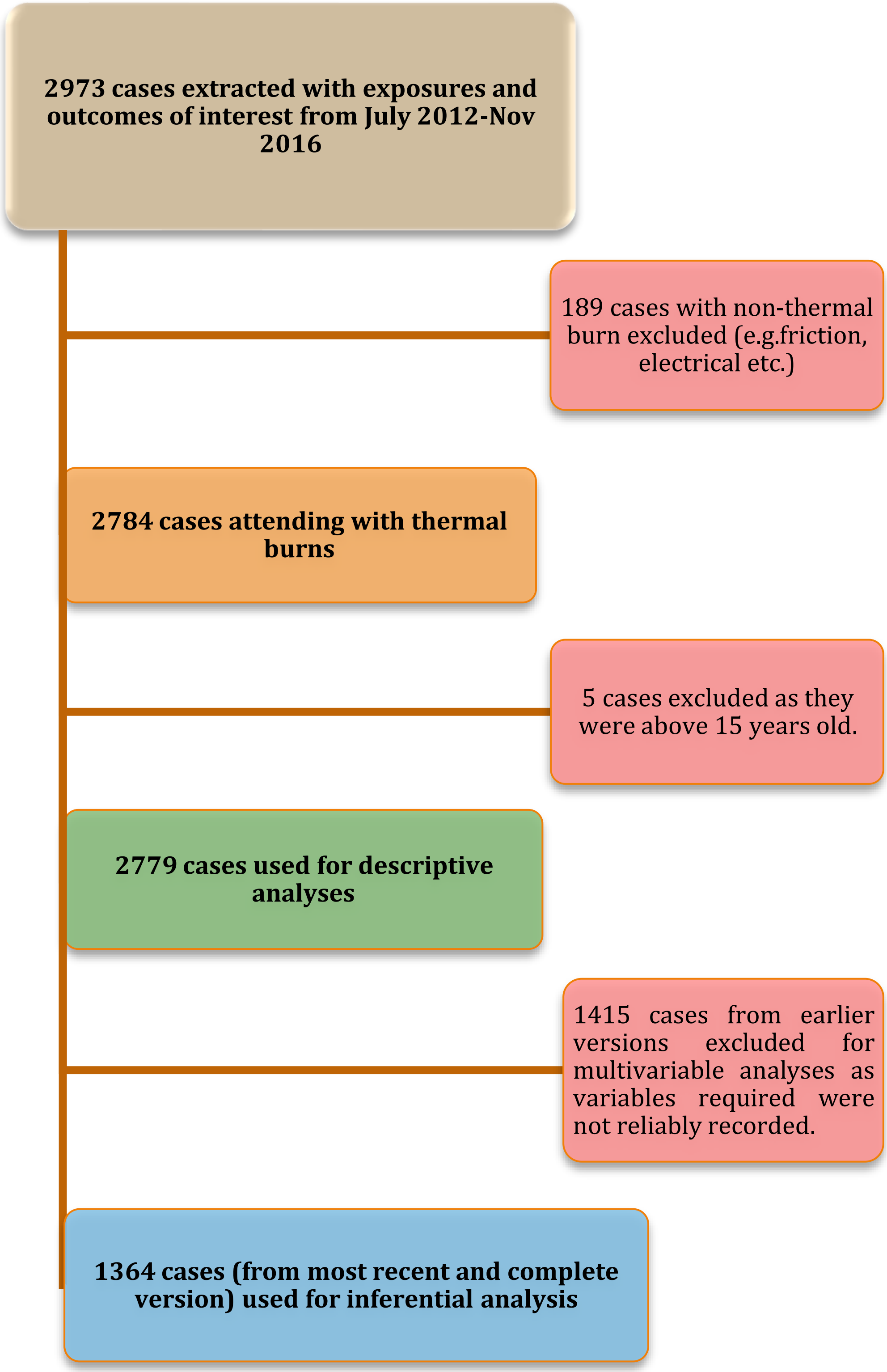
The prototype BaSAT proforma described in the previous section was then introduced to several paediatric emergency departments in England and Wales who agreed to use it for collating details regarding thermal injuries in attending children. The EDs that initially agreed to use the BaSAT proforma were Cardiff and Vale-ED, Cardiff and Vale Minor Injuries Unit, North Bristol Trust SMD and University Hospital Bristol Children's Hospital ED. Subsequently, the BaSAT was used in Pennine-North Manchester General Hospital, Pennine-Royal Oldham Hospital, Pennine-Fairfield General Hospital and Pennine-Rochdale Infirmary, Swansea-Morriston ED, Swansea-Morriston Burns Unit, Birmingham-Children's ED, Birmingham-Children's Burns Unit, North Wales-Wrexham Maelor Hospital

ED, North Wales-Ysbyty Gwynedd ED and North Wales-Glan Clwyd ED. Depending on the facilities at each ED, the BaSAT proforma was used in paper or electronic format, with the use of electronic forms encouraged where possible. Data collection began in July 2012 with a pilot version that has undergone refining over the years to the most current update, Version 6 (November 2016). The proforma is completed by junior doctors in ED and captures socio-demographical information collected from attending parents/carers of injured children as well as clinical information on the attending children. While BaSAT data are collected mainly from emergency rooms; all patients with burns are captured, including those who end up in admission and those that are discharged from the ED.

The data from participating EDs have been uploaded onto a REDCAP database by a team of research nurses, researchers and a data manager. Incomplete or missing data were tracked down as efficiently as possible and retrieved where the needed information was available. The BaSAT data used for this thesis were obtained by the author from the Scar Free Foundation Children's Burns Research Centre who is custodians of this dataset with permissions from the Data Manager of the centre, Mr Steve Gregory and the Director, Prof Alan Emond. The data requested were from the years 2012 to 2016. The Data Manager made the datasets available on the Research Electronic Data Capture (REDCAP) database. The author was given access to the REDCAP database from which he downloaded, cleaned, and recoded where necessary, and then analysed the data in STATA.

There were 2,973 cases of burn injuries in children aged 0-15 years presenting to emergency departments using the BaSAT between the years 2012 and 2016. However, based on the focus of this thesis and definitions of what constitute thermal injuries, any case that was not a scald, contact burn or flame burn was excluded. Friction and electrical "burns" were excluded after descriptive and inferential analyses. The exclusions left a total of 2,784 cases. Of these, five individuals were above 15 years of age and were dropped from the dataset bringing the total number of data points to 2,779. This number was used for the descriptive analyses (see Fig 5.1), and a smaller complete dataset was used for inferential analyses are in Fig. 5.1.

**Figure 5-1: Flowchart showing numbers in BaSAT datasets used for analyses.**



## 5.3 Descriptive Analyses

### 5.3.1 Outline

To determine whether the BaSAT sample was representative of the general population in distribution, tables have been created to descriptively display BaSAT sample numbers and those of the general population, taken from the 2011 UK Census Data for England. Odds ratios (OR) and 95% confidence intervals (CI) were then obtained to compare the proportions of both the BaSAT and the Census data.

### 5.3.2 Demographic Variables

#### 5.3.2.1 Age

The data provided showed 2,779 cases presenting to ED sites with thermal injuries from July 2012-Nov 2016. Data was 99.5% complete for this variable. Seventy per cent of children attending EDs were under five years of age. This proportion was more substantial than the 33% of children aged 0-5 in the general population according to the 2011 Census. There were correspondingly lower proportions of children attending hospital in the other age groups compared to their respective proportions in the general population. This proportion is shown below in Table 5.1

**Table 5-1: Proportions by the age of burn cases and the general population using the 2011 U.K. Census**

| AGE | BASAT SAMPLE | BASAT PROP. | 2011 CENSUS DATA | CENSUS PROP. | O.R FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|
| 0 to 4 years | 1944 | 0.70 | 3,318,449 | 0.33 | 4.78 | 4.40-5.18 |
| 5 to 9 years | 399 | 0.14 | 2,972,632 | 0.30 | 0.40 | 0.36-0.44 |
| 10 to 15 years | 422 | 0.16 | 3,731,755 | 0.37 | 0.30 | 0.27-0.34 |
| Total | 2765 | | 10,022,836 | | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O. P= comparison of two proportions. | | | | | | |

The table shows that the proportion of burns attendances at ED decreased with increasing age. Also, the proportions of data show children below age five years accounted for most of the children attending ED for burn injuries. The ORs for attending ED for burns/scalds in 0-4-year-old children was 12 times that of children aged 5-9 years old and 16 times that of children aged 10-15 years (see Table 5.1 above).

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#### 5.3.2.2 Sex

This variable was complete for 99.3% of the BaSAT dataset (2,759 out of 2779 children). Males formed 54.7% of the sample.

**Table 5-2: Proportions by sex of burn cases and the general population using the 2011 U.K. Census**

| SEX | BASAT SAMPLE | BASAT PROP. | 2011 CENSUS DATA | CENSUS PROP. | O.R FOR C.O. P | 95% CI FOR C.O. P |
|---|---|---|---|---|---|---|
| Male | 1,510 | 0.55 | 5,131,675 | 0.52 | 1.15 | 1.07-1.24 |
| Female | 1,249 | 0.45 | 4,891,161 | 0.48 | 0.87 | 0.81-0.94 |
| Total | 2,759 | | 10,022,836 | | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O. P= comparison of two proportions. | | | | | | |

There was a slight excess of males presenting with burn injury at EDs, i.e. 55% compared to 52% male children in the general population (see Table 5.2 above). Males were 1.2 times more likely to attend hospital for a burn event from the general population. Females were less likely to attend for burns compared to the general population.

On examining the existence of gender differences by age, six of the 2759 cases with complete gender information did not have age recorded. Hence, only the details of the 2753 children with complete age and sex information are presented as follows in Table 5.3

**Table 5-3: Proportions by age and sex of burn cases and the general population using the 2011 U.K. Census**

| SEX/AGE GROUP | BASAT SAMPLE | BASAT PROP. | 2011 CENSUS DATA | CENSUS PROP. | O.R FOR C.O.P | 95% CI FOR C.O.P |
|---|---|---|---|---|---|---|
| Males 0-4 years | 1,121 | 0.74 | 1,698,171 | 0.33 | 5.87 | 5.23-6.59 |
| Males 5-9 years | 196 | 0.13 | 1,521,271 | 0.30 | 0.35 | 0.31-0.41 |
| Males 10-15 years | 190 | 0.13 | 1,912,233 | 0.37 | 0.24 | 0.21-0.28 |
| TOTAL FOR MALES | 1,507 | 0.55 | 5,131,675 | 0.52 | 1.15 | 1.07-1.24 |
| Females 0-4 years | 814 | 0.65 | 1,620,278 | 0.33 | 3.80 | 3.39-4.27 |
| Females 5-9 years | 202 | 0.16 | 1,451,361 | 0.30 | 0.46 | 0.39-0.53 |
| Females 10-15 years | 230 | 0.18 | 1,819,522 | 0.37 | 0.38 | 0.33-0.44 |
| TOTAL FOR FEMALES | 1,246 | 0.45 | 4,891,161 | 0.49 | 0.87 | 0.80-0.94 |
| GRAND TOTAL | 2,753 | | 10,022,836 | | | |
| KEY: PROP. = proportions, CI= confidence interval, OR= odds ratio, C.O.P= comparison of two proportions. | | | | | | |

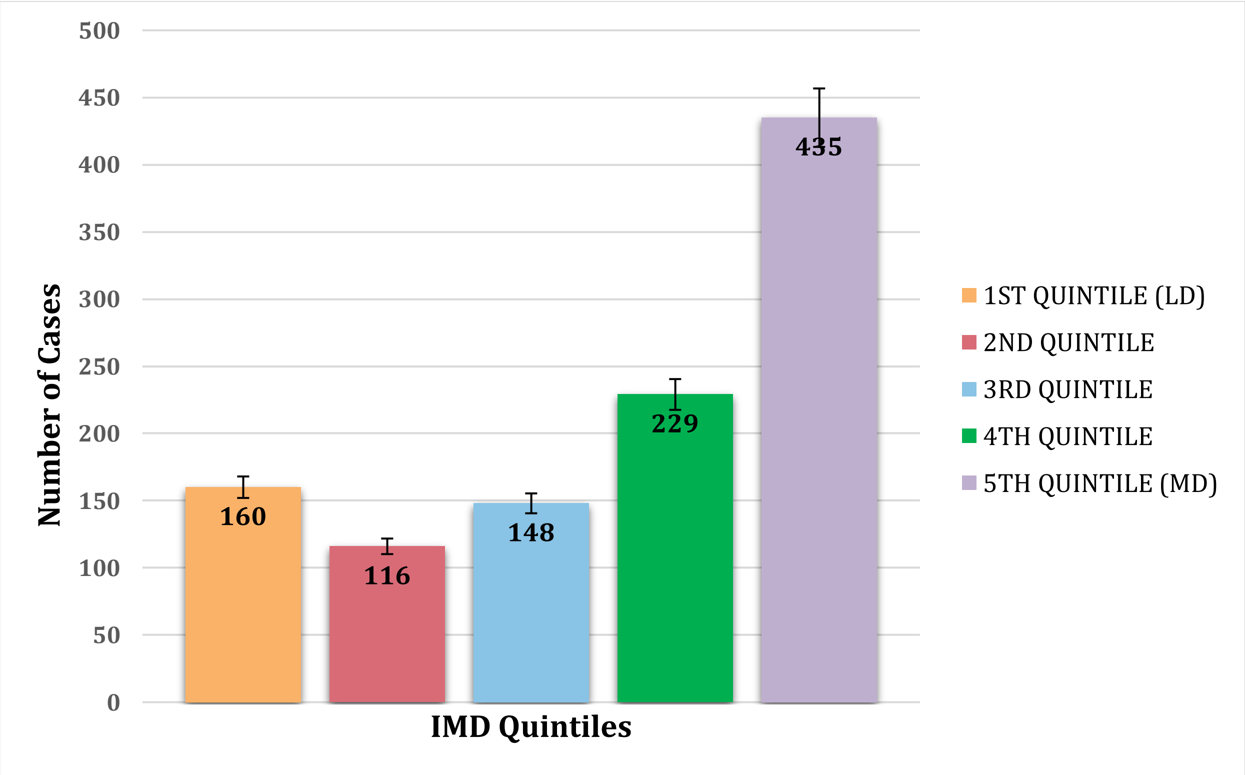
Male children aged 0-4 years of age were six times more likely to attend EDs with burns while females aged 0-4 years of age were four times more likely to attend with burns injuries compared to their proportions in the general population. Males and females in age groups ranging from 5-15 years old had a lesser likelihood of attending EDs for burns (ORs below 1). This result affirms that children aged 0-4 irrespective of their gender overrepresent at EDs with burn injuries.

#### 5.3.2.3 <u>Deprivation</u>

This variable in BaSAT is derived from the family's postcode, giving the overall IMD ranking scored on the Super Output Area an injured child lives in (see Appendix for Chapter 5 for more details). However, the IMD information was only complete for 1,088 out of 2779 (39%) individuals because full postcode was not collected for earlier versions (only version 6, the latest one) as it was not considered a mandatory variable at the time.

Below is the bar chart (Fig. 5.2) showing the distribution (for complete data) of ED attendance for burn injuries by IMD with LD representing the least deprived quintile and MD representing most deprived quintile:

**Figure 5-2: Under 16-year-olds' ED Burn Attendance by IMD quintiles in BaSAT 2012-2016**



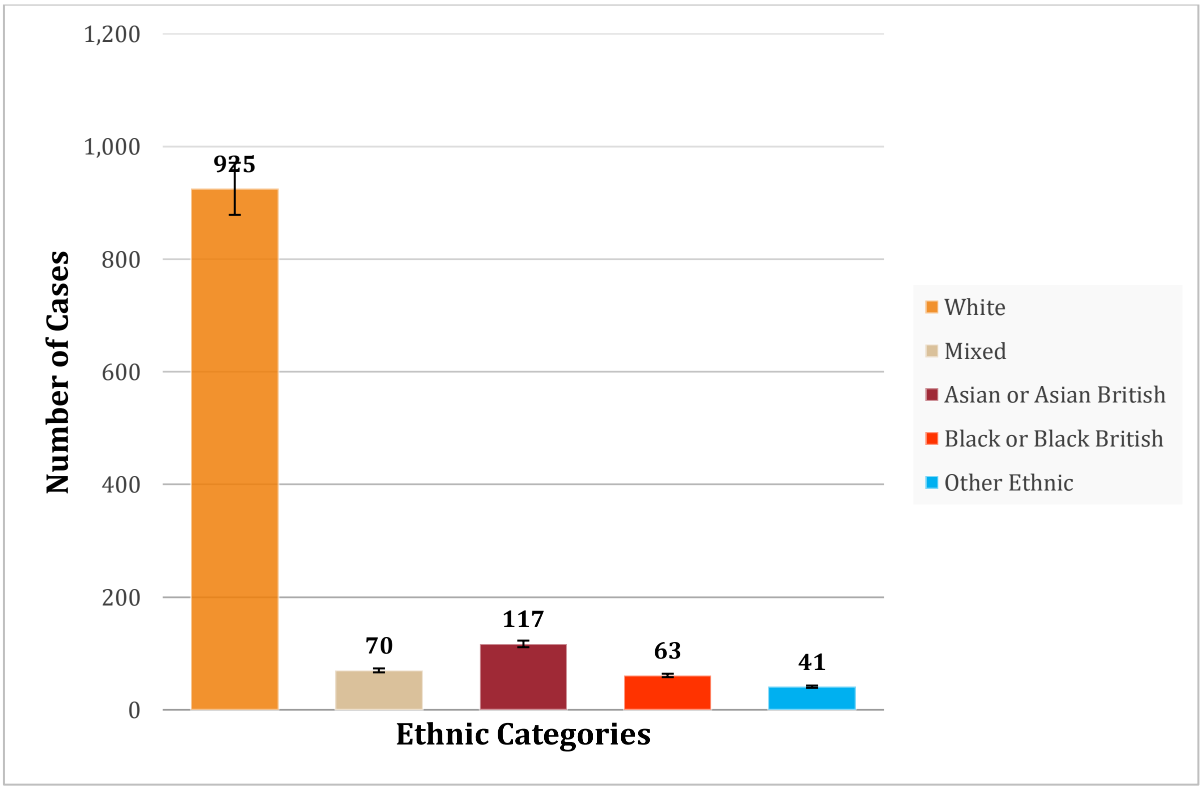

The above figure (Fig. 5.2) shows that the numbers of children presenting to EDs with burns seem to follow a gradient with the least numbers in less deprived quintiles, and a gradual increase with increasing deprivation scores.

#### 5.3.2.4 Ethnicity

Ethnicity was collected in the BaSAT using a classification of ethnic categories based on the 2011 UK Census. These data were re-coded for analyses to match the broad classification used by the Office for National Statistics, i.e. merging the respective ethnic groups into five broad categories used in 2011 Census- namely Asian/Asian British, Black/Black British, Mixed, Other and White/White British.

The process outline is in the Appendix section of Chapter 5. In the BaSAT sample, 1214 of 2779 children had complete ethnicity information (43.7%). Below is a presentation of the numbers of ED burn attendances by ethnicity (Fig. 5.3):

**Figure 5-3: Under 16-year-olds' ED Burn Attendance by Ethnicity in BaSAT 2012-2016**



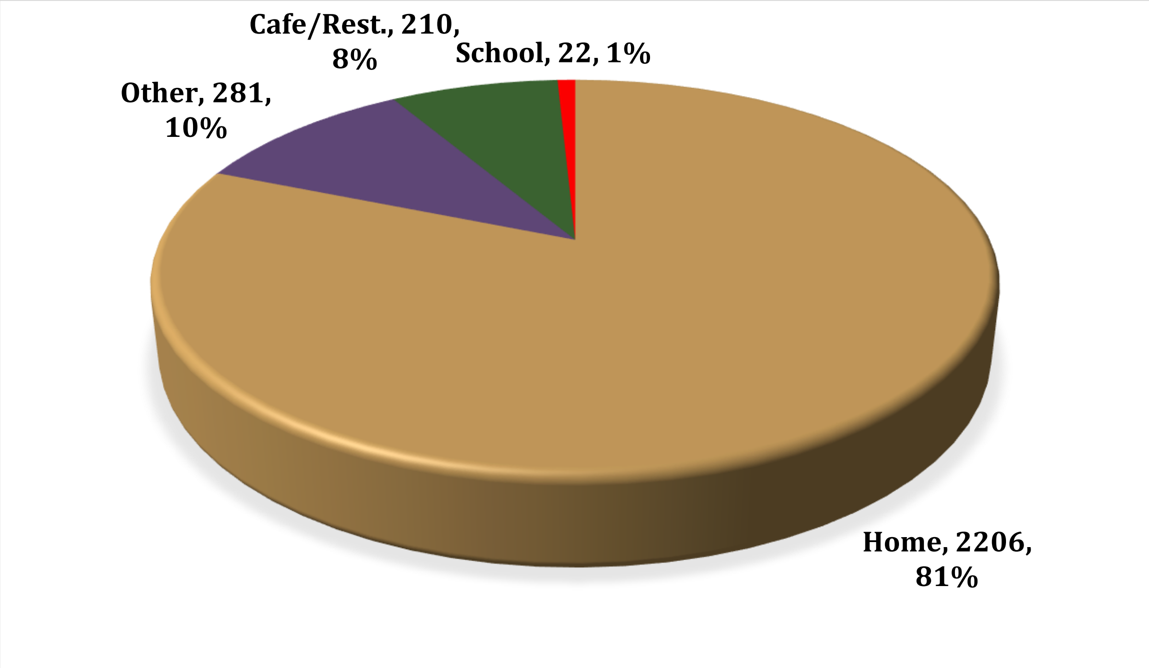

The above figure (Fig 5.3) shows that 76.2% of the sample with complete ethnicity information was White/White British. The remaining groups were made up of the minority ethnic groups with Asian/Asian British representing the largest subgroup.

As mentioned with IMD, a comparison of ethnic differences in the BaSAT sample to that of the general population was not made because of this variable only being 43.7% complete. However, the available data show a similar pattern of the ethnic distribution within the population but a likely over-representation of ethnic minorities presenting to EDs with burn injuries.

### 5.3.2.5 <u>Location of the burn event</u>

This variable was recorded by ED staff when they asked the parents/carers of injured children where the injury happened. Data were complete for 2719 out of the 2,779 (97.8%) cases seen over the four years. Most of the cases observed occurred at home (79.4%).

**Figure 5-4: Under 16-year-olds' Details on Location of Burn Event in BaSAT 2012-2016**




The above figure (Fig. 5.4) shows the burn events occurring mostly in the home as expected from the epidemiological studies identified in the systematic review carried out within this thesis. This rank is followed by “Other” category, which is a mixture of other places burns may happen in children below 16 years of age. However, if looking at other defined locations, cafés/restaurants were more likely locations for burns outside the home.

Location of burn event by age was available for 2716 (99.9%) out of the 2719 cases presented. The three missing cases did not have their ages recorded. Given the small numbers of burn events across other locations, this variable was re-categorised into a binary variable with options for home-based and injury outside the home. For details of the creation of this new variable, see Appendix for Chapter 5. Previous literature shows that children below 5 are more likely to get scalds and be injured at home. Figure 5.5 below shows the location of burn events by age group and burn type:

**Figure 5-5: Under 16-year-olds' Details on Location of Burn Event by Burn Type in BaSAT 2012-2016**

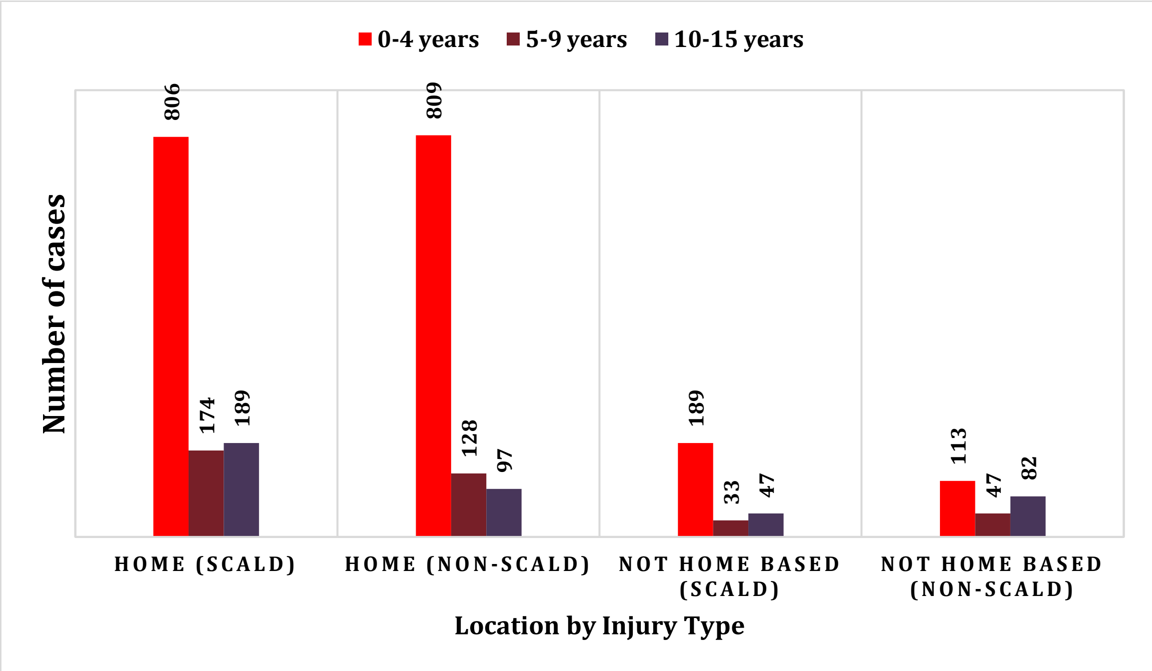



Fig. 5.5 above shows that in the 0-4y group, there were more scalds injuries than non-scalds, consistent with previous literature.

Also, Fig. 5 depicts most of the burn events occur in the home than elsewhere, i.e. 2206 (81.1%) of 2719 cases. By burn type, most scalds can be seen to occur in the home irrespective of age, i.e. 1169 (81.3%) of 1438 scald cases that have completeness for age and location of burn event. Of these home-based scald cases, 806 occurred in 0-4-year olds (68.9% of the 1169 home-based scalds). Also, for non-scalds, more numbers were observed occurring outside the home than scalds for the 5-9 and 10-15-year olds. This observation aligns with previous literature reporting older children having their injuries outside the home environment and often those that are non-scalds. Location of burn event can be considered an environmental factor- which from analyses done in Chapter 4 has been shown to have potent effects on the relationship between predictors and burn outcomes. Thus, it will be interesting to see how this affects BaSAT data analyses.

#### 5.3.2.6 Other Covariates

This section includes a description of covariates being used in some models used for multivariable analyses later.

##### *5.3.2.6.1 History of a social worker*

The allocation of a social worker to a family is a marker of social need. This information was collected by ED staff when they asked parents/carers accompanying the injured child if they were aware of an allocated social worker for that child at the time of presentation. The information for current social workers was 82.3% complete while that for past social workers was 57.3% complete. The reason for the differences in response rates for current and past social workers was not clear, but it may be due to recall bias or choice of the family not to disclose the information. The percentage of children with past social workers was 5.2% while those with current social workers were 4.5%.

##### *5.3.2.6.2 Domestic violence in the home*

This variable was collected by ED staff who asked accompanying parents/carers if they were aware of any domestic issues/violence in the home of the child with the burn event. Data were 56.0% complete, i.e. 1609 out of 2779 cases. Of the 1609 cases with complete information on this variable, 3.2% had some form of domestic violence in the home, i.e. 52 out of 1609 cases while others (96.8%) reported no domestic violence.

This variable is important as it may impact the ability for adequate supervision to be given in the home. An unstable relationship between parents or family members may increase the likelihood of inadequate supervision of those children most at risk of injuries.

### 5.3.3 Burn-related Outcomes

#### 5.3.3.1 Type of Thermal Injury

This variable was recorded by ED staff when they asked the parents/witnesses of presenting children what had caused the injury on presentation to E.Ds. Data were complete for 2755 out of the 2,779 (99.1%) cases seen over the four years.

Scalds were the leading type of burn injury accounting for 52.9% of complete cases, i.e. 1457 out of 2,779 cases. This rank was followed by contact burns (45.1%). As a subgroup, non-scalds (contact burns and flame burns) constituted 47.1% of the sample with complete burn type details.

#### 5.3.3.2 Depth of burn

This variable was collected during treatment of children reporting with burn injuries in ED departments in England and Wales. The clinicians collated records while examining the burn injuries. It was collected in individual categories, namely erythema/redness, blisters not burst, wet-pink burns and dry-white/charred burns. These categories represent the severity of the burn injury, with erythema having the least depth while the last group (dry-white/charred) are considered the most severe as the wounds are quite thick at this point and have done the most damage. This categorisation is accepted around paediatric departments and EDs across England and Wales who deal with treating burn injuries.

For analyses, the variable is recoded into a binary form with two outcomes namely non-full thickness burns (includes the erythema/redness, blisters not burst and wet-pink group as these are the less invasive burns) and full-thickness burns (dry-white/charred burns group as this is the most in-depth type). Data were 92.7% complete. Non-full thickness burns made up 95% of the cases.

#### 5.3.3.3 Use of first aid

This variable was collected by ED staff when they asked parents/carers of children presenting with burn event if any first aid was applied after the injury occurred. This variable was 94.5% complete, i.e. 2625 out of 2779 cases. The majority (93.5%) of parents/carers of children reported giving some form of first aid before attending the ED.

#### 5.3.3.4 Use of Cool Running Water (CRW) first aid

This variable was collected by ED staff when they asked parents/carers of children presenting with burn event if the first aid that was applied after the injury occurred was cold water (running under or immersion). The recommended and most commonly used first aid is cooling under running water. However, there were other scenarios, when parents used an inadequate treatment like applying toothpaste, turmeric, butter, egg. A few of these other aids were seen within this dataset, but numbers were tiny. For other forms of first aid not mentioned here, there were checkboxes and free text to write other applications of first aid.

Since clinicians accept cool water application as adequate, this was the focus of all the first aid methods used. The question had two options, where parents could state if running under tap/shower was used or immersion. Thus, of those children whose parents/carers reported using some form of first aid (i.e. 2455 cases), there were 1833 children (74.7%) whose parents applied cool running water or immersed the wound in cool water. 1440 (78.6%) of the 1833 cases had their wounds put under cool running water while the other 21.4% had theirs immersed in cool water.

### 5.3.4 Main Predictor variables

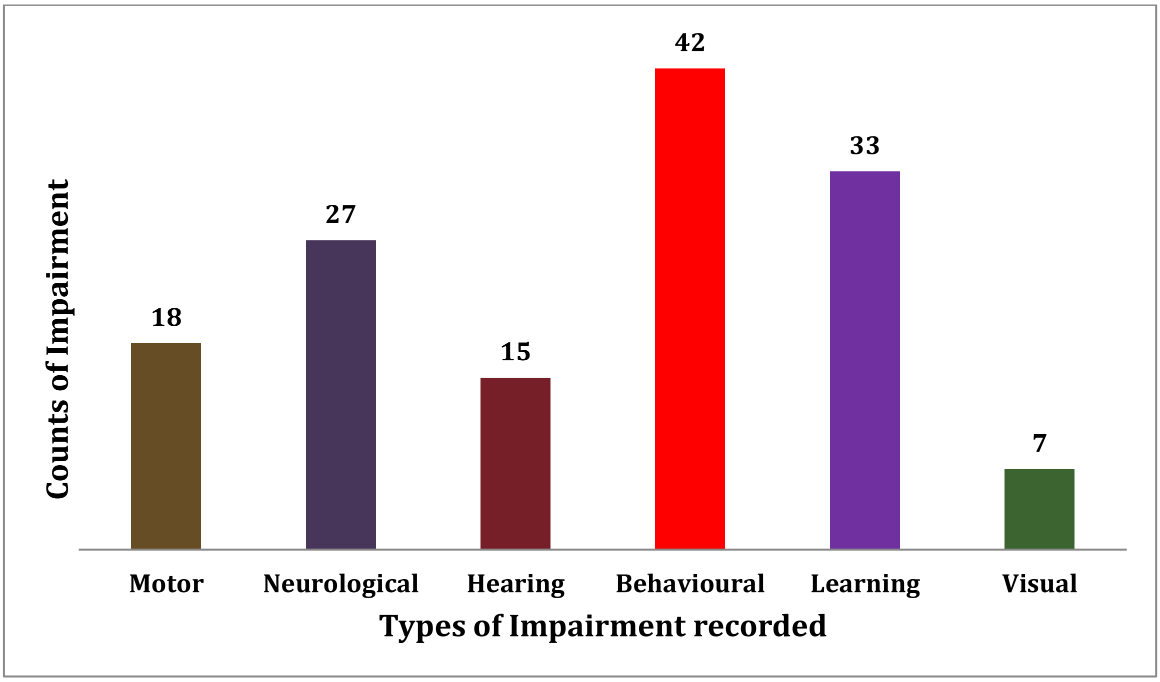
This subsection outlines the variables of interest that are the focus of the BaSAT analyses. They represent information regarding supervision and impairment.

#### 5.3.4.1 Pre-Injury Impairment

Parents/carers reported if the child with the burn event had any of the following impairments: motor, neurological, hearing, behavioural, learning and visual impairments. Parents could affirm multiple impairments if they felt their child had them

. This list of impairments describes broad categories that clinicians recognise and identify with as being easy to explain to attending parents/carers. Thus, parents selected what they believed their child had based on these explanations from clinical staff and diagnoses given by other doctors. The total number of impairments reported was 142, in 105 (3.8%) out of 2779 cases. Below is a chart (Fig.5.6), giving the numbers of each type of impairment:

**Figure 5-6: Under 16-year-olds' Details on Impairment Types in BaSAT 2012-2016**



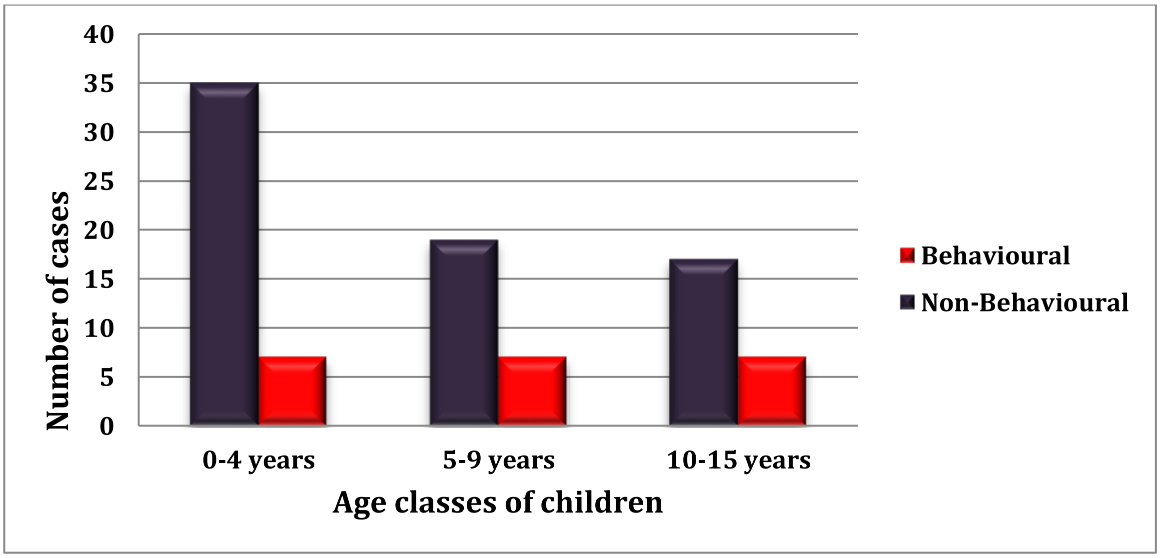

The above chart (fig. 5.6) shows that behavioural impairments were the most prevalent problems among children presenting with burn injuries, i.e. 42 (29.6%) out of 142 counts of impairment. This rank is closely followed by those with learning (23.2%) and neurological (19%) impairments, respectively.

For multivariable analyses, a dichotomous variable for impairment was made with two options: behavioural and non-behavioural. The latter would incorporate the remaining five individual categories as they all seem to be neurologically related. There were 92 (3.3%) out of the 2779 children that had single counts of impairments, and these were used in creating the dichotomous impairment variable.

##### *5.3.4.1.1 Age and Impairment*

This section outlines the relationship between the categorised ages and the type of impairment variable, as mentioned in the previous section. This relationship is relevant because some previous literature has reported that some children involved in burn events especially flame burns sometimes have behavioural impairments like ADHD (Badger *et al.*, 2008, Mangus *et al.*, 2004, Thomas *et al.*, 2004). However, other authors also mention that some children are undiagnosed with these conditions (as it may be difficult to do so if they are below five years old) until they are past the age of six years old. (Brehaut *et al* ., 2003, Cheak-Zamora and Farmer, 2015, Hutchings *et al.*, 2010, Mangus *et al.*, 2004, Merrill *et al.*, 2009). Thus, it is likely that the number of impairments listed may be more or have been misplaced based on parental assumptions. Level of completeness and "missingness" are the same as those outlined above for the age category. However, children that had missing data for age had no impairment.

**Figure 5-7: Under 16-year-olds' Details on Impairment by Age in BaSAT 2012-2016**




The above chart (Fig. 5.7) shows most of the children with recorded impairment belong to the 0-4-year-old group; the 5-9-year olds follow this and then the 10-15 years old. Thus, there seems to be a decrease in impairment numbers with increased age. Regarding impairment, most children seem to be in the non-behavioural impairment group than the behavioural. However, this may be different from the literature findings listed above because the non-behavioural group is made up of a mixture of 5 other defined impairments.

#### ***5.3.4.1.2 <u>Gender and Impairment</u>***

Gender differences in impaired children with burn events were investigated, as previous literature has established the existence of gender differences in burns. A few of these have shown that males with behavioural impairments were likely to experience burn events. Like age, the amount of complete and missing data for this relationship is the same as what has been presented above in gender.

However, a number of those with missing gender did present with impairment. There were gender differences observed within the data for impairment, with males having twice the number of either behavioural or non-behavioural impairment than females

##### *5.3.4.1.3* ***Burn Type and Impairment***

The relationship between burn type and impairment was examined because of previous literature. Some studies describe associations between children with behavioural impairments like ADHD and fire/flame burns due to such children having a fascination with playing with fire (Mangus *et al* ., 2004, Shai and Lupinacci, 2003, Street *et al* ., 2002, Vassilia *et al* ., 2004). Again, the amount of missing data here was the same as that for burn type described above. However, none of those with missing data for burn type had an impairment.

In summary, although there was evidence to suggest that scalds and non-scalds were more common in those with non-behavioural impairments compared to those with behavioural impairments, the differences were not statistically significant and may be due to chance.

#### 5.3.4.2 Supervision

The variables in point 1-4 below represent measures of supervision either as perceived by parents/witness and clinicians. Point 5 was a created variable that is based on the merging of the three variables describing a form of supervision. This newly derived variable named *overall supervision* was created to be used in the multivariable analyses as it is a fair balance of parental and clinical measures of adequate supervision derived for this thesis.

##### *5.3.4.2.1* ***Presence of another at the time of injury***

This binary variable was collected by ED staff asking parents/carers of the presenting child if there was anyone present at the time of the burn event. This information was 90.8% complete, i.e. 2522 out of 2779 cases. Most of the cases were reported to have the presence of another at the time of injury (78.8%).

##### *5.3.4.2.2* ***Who was present in the room at the time of Injury?***

ED staff specifically requested from parents/carers of injured children, the exact identity of who was present in the room with the child and the time of injury. The responses were individual questions within BaSAT. There were six options to choose from with this question. These were parents, siblings, grandparents, peers, other adult and others. Each option had complete data. Parents had the highest percentage of being the ones present with the child at the time of injury (62.3%). These numbers are below in Fig. 5.8.

**Figure 5-8: Under 16-year-olds' Details on Others Present at Injury in BaSAT 2012-2016**

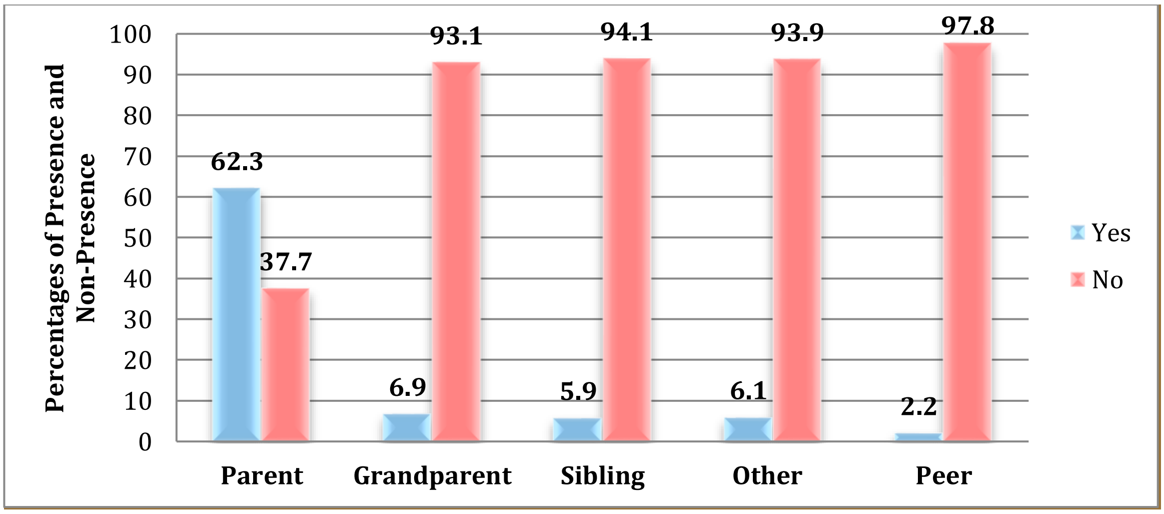



Figure 5.8 shows that parents were most likely to be present in the room when the burn event occurred with the child. Next in rank were grandparents (6.9%) and siblings (5.9%). The “other” category, as mentioned in previous sections, represents smaller different groups that may have been present, e.g. teachers, waiters and other relatives.

### *5.3.4.2.3 __Witnessing burn injury__*

This binary variable was collected by ED staff asking parents/carers of the presenting child if there was anyone who witnessed the burn event happen to the child. Data was 71.8% complete, i.e. 1994 out of 2779 cases had this question answered. Majority of cases with complete information were reported to have had someone witness the child getting the burn injury (84.2%), i.e. 1678 out of 1994 total cases who answered this question with a “Yes”.

#### ***5.3.4.2.4 Adult supervision at the time of injury***

This variable was collected by clinicians when examining the children with burns. The clinicians made a subjective judgement based on their prognosis of each case and the history surrounding the burn events (as told by parents/carers) whether there was adequate supervision. This variable was 84.3% complete, i.e. 2342 out of 2779 cases. Clinicians reported that the majority (91.3%) of the cases had no concerns with adequate adult supervision. In other words, 91.3% (2,138 out of the 2342 total cases) can be said to have had adequate supervision.

#### ***5.3.4.2.5 Overall supervision***

A derived variable was created for inferential analysis of the association between supervision and burn events in children under 16 years of age. The BaSAT dataset contains three proxy variables that could be used to measure supervision, namely: i) the presence of others at the time of injury, ii) if the injury was witnessed by those present and iii) the clinicians' subjective view of each case regarding the adequacy of supervision provided. All three were combined to form a "super" supervision variable that would take into consideration both the subjective views of parents/carers/witnesses and clinicians. All negative responses were coded as a 0 while all positive responses as a one amongst all the three measures of supervisions. A summed score of 0 across all three was tagged "worst supervision", a score of one was tagged "some supervision", a score of 2 was tagged "better supervision", and a score of 3 was tagged "best supervision". However, it became clear to dichotomise this new variable given lower numbers in some of the above categories. Therefore, categories with a score of 0, 1 and two were tagged as "suboptimal supervision" while those with a score of 3 were tagged as "optimal supervision".

This new variable was 66% complete, i.e. 1847 out of 2779 cases. Of the 1847 cases with complete information, only 392 (21.2%) had sub-optimal supervision. Of the 392 cases, 42 had sub-optimal supervision aged 6-15 years old. Of the 42 cases, 41 had someone present at the time of injury, 12 had someone witness it, and 28 had no clinical concerns on reporting to the hospital. There were no differences between age groups and level of overall supervision.

#### 5.3.4.2.5.1 ***All Supervision and Burn Type***

This comparison was carried out to determine if unsupervised children have certain types of burns compared to those that are unsupervised. The rationale was observations from previous literature surrounding parents of young children who were present and often witnessed the child getting injured from scalding agents (Natterer *et al.*, 2009, Schwebel and Kendrick, 2009, Saluja *et al.*, 2004, Morrongiello *et al*., 2006). The comparison within the BaSAT dataset will shed more light on if this is true for this population.  Data were complete for 1845 (66.4%) out of 2779 cases showing the relationship between the two variables. Below is a bar chart (Fig. 5.9) outlining the comparison with burn type (scalds versus non-scalds):

**Figure 5-9: Under 16-year-olds' Details on Burn Type by Supervision Level in BaSAT 2012-2016**

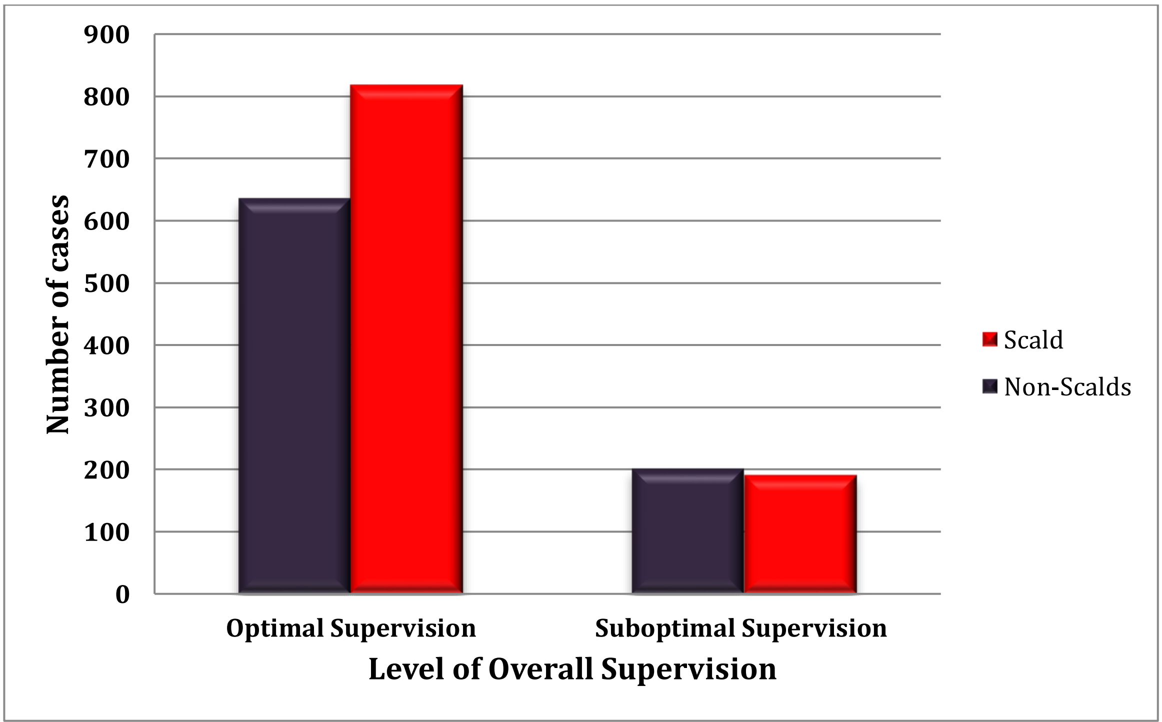



Figure 5.9 shows that children with “optimal” supervision had more injuries than those with “suboptimal” supervision. Furthermore, a more substantial number of those with optimal supervision had scalds. Children with suboptimal supervision had more non-scald injuries. These numbers suggest that parents/carers may be involved in behaviours that pose scald risks for children even under the most

diligent supervision, e.g. cooking, having a hot drink or meal while supervising. However, it could also reflect the fact that most of the cases here have more scalds or more optimal supervision.

### 5.3.5 Exploring Associations between Supervision, Domestic Violence, Social Worker History and Pre-Injury Impairment

This section sets to describe any associations between demographic variables like ethnicity, IMD, which maybe confounders, moderators, covariates or mediators in a burn injury model depending on the predictor variable of interest.

Variables that were significantly associated with the independent variable were used to adjust for the relationship with the dependent variable in the multivariable analyses (see conceptual diagrams below in Section 5.4.1). The associations were examined descriptively in the first instance via Chi-square and or Fisher Exact test (where appropriate). Statistical significance was set at the $p<0.05$. The numbers used to demonstrate these associations were the same used later for the multivariable analyses, i.e. the 1364 cases described in Fig. 5.1 above. The following associations were investigated:

#### 5.3.5.1 Ever have a social worker and all supervision

This relationship describes if there are any associations between current and past social workers and supervision. For current social workers and supervision, there were 920 (67.4%) out of the 1364 cases with complete data. Below is a table (Table 5.4) showing the cross-tabulation:

**Table 5-4 Cross-tabulation describing the relationship between Supervision and Current Social Worker (n=920)**

| | Current Social Worker | | | |
|---|---|---|---|---|
| **Supervision Level** | **Yes (%)** | **No (%)** | **Total** | **Chi-square (P-Value)** |
| **Suboptimal** | **9 (4.5)** | **192 (95.5)** | **201** | **0.14 (0.71)** |
| **Optimal** | **28 (3.9)** | **691 (96.1)** | **719** | |
| **Total** | **37 (4.0)** | **883 (96)** | **920** | |

For having a current social worker, the number of children with optimal supervision was greater than those with suboptimal supervision. However, there was no statistical significance between supervision levels in children and having a current social worker.

For past social workers and supervision, there were 904 (66.3%) out of the 1364 cases with complete data. Below is a table (Table 5.5) showing the cross-tabulation:

**Table 5-5: Cross tabulation describing the relationship between Supervision and Past Social Worker (n=904)**

| | **Current Past Worker** | | | |
|---|---|---|---|---|
| **Supervision Level** | **Yes (%)** | **No (%)** | **Total** | **Chi-square (P-Value)** |
| **Suboptimal** | **27 (13.6)** | **172 (86.4)** | **199** | **14.09 (P<0.001)** |
| **Optimal** | **40 (5.7)** | **665 (94.3)** | **705** | |
| **Total** | **67 (7.4)** | **837 (92.6)** | **904** | |

For having a past social worker, the number of children with optimal supervision was also more those with suboptimal supervision. However, there were statistically significant differences in the association between supervision levels in children and having a social worker in the past.

In all, this finding shows that these variables will be included when modelling the multivariable analyses for supervision (see conceptual diagrams in Section 5.4.1).

#### 5.3.5.2 <u>Ever reported domestic violence and all supervision</u>

This relationship describes if there are any associations between reported domestic violence in the home and supervision. There were 677 (49.6%) out of the 1364 cases with complete data. Below is a table **(Table 5.6)** showing the cross-tabulation:

**Table 5-6: Cross tabulation describing the relationship between Supervision and Reported Domestic Violence in the Home (n=677)**

| | Domestic Violence in the Home | | | |
|---|---|---|---|---|
| **Supervision Level** | **Yes (%)** | **No (%)** | **Total** | **Chi-square (P-Value)** |
| **Suboptimal** | **6 (4.3)** | **133 (95.7)** | **139** | **1.86 (0.17)** |
| **Optimal** | **12 (2.2)** | **526 (97.8)** | **538** | |
| **Total** | **18 (2.7)** | **659 (97.3)** | **677** | |

For domestic violence in the home, the number of children with optimal supervision was more those with suboptimal supervision. However, the association between supervision levels in children and the history of domestic violence in the home was not statistically significant.

This finding shows that domestic violence will be a co-variate when modelling the multivariable analyses for supervision.

#### 5.3.5.3 Ever had a social worker and impairment

This relationship describes if there are any associations between current and past social workers and pre-injury impairment.

For current social workers and impairment, there were 1179 (86.4%) out of the 1364 cases with complete data. Below is a table (Table 5.7) showing the cross-tabulation:

**Table 5-7: Cross tabulation describing the relationship between Current Social Worker and Impairment (n=1179)**

| | Behavioural and Non-Behavioural Impairment | | | | |
|---|---|---|---|---|---|
| **Current Social Worker** | **No Singular Impairment (%)** | **Behavioural (%)** | **Non-Behavioural (%)** | **Total** | **Fisher exact (P-value)** |
| **Yes** | **52 (83.8)** | **4 (6.5)** | **6 (9.7)** | **62** | **N/A(P<0.001)** |
| **No** | **1080 (96.7)** | **7 (0.6)** | **30 (2.7)** | **1117** | |
| **Total** | **1132 (96)** | **11 (0.9)** | **36 (3.1)** | **1179** | |

For children with impairments, the number of children with current social workers was greater than those with no current social workers. The associations between impairment status and having a current social worker was statistically significant. However, one should remember that by British law, disabled children have a disability social worker irrespective of suspicions of maltreatment. Thus, the few numbers attending EDs with burns must be interpreted with caution.

For past social workers and impairment, there were 1148 (84.1%) out of the 1364 cases with complete data. Below is a table (Table 5.8) showing the cross-tabulation:

**Table 5-8: Cross tabulation describing the relationship between Past Social Worker and Impairment (n=1148)**

| | Behavioural and Non-Behavioural Impairment | | | | |
|---|---|---|---|---|---|
| **Past Social Worker** | **No Singular Impairment (%)** | **Behavioural (%)** | **Non-Behavioural (%)** | **Total** | **Fisher exact (P-value)** |
| **Yes** | **86 (87.8)** | **4 (4.1)** | **8 (8.2)** | **98** | **N/A(P<0.001)** |
| **No** | **1019 (97.1)** | **6 (0.6)** | **25 (2.4)** | **1050** | |
| **Total** | **1105 (96.25)** | **10 (0.9)** | **33 (2.9)** | **1148** | |

For children with impairments, the number of children with past social workers was less than those with no past social workers. The association between impairment status and having a past social worker was statistically significant.

In all, these findings show that the effect of both current and past social worker will be adjusted for when modelling the multivariable analyses for impairment.

#### 5.3.5.4 <u>Ever reported domestic violence and impairment</u>

This relationship describes if there are any associations between reported domestic violence in the home and impairment. There were 845 (62%) out of the 1364 cases with complete data. Both impairment groups were combined because one of them had an empty cell. Below is a table (Table 5.9) showing the cross-tabulation:

**Table 5-9: Cross tabulation describing the relationship between Domestic Violence in the Home and Impairment (n=845)**

| | Any Defined Impairment | | | |
|---|---|---|---|---|
| **Domestic Violence in Home** | **No (%)** | **Yes (%)** | **Total** | **Fisher exact (P-value)** |
| **Yes** | **28 (96.6)** | **1 (3.4)** | **29** | **N/A(P=0.71)** |
| **No** | **786 (96.3)** | **30 (3.7)** | **816** | |
| **Total** | **814 (96.3)** | **31 (3.7)** | **845** | |

For children with defined impairments, the number of those with any domestic violence in the home were less than those with no such history in their home. However, there was no statistically significant association between defined impairment status in children and the history of domestic violence in the home.

This finding shows that domestic violence will be a co-variate when modelling the multivariable analyses for impairment.

### 5.3.6 Overall Supervision and Impairment

The relationship between all supervision and impairment was carried out to observe what the numbers show regarding impaired children and burn events if they were supervised or not. The data was like that described for the overall supervision variable in previous sections above, i.e. all complete and no missing information. Below is a bar chart (Fig 5.10) showing the differences in supervision levels among the impaired children:

**Figure 5-10: Under 16-year-olds' Details on Impairment Type by Supervision Level in BaSAT 2012-2016**

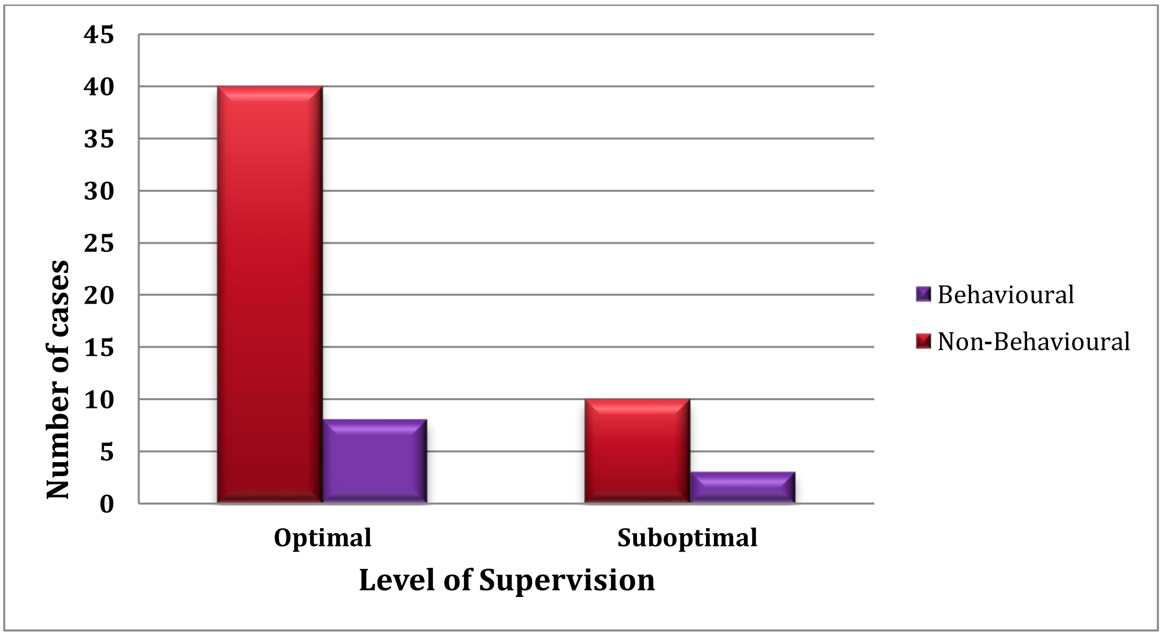



Figure 5.10 shows more numbers of impaired children had optimal supervision. This figure suggests that parents/carers give more optimal than suboptimal supervision for impaired children. These findings may suggest that the differences observed are down to the nature of the impairments themselves than the level of supervision.

## 5.4 Multivariable Analyses for BaSAT Data

These multivariable analyses used a complete case set of 1364 (49.1%) out of the 2779 cases used earlier. Chi-square tests were conducted using the MEDCALC online statistical software to check for significant differences between the numbers in each demographic variable used for analyses in the descriptive and multivariable datasets. There were no significant differences between the numbers of variables in both datasets. This phenomenon may be because the multivariable dataset is a subset of the descriptive dataset. Also, the percentage distribution of each variable across both datasets were quite similar for most of the variables.

The data for IMD was the same for both datasets since the IMD data was only calculated from the postcode of residence which became mandatory in the multivariable dataset (which is the most recent of the BaSAT data versions at the time these analyses was done). For more details, see the distribution of numbers by variable between the two datasets is depicted below in Table 5.10.

Unlike the HES dataset, the BaSAT dataset uniquely provides the type of burn injury. This variable has two options, as shown above in previous sections of this chapter into scald and non-scalds. This variable will serve as the primary outcome of the inferential analyses. Secondary outcomes include a dichotomised version of burn depth to measure severity, i.e. full-thickness versus non-full thickness burns as well as the application of cool water first aid, i.e. cool running water versus no cool running water.

The significant exposures of interest, as mentioned in previous sections and outlined in the conceptual diagrams below are pre-injury impairment and overall supervision. Other variables of interest will include categorised versions of ethnicity and IMD (these two variables act as a confounder/moderator/mediator in some of the conceptual diagrams but will also act as a secondary predictor of interest in answering some secondary research questions) to see what effect these have on burn outcomes mentioned above.

As with HES data, complete case series analyses (CCS) was also done on BaSAT data to see if missing data influenced the relationships between predictors and outcomes of interest. Given that CCS analyses are biased due to a reduction in sample size and loss of statistical power; resulting outputs from the all available data (AAD) analyses were presented where missing data were quite small, OR CCS analyses were not different from AAD analyses. Only analyses of the relationship between any defined impairment and cool running water (CRW) first aid, type of impairment and burn depth and ethnicity and burn depth, respectively, showed different CCS and AAD analyses. Thus, the analyses of these three relationships are present in their respective sub-sections (see sub-sections 5.5.2.1, 5.5.3.2 and 5.5.10 respectively). All other CCS analyses are in the Appendix for Chapter 5. This issue is discussed in Chapter 7 in the subsection on missing data.

**Table 5-10 Distribution of baseline demographic variables in the BaSAT samples used in the descriptive analysis (n=2779) and the multivariable analyses (n= 1364)**

| VARIABLES | NUMBERS IN DESCRIPTIVE DATASET [N=2779] (%) | NUMBERS IN MULTIVARIABLE DATASET [N=1364] (%) | P VALUES FROM CHI-SQUARE TEST COMPARING BOTH GROUPS |
|---|---|---|---|
| AGE | | | |
| 0-4 Years | 1944 (70%) | 970 (72%) | P =0.19 |
| 5-9 Years | 399 (14%) | 181 (13%) | P =0.38 |
| 10-15 Years | 422 (16%) | 202 (15%) | P =0.41 |
| SEX | | | |
| Male | 1510 (55%) | 731 (54%) | P =0.55 |
| Females | 1249 (45%) | 617 (46%) | P =0.55 |
| ETHNICITY | | | |
| White | 925 (76%) | 851 (76%) | P =1.00 |
| Mixed | 63 (5%) | 54 (5%) | P =1.00 |
| Asian/Asian British | 70 (6%) | 59 (5%) | P =0.29 |
| Black/Black British | 117 (10%) | 115 (11%) | P =0.43 |
| Other Ethnic | 41 (3%) | 38 (3%) | P =1.00 |
| LOCATION OF BURN EVENT | | | |
| Home based | 2206 (81%) | 1079 (81%) | P =1.00 |
| Non Home based | 513 (19%) | 254 (19%) | P =1.00 |
| IMD QUINTILES | | | |
| 1$^{st}$ Quintile (Least Deprived) | 160 (15%) | same as IMD data from this version | No comparison |
| 2$^{nd}$ Quintile | 116 (11%) | same as IMD data from this version | No comparison |
| 3$^{rd}$ Quintile | 148 (14%) | same as IMD data from this version | No comparison |
| 4$^{th}$ Quintile | 229 (21%) | same as IMD data from this version | No comparison |
| 5$^{th}$ Quintile (Most Deprived) | 432 (40%) | same as IMD data from this version | No comparison |

### 5.4.1 Conceptual Diagrams for BaSAT analyses

This section describes the conceptual diagrams that will inform the models used in the multivariable analyses of the BaSAT data. As the focus of the BaSAT data is on the effect of supervision and pre-injury impairment on having a thermal injury, burn severity or application of first aid; the conceptual diagrams below describe in minor detail within each diagram which category the variables fall under. The four conceptual diagrams described below are as follows:

1. Pre-injury impairment and burn type model
2. Pre-injury impairment and burn severity model
3. Supervision and burn type model
4. Supervision and burn severity model

**Figure 5-11: Pre-Injury Impairment and Burn Type Model**

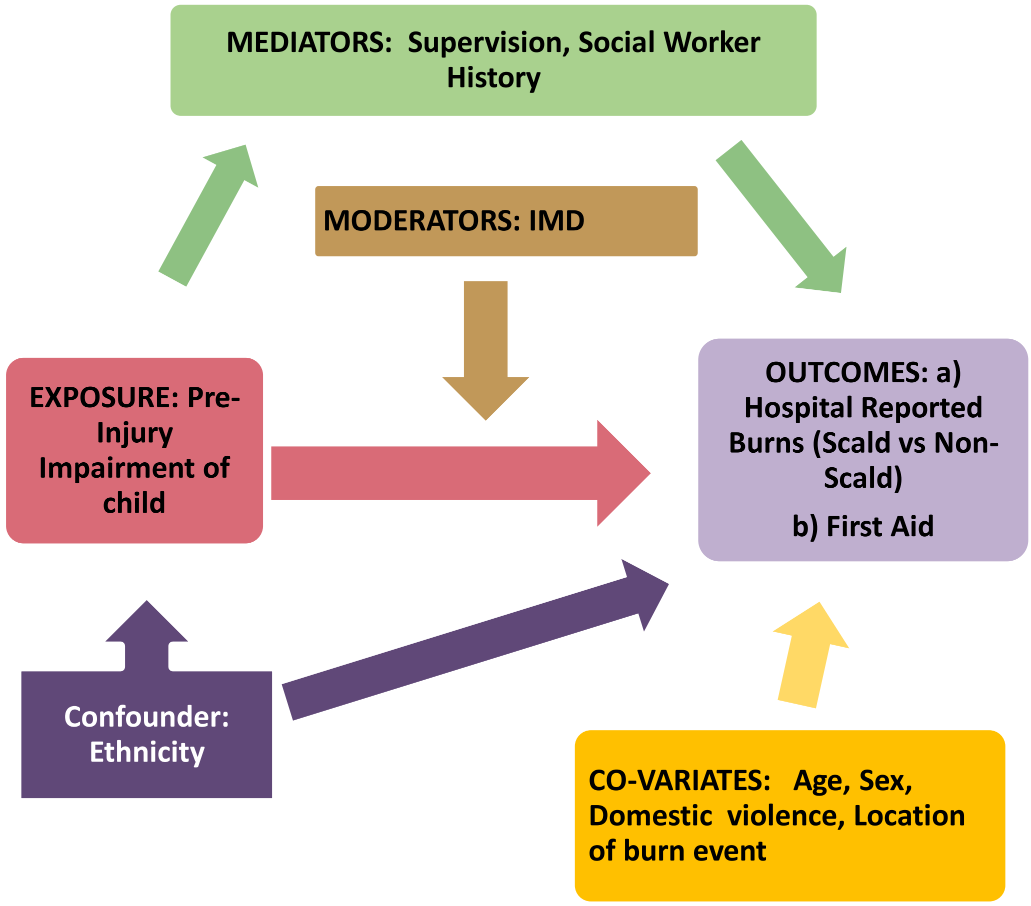


**Figure 5-12: Pre-injury impairment and burn severity model**

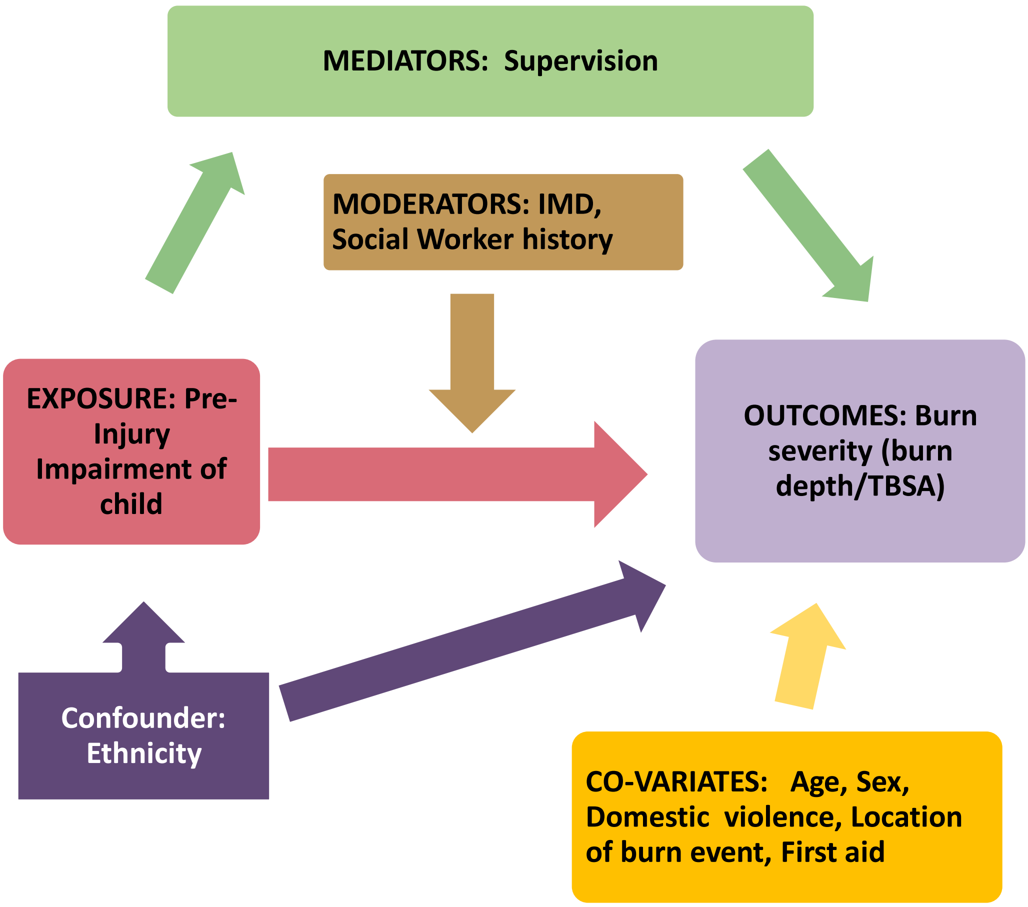


**Figure 5-13: Supervision and burn type model**

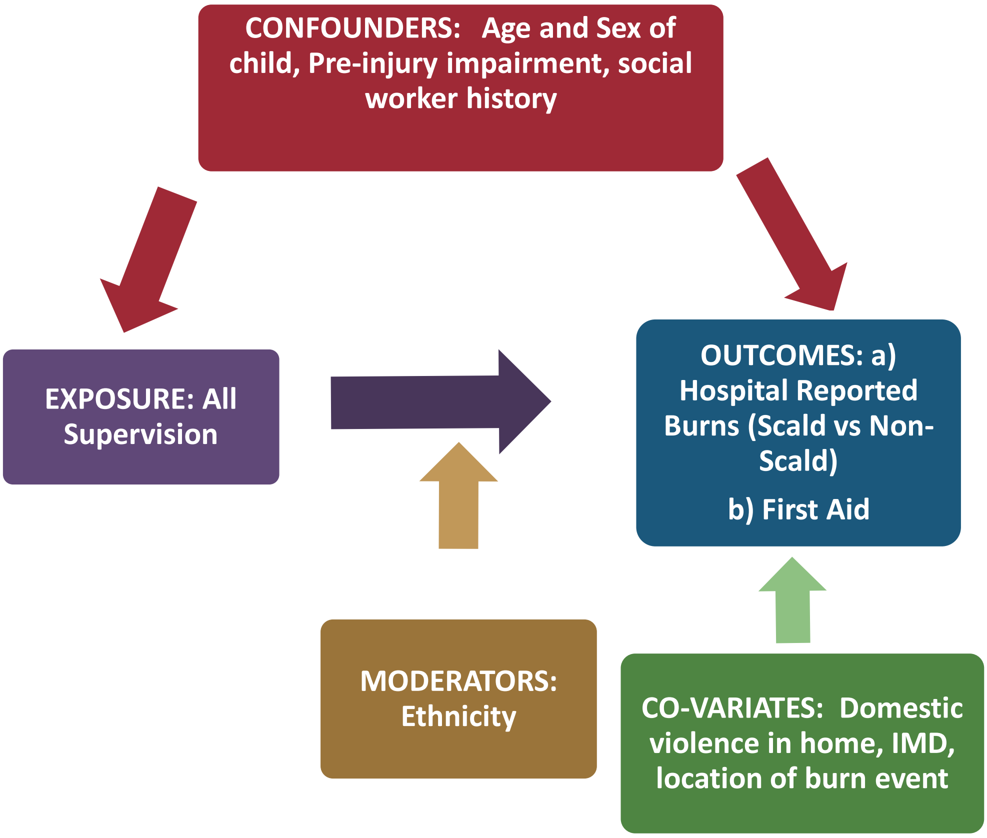
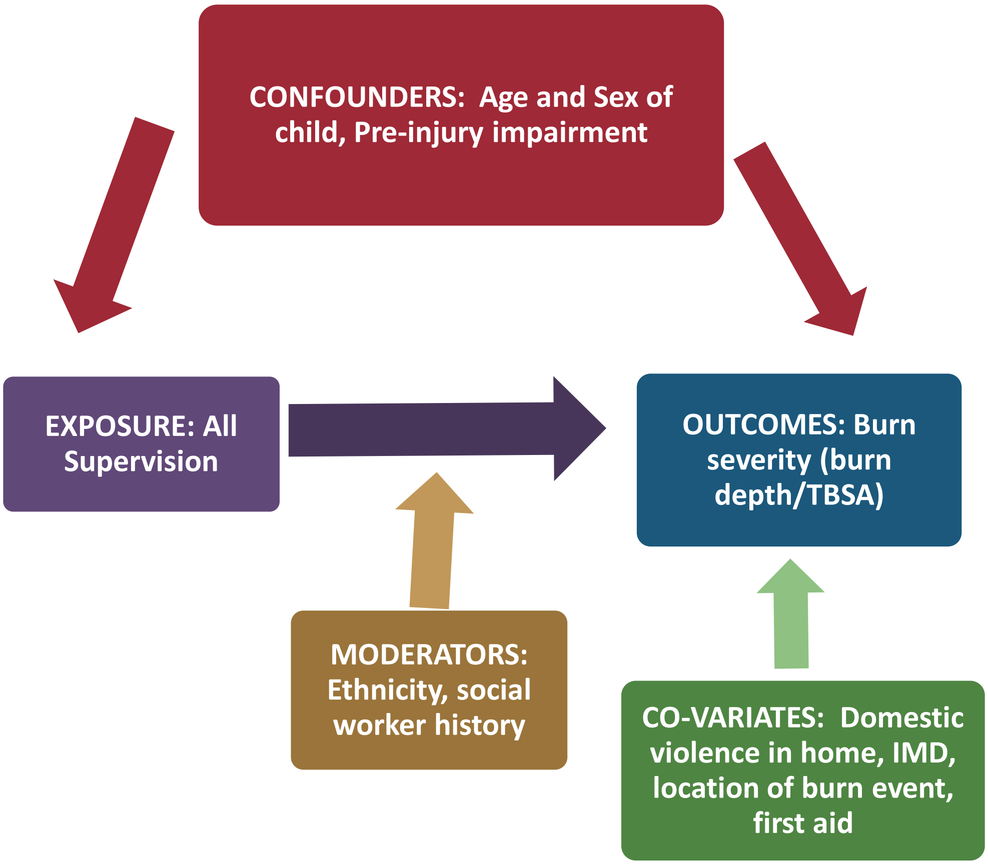


**Figure 5-14: Supervision and burn severity model**



## 5.5 Regression Analyses for BaSAT data

Each of the multivariable analyses will be summarised based on the research questions listed in the beginning sections of this chapter.

The results shown below compared the scald to non-scald cases as the primary outcome, with the burn's depth and first aid act as secondary outcomes. This section has been split into sub-sections to represent the analyses based on research questions. Within each section, tables are presented showing the unadjusted odds ratios and three adjusted models. These three adjusted models are:

1. Model 1: Unadjusted Odds Ratio (OR) + Individual Characteristics (Age, Sex, Impairment).

2. Model 2: Model 1 + Family Characteristics (e.g. Ethnicity, Domestic Violence in the home, Social Worker History, Overall Supervision).

3. Model 3: Model 2 + Environmental Characteristics (e.g. IMD and Location of burn event). Note the variables within each model will be interchanged based on what is the predictor of interest and which variable applies to the model as a confounder, mediator, moderator or co-variate as described by the conceptual diagrams above in section 5.4.1.

### 5.5.1 Research Question 1: Impairment versus No Impairment and Thermal Injury

Are children with impairments at higher risk of suffering scald versus non-scald?

#### 5.5.1.1 Any impairment and burn type

There were 1348 (98.8%) of 1364 cases with available information to show this relationship. The table (Table 5.11) below shows the relationship before and after adjustment for the necessary variables.

**Table 5-11: Multivariable Analyses showing the relationship between Any Defined Impairment and Burn Type (n=1348)**

| | Outcome Variable: Scalds (1) versus Non-Scalds (0) | | | |
|---|---|---|---|---|
| Predictor Variable: Any defined impairment | UNADJUSTED OR (95% CI) (n=1348) | MODEL 1* OR (95% CI) (n=1335) | MODEL 2* OR (95% CI) (n=567) | MODEL 3* OR (95% CI) (n=447) |
| No defined impairments (reference category) | 1 | 1 | 1 | 1 |
| With defined impairments | 1.16 (0.65-2.04) | 1.16 (0.65-2.07) | 0.89 (0.34-2.37) | 0.89 (0.30-2.61) |

*** Model 1 controls for individual factors (age and sex), Model 2 controls for family factors (Ethnicity, social worker history, overall supervision, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn Injury event).**

Table 5.11 further shows that before and after adjusting for individual, family and environmental factors, there was no association between having any defined impairment in children and having a scald compared to a non-scald. The confidence intervals of the odds ratios crossed one showing there was no relationship between children having a defined impairment and the type of burn injuries seen at ED.

### 5.5.1.2 Type of impairment and burn type

This relationship was examined to see if children with behavioural or non-behavioural impairment had differing odds of getting scald injuries compared to non-scald injuries. There were 1348 of 1364 (98.8%) cases in the multivariable dataset that had this information. There were no associations in children with a non-behavioural or behavioural impairment respectively attending EDs for a scald injury versus a non-scald. This ratio was before and after controlling for all individual, family and environmental factors. Below is a table (Table 5.12) showing the outputs for scald vs non-scald:

**Table 5-12 Multivariable Analyses showing the relationship between Type of Impairment and Burn Type (n=1348)**

| | Outcome Variable: Scalds (1) versus Non-scalds (0) | | | |
|---|---|---|---|---|
| **Predictor Variable: Type of Impairment** | **UNADJUSTED OR (95% CI) (n=1348)** | **MODEL 1* OR (95% CI) (n=1335)** | **MODEL 2* OR (95% CI) (n=1129)** | **MODEL 3* OR (95% CI) (n= 447)** |
| **No defined impairments (reference category)** | **1** | **1** | **1** | **1** |
| **Behaviourally Impaired** | **0.45 (0.14-1.52)** | **0.48 (0.14-1.63)** | **0.27 (0.03-2.59)** | **0.33 (0.03-3.35)** |
| **Non-behaviourally Impaired** | **1.56 (0.80-3.04)** | **1.53 (0.78-3.01)** | **1.27 (0.41-3.90)** | **1.23 (0.35-4.35)** |

***Model 1 controls for individual factors (Age and Sex), Model 2 controls for family factors (Ethnicity, Social Worker History, Overall supervision, Domestic Violence in the Home), Model 3 controls for environmental factors (IMD, Location of Burn Injury event).**

For Table 5.12, although the non-behavioural impaired children had higher odds ratios, the CI was wide and crossed 1, so overall no relationship could be confirmed between the type of impairment children had and type of burn injuries seen at ED.

## 5.5.2 Research Question 2: Impairment Vs No Impairment and CRW First Aid application

This question will be looking at differences in impaired and non-impaired children regarding the application of cool running water (CRW) first aid.

### 5.5.2.1 Any defined impairment and cool water first aid application

The information detailing this relationship was complete for all 1364 cases in the BaSAT dataset used for multivariable analysis. Below is a table (Table 5.12) outlining the odds ratios before and after adjusting for the necessary variables.

**Table 5-11 Multivariable Analyses showing the relationship between Any Defined Impairment and Cool Running Water First Aid Application (n=1364)**

| | Outcome Variable: CRW first aid applied (1) vs No CRW first aid (0) | | | |
|---|---|---|---|---|
| **Predictor Variable: Any defined impairment** | **UNADJUSTED OR (95% CI) (n=1364)** | **MODEL 1* OR (95% CI) (n=1344)** | **MODEL 2* OR (95% CI) (n=568)** | **MODEL 3* OR (95% CI) (n=447)** |
| **No defined impairments (reference category)** | **1** | **1** | **1** | **1** |
| **With defined impairments** | **0.65 (0.34-1.09)** | **0.68 (0.38-1.21)** | **0.32(0.11-0.88)** | **0.33 (0.10-1.02)** |

***Model 1 control for individual factors (age and sex), Model 2 controls for family factors (Ethnicity, social worker history, overall supervision, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

Table 5.13 shows that before and after adjusting for all individual, family and environmental factors, the relationship between the presence of a defined impairment in children and having CRW first aid applied post-injury was not statistically significant as the confidence intervals of the odds ratios crossed 1.

**Table 5-12 CCS Multivariable Analyses Showing Relationship between Any Defined Impairment and Cool Running Water First Aid Application (n=1364)**

| | Outcome Variable: CRW first aid applied (1) vs No CRW first aid (0) | | | |
|---|---|---|---|---|
| **Predictor Variable: Any defined impairment** | **UNADJUSTED OR (95% CI) (n=1364)** | **MODEL 1* OR (95% CI) (n=1344)** | **MODEL 2* OR (95% CI) (n=568)** | **MODEL 3* OR (95% CI) (n= 447)** |
| **No defined impairments (reference category)** | **1** | **1** | **1** | **1** |
| **With defined impairments** | **0.27 (0.09-0.82)** | **0.29 (0.09-0.90)** | **0.32 (0.10-1.01)** | **0.32 (0.10-1.02)** |

***Model 1 controls for individual factors (age and sex), Model 2 controls for family factors (Ethnicity, social worker history, overall supervision, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

Table 5.14 shows that CCS analyses differ from that of the AAD analyses. The unadjusted results and Model 1 results now showed that this relationship was statistically significant. However, the significance of this association disappeared after controlling for family and environmental factors.

#### 5.5.2.2 Type of impairment and cool running water (CRW) first aid application

Data detailing this relationship was complete for all 1364 cases in the BaSAT dataset used for multivariable analysis. Compared to children with no impairments, there was no association between children with non-behaviourally impairments and CRW first aid applied post-injury. However, for children with behavioural impairments, they were 0.3 times less likely to have CRW first aid applied post-injury, OR=0.26 (0.07-0.97). Below is a table (Table 5.14) outlining the odds ratios before and after adjusting for the necessary variables:

**Table 5-13: Multivariable Analyses showing the relationship between Type of Impairment and CRW First Aid Application (n=1364)**

| | Outcome Variable: CRW first aid applied (1) vs No CRW first aid (0) | | | |
|---|---|---|---|---|
| **Predictor Variable: Type of impairment** | **UNADJUSTED OR (95% CI) (n=1364)** | **MODEL 1* OR (95% CI) (n=1344)** | **MODEL 2* OR (95% CI) (n=1132)** | **MODEL 3* OR (95% CI) (n=442)** |
| **No defined impairments (reference category)** | **1** | **1** | **1** | **1** |
| **Behaviourally impaired** | **0.26 (0.07-0.97)** | **0.30 (0.08-1.15)** | **-** | **-** |
| **Non-behaviourally impaired** | **0.78 (0.41-1.50)** | **0.85 (0.44-1.63)** | **0.48 (0.16-1.46)** | **0.54 (0.16-1.90)** |

***Model 1 control for individual factors (Age and Sex), Model 2 controls for family factors (Ethnicity, Social Worker History, Overall supervision, Domestic Violence in the Home), Model 3 controls for environmental factors (IMD, Location of Burn Injury event).**

Table 5.15 shows that, after adjusting for all individual, family and environmental factors, there was no association between type of impairment and the application of CRW first-aid post burn injury.

## 5.5.3 Research Question 3: Impairment Vs No Impairment and Burn Depth

### 5.5.3.1 Any Defined Impairment and Burn Depth

This section outlines the relationship between children having any of the defined impairments and burn depth. The number of those with complete information was 1229 out of 1364 cases, i.e. 90.1%. Below is the table (Table 5.16) outlining this information before and after adjustment for the necessary variables:

**Table 5-14 Multivariable Analyses showing the relationship between Any Defined Impairment and Burn Depth (n=1229)**

| | Outcome Variable: Burn Depth (Full-thickness (1) versus non-full thickness (0)) | | | |
|---|---|---|---|---|
| **Predictor Variable: Any defined impairment** | **UNADJUSTED OR (95% CI) (n=1229)** | **MODEL 1* OR (95% CI) (n=1219)** | **MODEL 2* OR (95% CI) (n=440)** | **MODEL 3* OR (95% CI) (n=323)** |
| **No defined impairments (reference category)** | **1** | **1** | **1** | **1** |
| **With defined impairments** | **2.49 (0.95-6.56)** | **2.10 (0.78-5.64)** | **1.21 (0.12-11.85)** | **1.08(0.10-11.54)** |

***Model 1 control for individual factors (age and sex), Model 2 controls for family factors (Ethnicity, social worker history, overall supervision, and domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

Table 5.16 shows that compared to children with no impairment, there were no associations between any defined impairment and having deeper burns before and after adjustment for all individual, family and environmental factors. The confidence intervals of the odds ratios were wide and crossed 1, confirming a statistically insignificant relationship between children having a defined impairment and the depth of burn injuries.

### 5.5.3.2 Type of Impairment and Burn Depth

This analysis examines the relationship between behavioural or non-behavioural impairment and burns depth. Data were complete for 1229 (90.1%) of the 1364 cases detailing this relationship. Table 5.17 details the relationship between impairment type, before and after adjustment for the necessary variables.

**Table 5-15: Multivariable Analyses showing the relationship between Type of Impairment and Burn Depth (n=1229)**

| | Outcome Variable: Burn Depth (Full-thickness (1) versus non-full thickness (0)) | | | |
|---|---|---|---|---|
| Predictor Variable: Type of impairment | UNADJUSTED OR (95% CI) (n=1229) | MODEL 1* OR (95% CI) (n=1219) | MODEL 2* OR (95% CI) (n=429) | MODEL 3* OR (95% CI) (n=313) |
| No defined impairments (reference category) | 1 | 1 | 1 | 1 |
| Behaviourally impaired | 8.33 (2.10-33.0) | 5.76 (1.38-24.0) | 6.21 (0.44-86.8) | 4.28 (0.29-62.6) |
| Non-behaviourally impaired | 1.21 (0.28-5.19) | 1.10 (0.25-4.78) | - | - |

*** Model 1 control for individual factors (age and sex), Model 2 controls for family factors (Ethnicity, social worker history, overall supervision, and domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

Table 5.17 shows that children with behavioural impairments were eight times more likely to get severe burns than children with no defined impairments. This finding was statistically significant even after controlling for individual factors i.e. the odds ratio was reduced by 257%. However, after controlling for family and environmental factors, the odds ratios were further attenuated and lost statistical significance. The confidence intervals of the odds ratios were wide (suggesting small sample size) and crossed 1. It seems individual factors had the most impact on this relationship.

For children with non-behavioural impairment, there was no association with having deeper burns compared to children with no defined impairment. The confidence intervals of the odds ratios confirm a statistically insignificant (as they cross 1) relationship between children having a non-behavioural impairment and burn depth.

**Table 5-16 CCS multivariable Analyses Showing Relationship between Type of Impairment and Burn Depth (n=410)**

| | Outcome Variable: Burn Depth (Full-thickness (1) versus non-full thickness (0)) | | | |
|---|---|---|---|---|
| Predictor Variable: Type of impairment | UNADJUSTED<br>OR (95% CI)<br>(n=410) | MODEL 1*<br>OR (95% CI)<br>(n=350) | MODEL 2*<br>OR (95% CI)<br>(n=350) | MODEL 3*<br>OR (95% CI)<br>(n=309) |
| No defined impairments (reference category) | 1 | 1 | 1 | 1 |
| Behaviourally impaired | 9.33 (0.91-95.5) | 8.17 (0.59-112.6) | 6.59 (0.44-99.11) | 3.90 (0.26-57.8) |
| Non-behaviourally impaired | 1 | 1 | 1 | 1 |

*** Model 1 controls for individual factors (age and sex), Model 2 controls for family factors (Ethnicity, social worker history, overall supervision, and domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

In Table 5.18, CCS analyses now show all models lack statistical significance for this relationship because the numbers are small and the CI very wide. The CCS analyses do suggest there may be some bias due to missing data in the confounders/mediators/moderators affecting this relationship.

### 5.5.4 Research Question 4: Supervision Levels and Thermal Injury

This subsection seeks to describe the relationship between forms of supervision and the risk of having a scald versus a non-scald. Data for this relationship were complete for 940 (68.9%) of 1364 cases in this dataset. Despite the level of “missingness”, CCS and AAD analyses results were similar. Thus, AAD analyses were presented for supervision levels. Below is a table (Table 5.18) outlining the odds ratios before and after adjusting for the necessary variables:

**Table 5-17: Multivariable Analyses showing the relationship between Overall Supervision and Burns Type (n=940)**

| | Outcome Variable: Scalds (1) versus Non-scalds (0) | | | |
|---|---|---|---|---|
| **Predictor Variable: Overall supervision** | **UNADJUSTED**<br>**OR (95% CI) (n=940)** | **MODEL 1***<br>**OR (95% CI) (n=930)** | **MODEL 2***<br>**OR (95% CI) (n=567)** | **MODEL 3***<br>**OR (95% CI) (n=447)** |
| **Optimal supervision (reference category)** | **1** | **1** | **1** | **1** |
| **Suboptimal supervision** | **0.66 (0.49-0.90)** | **0.66 (0.48-0.91)** | **0.53 (0.34-0.81)** | **0.63 (0.39-1.03)** |

***Model 1 control for individual factors (Age, Sex and Impairment), Model 2 controls for family factors (Ethnicity, Social Worker History, Domestic Violence in the Home), Model 3 controls for environmental factors (IMD, Location of Burn Injury event).**

Table 5.19 shows that compared with children who had optimal supervision; those with suboptimal supervision had a reduced likelihood of having a scald. The unadjusted model shows that children with sub-optimal supervision are associated with a 34% (95% CI= 10% to 51%) decrease in scald injuries compared with those with optimal supervision. The table also shows that individual factors did not affect the relationship between supervision and burn type. However, family factors strengthened the odds ratios by 13%. This effect was then further attenuated after controlling for environmental factors. All odds ratios were statistically significant, except in Model 3 after controlling for all factors. In Model 3, the confidence intervals of the odds ratios depict cross 1 and so the association between supervision and type of injury may be due to chance. In all, family and environmental factors seem to have the biggest influences on this relationship.

### 5.5.5 Research Question 5: Supervision Levels and CRW First Aid

Data detailing this relationship was 100% complete for cases in this BaSAT dataset used for multivariable analysis. Below is a table (Table 5.19) outlining the odds ratios before and after adjusting for the necessary variables:

**Table 5-18 Multivariable Analyses showing the relationship between Overall Supervision and Cool Running Water First Aid Application (n=941)**

| | Outcome Variable: CRW first aid applied (1) vs No CRW first aid (0) | | | |
|---|---|---|---|---|
| Predictor Variable: Overall supervision | UNADJUSTED OR (95% CI) (n=941) | MODEL 1* OR (95% CI) (n=931) | MODEL 2* OR (95% CI) (n=567) | MODEL 3* OR (95% CI) (n=447) |
| Optimal supervision (reference category) | 1 | 1 | 1 | 1 |
| Suboptimal supervision | 0.58 (0.43-0.80) | 0.57 (0.42-0.79) | 0.60 (0.39-0.92) | 0.56 (0.34-0.90) |

***Model 1 controls for individual factors (age, sex and Impairment), Model 2 controls for family factors (Ethnicity, social worker history, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

Table 5.20 shows that children with suboptimal supervision were consistently less likely to have CRW first aid applied to their wounds post-injury than those with optimal supervision. The unadjusted model shows that children with suboptimal supervision are associated with a 42% (95% CI= 20% to 57%) decrease in CRW first aid application after burn injuries compared to those with optimal supervision. Even after adjusting for all individual, family and environmental factors, the adjusted model shows that children with suboptimal supervision are associated with a 44% (95% CI= 10% to 66%) decrease in CRW first aid application after burn injuries compared to those with optimal supervision. The confidence intervals were narrow and didn't cross 1, suggesting a significant relationship between the exposure and outcome. In all, family and environmental factors seem to have some effects after adjustment on this relationship i.e. a 2% decrease and 2% increase respectively in odds ratios.

## 5.5.6 Research Question 6: Supervision Levels and Burn Depth

This question examines the relationship between overall supervision and burns depth. Data on this relationship was in 888 (65.1%) of the 1364 cases of the multivariable BaSAT dataset. Below is a table (Table 5.21) detailing the relationship before and after adjustment for the necessary variables.

**Table 5-19: Multivariable Analyses showing the relationship between Overall Supervision and Burn Depth (n=888)**

| | **Outcome Variable: Burn Depth (Full-thickness (1) versus non-full thickness (0))** | | | |
|---|---|---|---|---|
| **Predictor Variable: Overall supervision** | **UNADJUSTED**<br>**OR (95% CI) (n=888)** | **MODEL 1*** <br>**OR (95% CI) (n=879)** | **MODEL 2*** <br>**OR (95% CI) (n=440)** | **MODEL 3*** <br>**OR (95% CI) (n=323)** |
| **Optimal supervision (reference category)** | **1** | **1** | **1** | **1** |
| **Suboptimal supervision** | **1.29 (0.64-2.63)** | **1.37(0.67-2.80)** | **1.59(0.54-4.69)** | **1.64(0.47-5.74)** |

***Model 1 controls for individual factors (age, sex and Impairment), Model 2 controls for family factors (Ethnicity, social worker history, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

Table 5.21 shows no association between children with suboptimal supervision and severe burns when compared to children with optimal supervision. The confidence intervals of the odds ratios show a statistically insignificant (as the CIs cross 1) relationship between children's supervision status and the level of burn depth.

## 5.5.7 Research Question 7: IMD and CRW First Aid

This relationship was examined based on a hypothesis that children dwelling in areas with more deprivation are less likely to have running cold water first aid applied to their wounds post-injury. There were 1088 (79.8%) out of 1364 cases with complete information describing this relationship. Below is a table (Table 5.22) outlining the odds ratios before and after adjusting for the necessary variables:

**Table 5-20: Multivariable Analyses showing the relationship between IMD and CRW First Aid Application (n=1088)**

| | Outcome Variable: CRW first aid applied (1) vs No CRW first aid (0) | | | |
|---|---|---|---|---|
| Predictor Variable: Index of Multiple Deprivation | UNADJUSTED<br>OR (95% CI) (n=1088) | MODEL 1*<br>OR (95% CI) (n=1072) | MODEL 2*<br>OR (95% CI) (n= 449) | MODEL 3*<br>OR (95% CI) (n=447) |
| Reference category: 1st Quintile | 1 | 1 | 1 | 1 |
| 2nd Quintile | 0.87 (0.54-1.42) | 0.82 (0.50-1.36) | 0.75 (0.34-1.65) | 0.69 (0.31-1.53) |
| 3rd Quintile | 0.98 (0.62-1.55) | 0.92 (0.57-1.47) | 0.64 (0.31-1.32) | 0.61 (0.29-1.26) |
| 4th Quintile | 0.73 (0.48-1.10) | 0.73 (0.48-1.11) | 0.65 (0.33-1.30) | 0.62 (0.31-1.24) |
| 5th Quintile | 0.60 (0.42-0.88) | 0.62 (0.42-0.90) | 0.45 (0.23-0.85) | 0.43 (0.22-0.81) |

***Model 1 controls for individual factors (Age, Sex and Impairment), Model 2 controls for family factors (Ethnicity, Social Worker History, Domestic Violence in the Home and Overall Supervision), and Model 3 controls for environmental factors (Location of Burn Injury event).**

Table 5.21 shows the odds ratios reduced as one moved up the deprivation quintile. Compared to children living in areas of the least deprived quintile (1st quintile), those in the most deprived quintile (5th quintile) are less likely to apply cold water first aid. The unadjusted model shows that children dwelling in the most deprivation are associated with a 40% (95% CI= 12% to 58%) decrease in CRW first aid application after burn injuries compared to those dwelling in areas with the least deprivation. The 5th quintile was the only one with an OR having a statistically significant relationship with CRW first aid before and after adjusting for all individual, family and environmental factors. The adjusted model shows that children dwelling in the most deprivation are associated with a 57% (95% CI= 19% to 78%) decrease in CRW first aid application after burn injuries compared to those dwelling in areas with the least deprivation. Environmental factors seem to have a substantial effect on this relationship, e.g. in the 5th quintile, the adjusted results were strengthened by 17%. However, for other quintiles, this effect may be due to chance as they showed statistically insignificant results (i.e. the CIs crossed 1).

### 5.5.8 Research Question 8: IMD and Burn Depth

This relationship was examined based on the hypothesis that children from more deprived quintiles may have more profound thermal injuries than those from less deprived quintiles. There were 1,002 (73.5%) out of 1364 cases with complete information describing this relationship. Below is a table (Table 5.23) outlining the odds ratios before and after adjusting for the necessary variables:

**Table 5-21: Multivariable Analyses showing the relationship between IMD and Burn Depth (n=1002)**

| | Outcome Variable: Burn Depth (Full-thickness (1) versus non-full thickness (0)) | | | |
|---|---|---|---|---|
| Predictor Variable: Index of Multiple Deprivation | UNADJUSTED<br>OR (95% CI) (n=1002) | MODEL 1*<br>OR (95% CI) (n=994) | MODEL 2*<br>OR (95% CI) (n=324) | MODEL 3*<br>OR (95% CI) (n=323) |
| Reference category: 1st Quintile | 1 | 1 | 1 | 1 |
| 2nd Quintile | 0.21 (0.05-0.97) | 0.23 (0.05-1.07) | - | - |
| 3rd Quintile | 0.25 (0.07-0.91) | 0.28 (0.08-1.04) | 0.66 (0.10-4.22) | 0.99 (0.13-7.56) |
| 4th Quintile | 0.58 (0.24-1.37) | 0.63 (0.26-1.52) | 0.76 (0.14-4.20) | 1.12 (0.17-7.49) |
| 5th Quintile | 0.75 (0.37-1.55) | 0.80 (0.39-1.66) | 1.27 (0.31-5.22) | 1.89 (0.37-9.62) |

***Model 1 controls for individual factors (age, sex and Impairment), Model 2 controls for family factors (Ethnicity, social worker history, domestic violence in the home), and Model 3 controls for environmental factors (Location of burn injury event).**

Table 5.23 shows unadjusted results that report an association across the 2nd and 3rd deprivation quintiles in getting a severe burn compared to children in the least deprived quintile. However, after adjustment for all individual, family and environmental factors, the odds ratios attenuated and lost statistical significance. The confidence intervals of the odds ratios confirm a statistically insignificant (as they crossed 1) relationship between IMD quintile and burn depth.

### 5.5.9 Research Question 9: Ethnicity and CRW First Aid

This relationship was examined to test a hypothesis that children from minority ethnic groups would have no CRW first aid applied to their burn wounds post-injury by their parents/carers. There were 1117 (81.9%) out of 1364 cases with complete information describing this relationship. Below is a table (Table 5.24) outlining the odds ratios before and after adjusting for the necessary variables:

**Table 5-22: Multivariable Analyses showing the relationship between Ethnicity and CRW First Aid Application (n=1117)**

| | **Outcome Variable: CRW first aid applied (1) vs No CRW first aid (0)** | | | |
|---|---|---|---|---|
| **Predictor Variable: Ethnicity** | **UNADJUSTED**<br>**OR (95% CI) (n=1117)** | **MODEL 1***<br>**OR (95% CI) (n=1105)** | **MODEL 2***<br>**OR (95% CI) (n=568)** | **MODEL 3***<br>**OR (95% CI) (n=447)** |
| **Reference category: White** | **1** | **1** | **1** | **1** |
| **Mixed** | **0.69 (0.41-1.18)** | **0.71 (0.41-1.22)** | **0.76 (0.37-1.58)** | **0.84 (0.34-2.04)** |
| **Asian/Asian British** | **0.69 (0.46-1.01)** | **0.68 (0.46-1.02)** | **1.80 (0.86-3.75)** | **1.44 (0.54-3.86)** |
| **Black/Black British** | **1.05 (0.60-1.83)** | **1.07 (0.61-1.89)** | **0.59 (0.24-1.46)** | **0.73 (0.22-2.41)** |
| **“Other” Ethnicity** | **0.99 (0.51-1.92)** | **1.00 (0.51-1.94)** | **8.53(1.09-66.63)** | **5.70 (0.68-48.09)** |

***Model 1 controls for individual factors (age, sex and Impairment), Model 2 controls for family factors (Social worker history, overall supervision, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

Table 5.24 shows that when compared with children of the white majority, those of ethnic minorities had no association in having CRW first aid applied after burn injury by parents/carers. The confidence intervals of the odds ratios were statistically insignificant (as they cross 1).

### 5.5.10 Research Question 10: Ethnicity and Burn Depth

This relationship was examined to see if there is an association between being of ethnic minority and having deeper burns. There were 1,019 (74.7%) out of

1,364 cases with complete information describing this relationship. Below is a table (Table 5.25) outlining the odds ratios before and after adjusting for the necessary variables:

**Table 5-23: Multivariable Analyses showing the relationship between Ethnicity and Burn Depth (n=1019)**

| | **Outcome Variable: Burn Depth (Full-thickness (1) versus non-full thickness (0))** | | | |
|---|---|---|---|---|
| **Predictor Variable: Ethnicity** | **UNADJUSTED**<br>**OR (95% CI) (n=1019)** | **MODEL 1***<br>**OR (95% CI) (n=1010)** | **MODEL 2***<br>**OR (95% CI) (n= 440)** | **MODEL 3***<br>**OR (95% CI) (n=323)** |
| **Reference category: White** | **1** | **1** | **1** | **1** |
| **Mixed** | **1.38 (0.48-3.99)** | **1.29 (0.44-3.79)** | | **-** |
| **Asian/Asian British** | **0.35 (0.08-1.47)** | **0.38 (0.09-1.61)** | **-** | **-** |
| **Black/Black British** | **1.53 (0.53-4.46)** | **1.88 (0.63-5.59)** | **-** | **-** |
| **“Other” Ethnicity** | **0.55 (0.07-4.17)** | **0.51 (0.07-3.87)** | **-** | **-** |

***Model 1 controls for individual factors (age, sex and Impairment), Model 2 controls for family factors (Social worker history, overall supervision, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

Table 5.25 shows no association between children being of minority ethnic status and having severe burns compared to children of the ethnic majority. The confidence intervals of the odds ratios confirm a statistically insignificant (as they were wide and crossed 1) relationship between ethnic minority status and having deep burns. Regression outputs were only available for unadjusted and model 1 results.

When CCS analyses were carried out, visible changes from the AAD analyses occurred. None of the models produced odds ratios as the relationship between ethnicity and burns depth showed collinearity in CCS analyses. (see AT 5.12 in Appendix for Chapter 5).

## 5.6 Summary

The results presented in this chapter demonstrate the socio-demographical risks associated with burn attendances in paediatric emergency departments in England and Wales. Key findings include:

1. There are lots of similarities with findings from HES, including larger proportions of males than females, as well as the overrepresentation of children from ethnic minority and deprived backgrounds.
2. Like HES, environmental factors play an important role in the risk of getting burn injuries and severe burns. However, this chapter has shown there is even a stronger effect of family factors on these risks.
3. The contributions of developmental impairment and supervision in the risk of getting any thermal injuries and of severe burns were explored. After adjusting for all individual, family and environmental factors, the only persisting association was between supervision levels and CRW first aid.
4. The following relationships were shown to be statistically significant after adjustment for individual, family and environmental factors:

4a) Children with suboptimal supervision were less likely to have cool running water first aid applied to their wounds post-injury compared to children with optimal supervision, OR=0.56 (0.34-0.90).

4b) Children in the 5$^{th}$ IMD quintile (the most deprived IMD quintile) were less likely to have cool running water first aid applied to their wounds post-injury compared to children from the least deprived quintile, OR=0.43 (0.22-0.81).

5. These findings further support results in Chapter 4 regarding the higher risk for children from the most deprived quintiles
6. These findings add to evidence that the health-seeking behaviour (first aid application) of parents/carers immediately after burn injuries in their children is less appropriate if they have shown

suboptimal supervision or are from deprived or ethnic minority backgrounds.

# **CHAPTER 6** : THE ROLE OF ETHNICITY IN HEALTH INEQUALITIES ASSOCIATED WITH CHILDREN'S BURNS

## 6.1 Background

This chapter will examine the role of ethnicity in health inequalities observed among children, and explore the evidence related to ethnicity and children's burns. The complex interrelation between ethnicity, deprivation and health outcomes will be explored. Where feasible, burn specific literature relating to children in the UK has been used to reference statements made in the text. Where not available, examples and references have been drawn from non-burn, adult or non-UK literature.

## 6.2 Definitions

### 6.2.1 Definitions of concepts around inequalities

The word '**Inequality**' means variability, difference or unevenness. The causes of health inequalities are complex and involve socio-economic or socio-demographical factors like income, geography, race, ethnicity, family and individual characteristics (Bhopal, 2014, Davidson (2015) and Marmot *et al.* (2010)). As such, health inequalities do not solely arise from financial factors (Davidson (2015), Galea (2017)). **Disparity** is a synonym for inequality (according to the Merriam-Webster Dictionary) and is mostly used in American literature interchangeably with inequality. This chapter will explore health inequalities in children across different ethnic groups.

Health inequalities illustrate differences in health experience or health outcomes between groups of people and they are often the result of social factors (Davidson (2015), LaVeist and Isaac, (2012)). However, health inequalities may also be the result of unfair issues or policies that impact disproportionately to one group of the population (**health inequity**) (Bhopal, 2014 and Marmot *et al.* (2010)).

**Acculturation** has several definitions and ways of being measured. In this research, the term is used in the context of ethnic groups finding themselves in a new host environment and describes how, through contact with the members and cultures of their host communities, their cultural practices change over time (Stronks *et al.* (2013). Within health research, length of stay or ability to speak the language of the host community may be used as a proxy for acculturation (Singh *et al.*, (2013) and Stronks *et al.* (2013)).

**Social dominance** derives from a theory posited by Sidanius and Pratto (1999) to explain hierarchies in social structures that are based on traits such as gender, race, age, economic status, and other characteristics. For example, in modern western society (and in the context of this chapter), the white male group tends to be dominant over minority ethnic groups. Social dominance can consequently influence the health experiences and outcomes of children including those in ethnic minority groups.

### 6.2.2 Definitions of race, ethnicity, indigenous status and nationality

Ethnicity can be classified in different ways, and these vary between populations (Bhopal (2014)). However, every classification system seems to be created from either racial origin, ethnic group or a mixture of both (Cheng and Goodman (2015)). The concept of race is a biological description of an individual mostly based on anthropological features (Chaturvedi (2001)). Individuals usually have one race, which is genetically determined. However, due to the miscegenation of races, some individuals may be classified as biracial or multiracial. An ethnic group is a sociological identity of people based on shared culture and similarities (Stronks *et al.*, 2013). An individual can belong to more than one ethnic group. However, due to globalisation, and migration, it has become increasingly difficult to restrict individuals to a specific ethnic group (Chaturvedi (2001), Cheng and Goodman (2015)). This reason is most familiar with people of “mixed” race or ethnicities that reflects the variations in their ancestry or inherited culture. A classic case study is Brazil, which is claimed to be one of the most racially diverse countries of the world. Brazil has had to refine their ethnicity classification systems over time to accommodate variations in race and ethnic groups either brought about by miscegenation or acculturation (HITA (2007), Paim *et al.*, (2011), Schmidt *et al.,* 2011). However, these classifications do not still account for every possible subtype because of societal perceptions of which group people believe they belong to (Chaturvedi (2001), Cheng and Goodman (2015)). Ethnic groups take time to become accepted or recognised, and this may depend on societal laws, culture, values and numbers, before any official recognition by governments of individual countries (Chaturvedi (2001), Cheng and Goodman (2015)).

Some countries utilise the concept of "nationality" instead when describing their ethnic profile. Nationality is often cited in studies from such regions as the "country of origin or birth" (Stronks *et al.,* 2013). This definition encapsulates a mixture of races and ethnicities. Nationality is a macro-level variable that does not account for the heterogeneity of peoples. Thus, one needs to remember that "ethnicity" and "nationality" do not mean the same thing.

Studies from the Scandinavian region, i.e. Sweden, Norway and Denmark, tend to use the parental nationality or country of birth to determine ethnicity. The children in these studies are either of Scandinavian or distant background. Some authors from these countries are beginning to classify ethnicity based on parental country of origin to distinguish the different ethnic groups within the "foreign background classification" (Hjern *et al.* (2001), Karimi *et al.* (2015)). It may take time for the recognition of some classifications as the numbers are initially not large enough to warrant an identity label. Also, countries in this region have more recently begun to see an influx of peoples with different backgrounds, in the 20th century compared to their other European or American counterparts that have had such migration for decades or even centuries (Karimi *et al.*, 2015). The disadvantage of using parental nationality is it does not account for parents that have switched nationalities (claiming Scandinavian citizenship over their native one), those with dual nationalities, or children and young people that would identify as Scandinavian born (Cheng and Goodman (2015), Stronks *et al.* (2013))

The identification of populations as “indigenous” may occur in health research publications from countries like Canada, Australia, New Zealand, Mexico and South Africa. This classification tends to group any native settlers of these regions even if they have distinct identities and irrespective of the size of the different groups of native settlers. Another reason for the extensive utilisation of this classification is that the concept of privilege associated with the ethnic majority does not work in all cases. This phenomenon is real for South Africa, where the majority is black, but they still have the worse health outcomes compared to the minority whites, or for Mexico, where the majority are a mixture of two or more races. The disadvantage of the classification (especially for a health researcher) is that it fails to account for the many inequalities between the individual ethnic groups that classify as indigenous and the majority group of that population (Cheng and Goodman (2015), Riedlinger *et al.* (2015), Saridi *et al.* (1997)).

#### 6.2.2.1 Challenges of collecting and recording ethnic group status

Self-reporting by participants is the recommended way of collecting ethnicity data. The classification criteria used by authors are sometimes based on personal observations, literature reviews, vital statistics records and censuses (Cheng and Goodman (2015); Cheng *et al.* (2016)). Ethnic data are collected in the NHS using the UK 2011 Census data categorisation of ethnicity (Garratt *et al.*, (2010) and HES (2016)). This classification has been replicated in several studies, and shown to be reliable (Brewster *et al.*, (2013) and Tan *et al.*, (2012)). However, many ethnicities are not currently included in census classifications, usually due to the relatively small size of that population. Also, it depends on how many migrate to the UK or other developed countries and dwell there (Cheng and Goodman (2015) Ekeus *et al. (*2004) and Toole *et al.* (2006)). Over time, this leads to changes in the ethnic profile of any country and these may not be reflected until the next census (Carlsson *et al. (*2006), Hjern *et al.* (2001[b]) and Toole *et al.* (2006). Thus, there may be some ethnicities that have not been taken into consideration during classification as individual groups and are merged into “Other” (Cheng and Goodman (2015), Dorling (1995) and Jack *et al.* (2006). In the UK, the “Other” ethnic category includes individuals that identify as Arab and other ethnic groups (retrieved from the free text in which individuals can describe their identity) that have not been classified in the major ethnic categories i.e. White, Asian, Black and Mixed, employed by the 2011 Census (ONS 2018 and ONS 2019). However, it is important to stress that these broad categories have as subgroups "Other White, Black, Asian and Mixed". The broad "Other" ethnic category doesn't refer to those sub-categories. ONS (2018) and ONS (2019) mention that the changes in demography may have an effect on ethnic categorisation in any future census, seeing that Arabs were added to the "Other" category in the 2011 Census, Gypsy/Irish Traveller were added to "other White" subcategory and the Chinese were taken out of "other Asian" and given their subcategory under the Asian category. Thus, the 2001 and 2011 Census data can't be directly compared due to these changes until they are adjusted. Gruer *et al.* (2018) report that this heterogeneity of the "Other" category has made its usage difficult in ethnic studies. Thus, over time, if numbers of component ethnic minorities within the "Other" category grow, they may be elevated to their independent category. The HES and BaSAT data used for this thesis follow the ethnic classification used in the UK 2011 census data.

Ethnic profiles of high-income nations of the world have changed over time due to colonisation, migration and globalisation, with an influx of people from low and middle-income countries (LMIC) and this may lead to changes in the social and health profile of the population (Bhopal (2014), Coleman (2013), Dorling (1995) and Whitmarsh (2008)). For instance, Markaki (2015) and Vargas-Silva and Rienzo (2017) report that non-UK born children and young people were more likely to be living in the West Midlands, East Midlands, and some parts of North West and London region than other regions of the UK.

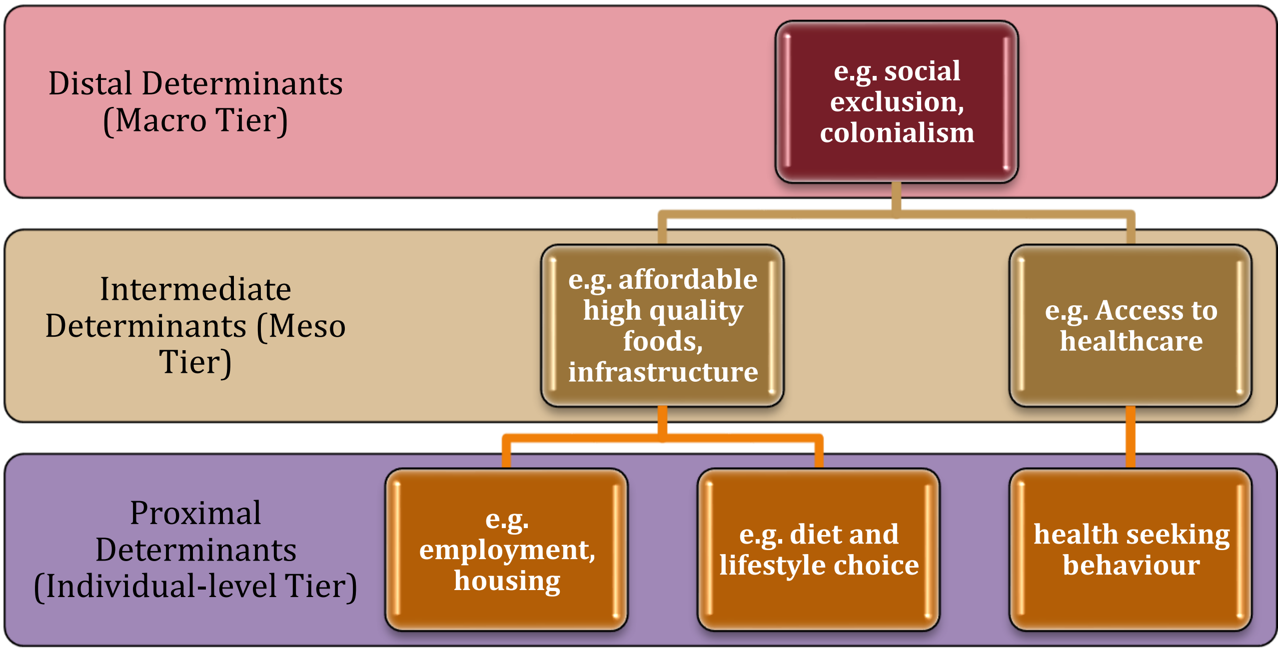
In all, ethnicity is a socially constructed concept. As a result, ethnic group categories should be expected to change with time (Dorling (1995). Researchers need to recognise this issue and work within the classification systems considered to be most appropriate at the time the data were collected. Also, there needs to be continued assurance that this information will always be used for "the public good" (Stronks *et al.*, 2013).

## 6.3 Framework for considering the determinants for ethnic minority health

This section will outline examples of two possible frameworks that show the complexities that influence ethnic minority health outcomes. One is a systemic model by Davidson (2015), while the other is a social model by Nitcher *et al.* (2009) showing the adoption or rejection of health behaviours using a named outcome (which can be adapted for use in issues around burn injury outcomes in children).

Davidson (2015) tries to group all the determinants responsible for ethnic inequalities in health into three tiers. These tiers are made up of macro, meso and individual level variables. Macro variables (also called distal determinants) are usually based on context and history, e.g. racism, xenophobia, ethnocentricity, colonialism, social exclusion and community governance/self-determination. Meso variables (also called intermediate determinants) are based on the community capacity and opportunities, e.g. high-quality food, access to healthcare and infrastructure. Individual-level variables (or proximal determinants) are based on personal choice and variables, e.g. individual income, housing condition, diet and lifestyle choices (Davidson (2015). These tiers all work together in a cycle to influence health outcomes.

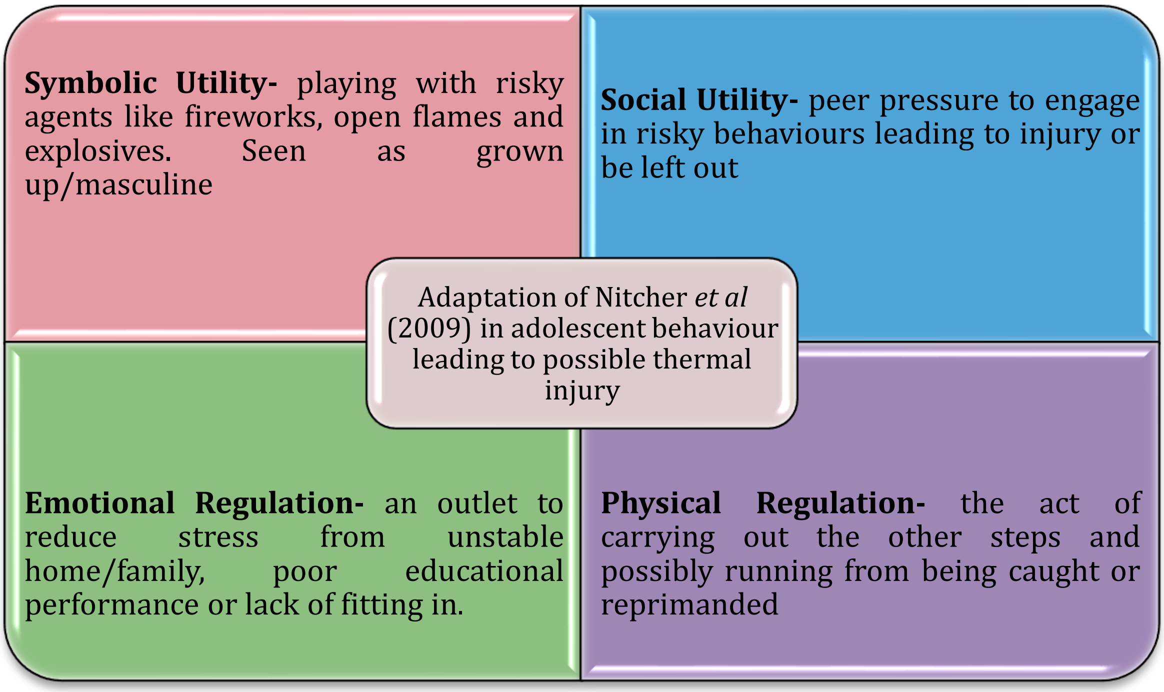
**Figure 6-1 Hierarchy of Determinants of Ethnic Minority Health (adapted from Davidson (2015))**




The social model of health behaviours described by Nichter *et al.* (2009) was developed to illustrate the multiple factors that made tobacco cessation interventions among men in India and Indonesia difficult. The authors were able to state four forms of utility that made men from these countries find quitting smoking difficult. These utilities were symbolic (men are considered more masculine, mature, sophisticated, assertive and so on if they smoke), social (facilitates social relationships, relaxation and work to leisure transitions), emotion regulation (seen as a stress reducer) and physical regulation (used as a stimulant to regulate physical functions from sleep to hunger and so on). Nichter *et al.* (2009) argue that for smoking cessation interventions to be successful and the inequalities to cease, each of these utilities needs to be addressed. However, this is something that needs to be done from different standpoints- from the individual to that of the family, the community, media and the government (Salant and Luaderdale (2003), Scrimshaw (2006)).

The Nitcher *et al.* (2009) model describes the cycles that influence an individual's behaviour (proximal determinants) and can, therefore, be viewed as a subset of the Davidson (2015) systemic framework. Based on reports from previous literature, an adaptation of Nitcher *et al.* (2009) model to why older children and young people may engage in risky behaviours leading to burn-injury outcomes is described below:

**Figure 6-2 Adaptation of Nitcher *et al*. (2009) describing the possible cycles for some behaviours that may lead to burn injury in older male children**




## 6.4 The context of culture and health inequalities

Inequalities in health outcomes (e.g. the increase or decrease of the risk of an injury or changing from unhealthy to healthy diets (Salant and Luaderdale (2003), Morello *et al.* (2012)) may be as a result of cultural norms for different ethnic groups (Lara *et al.* (2005) (Jayaweera (2014)). When culture impacts on health status or outcomes, we begin to have a crossover in which health inequalities occur across ethnic groups (Jayaweera (2014) and Lara *et al.* (2005)). The impact of the cultural norms is likely to partly depend on the context in which those cultural behaviours and practices are applied (Davidson (2015), Lara *et al.* (2005)). Thus, multiple factors built on the foundations of culture result in individual behaviour which leads to health inequalities across different ethnic groups (Salant and Luaderdale (2003), Davidson (2015) and Nichter *et al.* (2009)). These behaviours may be stereotypical for a group of people if they are accepted as a way of life (Davidson (2015), Nichter *et al.* (2009) and Lara *et al.* (2005)). For example, Nitcher *et al.* (2009) identified from their qualitative interviews with the Indian and Indonesian men in their study, the key points the men thought would help them cease smoking. These points included turning down smoking invitations while still keeping social networks alive, a call on the media to reduce advertising that glamorises or encourages smoking and turning medical advice to stop smoking from a "death sentence" to encouragement for healthier lifestyles (Nitcher *et al.*, 2009).

### 6.4.1 The association between race, ethnicity and health outcomes

Different racial groups have different risks of some adverse health outcomes. E.g. Caucasians have a higher risk of melanoma due to a lack of melanin in the skin (McMichael *et al.*, 2006), Afro-Caribbean males are at increased risk of prostate cancer (Dishman *et al.* (2004), and South Asians and Blacks have increased risks of heart disease and diabetes (Bradby and Chandola (2010), Dishman *et al.* (2004)). Children of people from these racial groups inherit these risks independently of their ethnicity. However, this isn't a direct relationship because there is an interplay between one's racial group and the environment that may influence the genes that are passed on to children (Whitmarsh, 2008).

Since ethnicity is a social construct, it may be possible to change social norms and behaviours to reduce health inequalities and poor health outcomes (Lara *et al.*, 2005). Changing behaviours though is very difficult (Galea (2017), Salant and Lauderdale (2003)). Examples, where cultural norms are strongly established but have adverse health outcomes, include female genital mutilation (FGM), cousin marriage in some Afro-Asiatic cultures, gender-based violence, or coming of age rights (Bhopal (2014), Donaldson and Scally (2009), Kaplan *et al.* 2011 cited in

Galea, 2017). These behaviours are modifiable and need not be handed down to future generations. However, this all depends on the “open-mindedness” of an individual, their family and the community (Galea, 2017, Nitcher *et al.* (2009)).

Gruer *et al.* (2018) explored inequalities in hospital admission in Scotland by ethnic groups. The authors found that Black/Black Scottish and Pakistani males, and African, Pakistani and Caribbean females were more likely to be admitted to hospital than White ethnic groups, even after adjusting for age, socioeconomic status, education and housing tenure. However, the study illustrated the unreliability of some hospital records in properly identifying and recording ethnic identity. In all, Gruer *et al.* (2018) conclude that use of health services will vary by country, migrant status, ethnicity and most importantly the outcome being assessed. All these should be taken into consideration before concluding the research findings.

### 6.4.2 Understanding social and cultural influences on health inequalities across ethnic groups

To better understand the cultural contexts of health it is necessary to consider two perspectives; the insider (i.e. how people attach meanings to things based on their cultural perspective) and the outsider (i.e. how people foreign to one culture approach or interpreted it without fully understanding how it operates) Scrimshaw (2006). Thus, to reduce health inequalities and improve outcomes for minority ethnic groups, health service providers need to understand the perspectives of service users (Donaldson and Scally (2009)).  For example, Donaldson and Scally (2009) report that in areas of Britain with high ethnic minority populations, there has been high perinatal mortality among minority women. These rates were associated with a variety of cultural and contextual factors including dietary practices, maternal or child illness, lack of interpreters, and failure of service providers to understand cultural and religious beliefs of service users. There can also be lack of trust and understanding on both sides; Van Ryn and Burke (2008) in a study on cardiac rehabilitation found physicians had stereotypical perceptions of ethnic minority patients who had poor treatment compliance and engagement. In contrast, Jackson *et al.* (2017) illustrated minority groups lack trust in health professionals in a study exploring immunisation uptake in Gypsy/Traveller communities in the UK. Factors compounding this mutual lack of understanding included frequent travelling, low levels of parental education and literacy, and having English as an additional language.

Ethnic group inequalities in health outcomes may also be as a result of hierarchical and structural unfairness, that set up individuals from ethnic minorities to have a greater risk of failure (LaVeist and Isaac (2012)). Davidson (2015) studying Aboriginal peoples in the US, Canada and Australia observed that low employment, poor nutrition, inadequate housing and overcrowding gave rise to alcoholism, family violence, heart and liver diseases, and suicide. Foods and diets traditionally eaten by indigenous groups (often relatively healthy) were either "phased out" for more Western-like diets through assimilation or were hard to maintain due to macro-level factors that restricted minority groups from purchasing or growing healthy or traditional foods, particularly observed if minority groups were placed in remote reserves (LaVeist and Isaac (2012), Lara *et al.* (2005)).

Chakraborty *et al.* (2013) described ethnic inequalities with psychosis in children and young people in the UK, with those from Black Caribbean families having an elevated risk of reporting schizophrenia. Lone parent homes, separation from parents and being raised in the foster care system or children's homes were reported as covariates in this relationship. In all, Donaldson and Scally (2009) and Jayaweera (2014) report that social exclusion and racial discrimination (even when perceived) are significant risk factors for mental health issues among ethnic minorities in the UK even when the socioeconomic status has been controlled for.

## 6.5 The role of migration, acculturation, social cohesion and co-existence on ethnic groups

In discussing the concept of ethnicity in health inequalities, it is essential to consider the role of migration and the relationships between the migrant and the native population. Vargas-Silva and Rienzo, (2017) state that the number of foreign-born people in the UK more than doubled (from 3.8 to 8.7 million, of which 52% are women) in 22 years (1993-2015), and that 8.9% of the total UK population were foreign-born citizens in 2015. Based on the 2011 UK Census, two-thirds of the 16-25 immigrant population came from India, China and the EU accession countries from 2007-2011, compared to a quarter that came from Jamaica and South Africa (Markaki and Sumption 2016). In the UK, among people who are not the UK born, the most common country of birth and nationality is currently Poland (Vargas-Silva and Rienzo, 2017). Migration can occur for a host of reasons, e.g. consequence of wars with some migrants seeking refuge or a new life, or governmental policies to improve the workforce and economy (Markaki and Sumption (2016). Over time, this may lead to issues of integration between the native and the migrant. For example, Bhopal (2014) states that over time, if a migrant decides to settle in a new-found land and become a citizen, the progeny of such migrants and future descendants are often not recognised as natives by the indigent population but are still associated with their ancestry. Coleman (2013) reports that in 2010, 10-20% of the population of Western European countries were identified as people of “immigrant origin” even though they were a second or third generation born.

Blinder *et al.* (2011) studied public opinion on immigration and discovered that there was a public misunderstanding of who classifies as an immigrant based on official policies. Some of the UK public believe that asylum seekers constituted the largest portion of immigrants (actually students are, and asylum seekers are the smallest group) and that non-EU immigration was more than EU immigration (which was the other way round especially for low skilled workers). In all, Blinder *et al.* (2011) reported that 57% of their interviewees called for a reduction in permanent immigration while 47% called for a reduction in temporary migration. Such moves may only strain relations by making social cohesion and understanding of the ethnic differences in developed countries more difficult (Bhopal, 2014, Lara *et al.* (2005)). For instance, Zoni *et al.* (2018) reported the risk of injury among adult immigrants compared to native Spaniards in primary care facilities in Spain. The risk was highest for North Africans, followed by Sub-Saharan Africans. However, other immigrants had lower rates (Asian/Oceanic immigrants had lower risk than native Spaniards) after controlling for age and socioeconomic status. Zoni *et al.* (2018) state that a likely explanation is that migrants tend not to engage in high risk-taking behaviours and sporting activities that increase the likelihood of injury compared to the native population. Zoni *et al.* (2018) also highlight the risk of underestimation of true injury incidence, due to undocumented migrants who are denied access to universal healthcare due to migration policies (e.g. the Royal Decree16 of 2012).

Acculturation involves acquiring cultural elements of the dominant society migrants may find themselves in, through all means of life (e.g. food to language and so on) needed to assimilate and survive (Jayaweera (2014), Lara *et al.*, (2005)). Over time, social theorists and anthropologists recognised that cultural influences are not only in one direction, i.e. in favour of the majority culture and posited that the majority culture could also develop based on the influence of the immigrant culture. (Lara *et al.* (2005), Scrimshaw (2006)). Thus, two-way theories of acculturation began to spring up (bidimensional acculturation), where the dominant culture learns from others and vice versa, or the native learns from the immigrant and vice versa (Lara *et al.*, 2005, Salant and Luaderdale (2003)). Lara *et al.* (2005) identify four states of bidimensional acculturation. First, assimilation- the native or migrant accepts the new culture wholeheartedly and abandons their original culture. Secondly, separation when the individual maintains their original culture by rejecting or avoiding the new culture. Thirdly, integration, when the individual accepts and values both cultures (evenly or unevenly) and finally, marginalisation when the individual is excluded or alienates (by choice or not) from both their original and new cultures. For example, Bhopal (2014) and Jayaweera (2014) states that new migrants in usually industrialised and wealthy countries may face culture shock and intense pressure to engage in unhealthy lifestyles like drinking and smoking or switching to diets that may be high in fat or energy to fit into their adopted society. Morello *et al.* (2012) did a study which showed that reduced parental acculturation among immigrant Hispanic families in the US was associated with higher consumption of fruits by their children compared to children of other families that had shown higher parental acculturation to the high fat and energy foods predominant in the US industry. This finding was significant even after adjusting for socio-demographical factors like parental BMI, country of birth, educational status, and family income.

The extent to which an individual may stick to a certain way of life can be explained by a biosocial model that is akin to Dahlgren and Whitehead's model of the determinants of health: i.e. the individuals themselves, their family background and the environment they live in (Davidson (2015), Lara *et al.*, 2005, Salant and Luaderdale (2003)). Within this model, ethnic inequities may exacerbate inequalities (Bhopal (2014), LaVeist and Wallace (2002) and LaVeist and Isaac (2012)). For example, Markaki and Sumption (2016) stated that in 2014 on average, young foreign-born workers were more likely to be employed in low skill level jobs than their UK counterparts despite the former having more likelihood of a degree than the latter. This hierarchical system also presents a very interesting case for the intertwining of race, gender, class and culture. For example, the experiences of health and wellbeing among ethnic minority women are often worse than their male counterparts and overall, worse than the White majority in the developed countries they reside (Letherby (2010), Williams and Collins (1995).

## 6.6 Policies and issues that influence the wellbeing of children

Marmot and Bell's (2012) concept of proportionate universalism seeks to reduce inequality gaps among different population groups by ensuring not only every group gets an equal distribution of resources to function at an acceptable standard that indicates good quality of life, but also suggests more resources should be put into those who have an elevated risk for worst outcomes. This approach promotes equity across all the population groups. It is important to note that this concept captures the goal of equality and equity, such that the most well-off groups don't become lower in standards if all the attention and resources are only given to the worst groups of the population. (Bhopal (2014), Davidson (2015)).

Reducing inequalities in children will not be achieved unless one addresses the inequalities their parents/carers regularly face (Marmot *et al.* (2010), Murray (2003) and Lovasi *et al.* (2009)). For example, there is an inequality in school attainment by ethnic group with minority groups less likely to attain GCSEs than majority groups, but this inequality can only begin to be addressed through universal access to preschool education (Bradby and Chandola (2010) and Davidson (2015)).

In most developed countries of the world, the welfare of a child is highly valued. Children are not expected to care for themselves at such a vulnerable life stage (RCPCH, 2017). Their focus is to develop their talents and abilities to the very best as they approach adulthood and independence. Sadly, many children worldwide may not have a protective umbrella to reach adulthood safely. Due to circumstances of life received from parents, carers or governments or other sources, some children are at a greater disadvantage because of issues like poverty, disability, being in need and having to grow up early (Kendrick *et al.* (2005), RCPCH, 2017). For this group of children, survival to adulthood may not equate to a good quality of life for some, and there is the likelihood of a transgenerational transfer of their bad experiences and outcomes to their descendants (Galea, 2017, Marmot *et al.* (2010)). Also, having experienced some adversity, ending the cycle of poverty and making healthy lifestyle choices may be difficult (Bell and Machin, 2013). These issues show how difficult it is to narrow health inequalities along the life course, a task that requires individuals and governments to work together to effect change over long periods. In the UK context, Davidson (2015) cites the 2011 Fawcett Society report which states how the reduction of the working tax credit and its child care component- both of which have been very helpful to low income and single parent families- worsened poverty levels in this group.  Also, in a bid to keep children and young people safe from racial abuse and harm, the UK government also instituted several social policies, e.g. the Race Relations (Amendment) Act 2000 (Bhopal, 2014). Such actions assure the general public that their government is actively seeking to improve their services and the welfare of its citizens by maintaining fairness.

With increasing rates of globalisation and travel, it is essential that ethnic minority records, culture and patterning are researched so that recent migrants and those with uncertain status, e.g. travellers or undocumented immigrants are not excluded (Bradby and Chandola, (2010), Bhopal (2014) and Mendoza *et al.* (2019)). Coleman (2013) and the Migration Observatory (2018) also report concerns of current affairs issues (such as Brexit or the Windrush scandal) setting back the achievements of civil right movements, researchers and clinicians in pushing for recognition and fair treatment of ethnic minorities in the UK. Unless ethnic group status is recorded, researchers cannot explore this element of inequalities in child health or the impact of interventions to reduce inequalities in child health by ethnic group. However, there are many reasons why the ethnic group may not be recorded, e.g. because it is not asked for, or because it is not disclosed for fear of stigma or prejudice (Stronks *et al.*, 2013).

## 6.7 Ethnicity and burns

### 6.7.1 Inequalities by ethnicity

#### 6.7.1.1 The strength of evidence:

The literature review on paediatric burns described in Chapter 2 found 25.8% of papers (32/124 studies) investigated the association between ethnicity and burns (See Appendices for CASP tool tables (AS 2.3), Table of Methods (AT 2.7) and Table of Results (AT 2.8)). These studies describe the proportion of burn injuries in minority ethnic or indigenous groups compared to the ethnic majority in their respective populations.

The specific aim of 9 of the 32 (28.1%) papers was to examine the association between ethnicity and burn injury. Six of these nine papers were from the USA; 1 each was from Sweden, the UK and a multi-regional study. The remaining 23 papers had ethnicity included as a covariate. All 32 papers demonstrated inequality in burn risk, with children from minority ethnic groups associated with increased burn risk (see Table of Results (AT 2.8)). This association was consistent across the studies and was independent of ranking in study design, study quality, settings or populations.

The different papers used different concepts of ethnicity including racial classifications, indigenous status or nationality status. These terms will be collectively described as "ethnicity" from this point.

This body of evidence showing associations between family ethnicity and burn risk to children can be criticised on several grounds: representativeness, measurement bias, study design and missing data

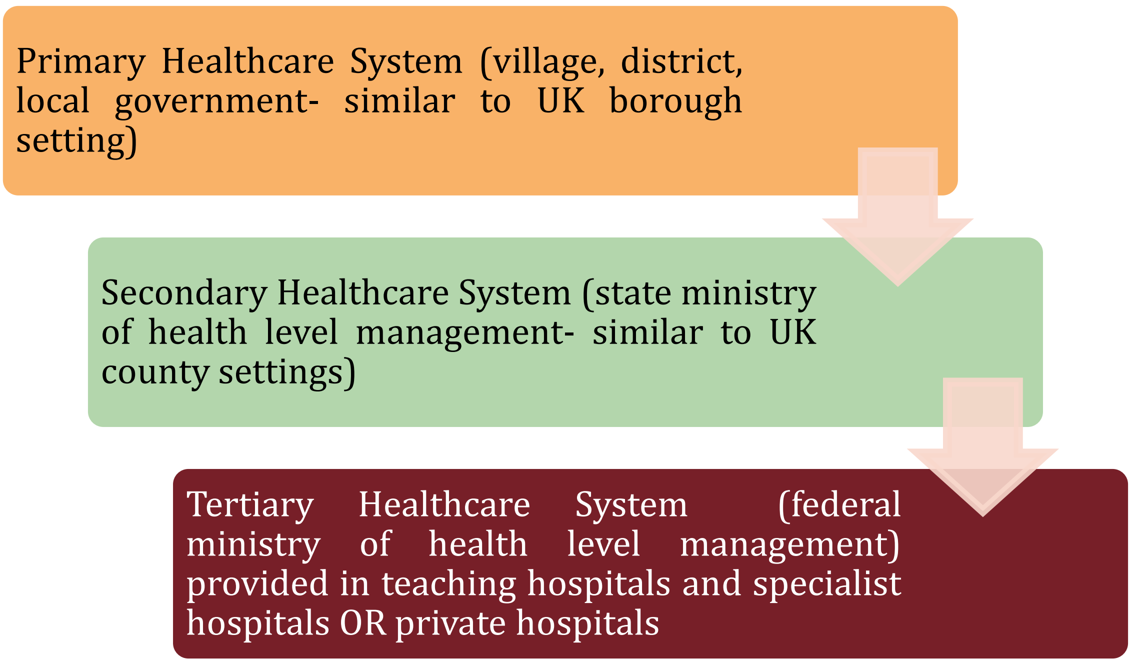
#### 6.7.1.2 Representativeness:

Overall, most papers with ethnicity data were from the USA (15 studies), then Australasia (5 studies) and Sweden (3 studies). Two each were from the UK, Greece and Canada while one each was from Norway, Ireland and multi-regional. Fourteen of the 32 (43.8%) studies used data mostly derived from hospitals. Six of the 32 (18.8%) studies had a mixture of data sources like censuses, vital statistics, health centre, hospitals, consumer data and transport registries. Five of the 32 (15.6%) studies used burn centre data only. The other seven studies each used data from only population surveys, fire department, trauma registry, vital statistics, burn registry and health insurance respectively. Based on these numbers, 1 (3.1%) of the 32 studies may have questionable internal validity since the data were not originally intended for burn injury research. Of the fourteen studies that used only hospital data, five (35.7%) were based on data from a single hospital. Six studies were on several hospitals in their region of interest. The remaining five studies each used data from 2,784 hospitals, 91 hospitals, five hospitals, four hospitals and two hospitals respectively. Four of the 14 hospital-based studies carried out data linkage to other population-wide databases within the regions of study. These data-linked studies were also part of the five that used several hospitals. Sixteen of the 32 (50%) studies were reported by their authors to be representative of their general population of interest. These studies may, therefore, be considered to demonstrate good external validity, in that their findings relating to medically reported burns may be generalisable to the wider population from which their samples were drawn.

Measures of the frequency of burns in people from ethnic minorities may vary due to several reasons relating to their access to, and use of, health services. Studies investigating ethnicity and burns using hospital–derived samples may give conflicting results because of variable use of services and access issues (Shavers (2007), Tan *et al.* (2012), Karimi *et al.* (2015)). For example, ethnic minorities may over-present at hospitals for treatment rather than go to the GP for non-urgent conditions due to lack of awareness of the primary healthcare system especially if they are recent migrants. Conversely, they may fail to present to the hospital if they have limited spoken or reading English. This behaviour may be because the health system structure differs in their country of origin. For example, in some African countries, some citizens seek healthcare from hospitals (public or private), often within specialist clinics, e.g. obstetrics and gynaecology, nephrology, oncology, visual and dental care. Others bypass primary healthcare facilities (if existent) and go directly to hospital. This issue often happens if such primary healthcare facilities are understaffed, underfunded or are lacking recording/surveillance systems and the necessary infrastructure needed for treatment (Welcome, 2011). Unfortunately, these inadequacies may be due to poor management, corruption or lack of financial support from native governements to support or improve the healthcare system (Welcome, 2011). As a result, citizens attend private hospital where they pay for their treatment or do so via medical insurance provided as part of a work/pensions package (Welcome, 2011).

Welcome (2011) gives a brief insight into the Nigerian health system which is shown in the diagram below. The healthcare system was built on ancient patterns of referral that took into account socioeconomic development of an area and government tier administration systems across the country. “Primary health care” is often the first point of contact in the lowest tier as shown in the diagram below. They are often not equipped for difficult cases and thus such cases are “referred to secondary health care”. This action is the first level of “specialty services” and is available at different divisions within the state government. These “secondary health care systems” may have intermeidate level laboratories, diagnostic services and rehabilitation, etc. If the cases presenting in such facilities are beyond their capabilities, then the patient is referred to "tertiary healthcare system" where they are expected to have the full range of services needed for treatment. The federal government is in charge of this tertiary systeem. However, this is largely in collaboration with voluntary and nongovernmental organizations (domestic or foreign) or private practices dispersed around different parts of the country. As a result, if a patient is located in an area with the "primary healthcare system" and knows of this "referral process" and the associated difficulties, they end up going straight to the tertiary system where they are bound to end up. Thus, given the health system climate in Nigeria, this action is not rare. Those who cant afford going through the process may end up seeking "alternate" sources of treatment which may be unsafe e.g herbal concotions that are untested/unapproved. In all, Welcome (2011) suggests adapting successful health systems used in the US or UK to the Nigerian setting but only after the numerous issues therein have been tackled for this change to be successful.

**Figure 6-3 Basic Layout of Referral in the Nigerian Health System (adapted from Welcome, 2011)**



Thus, on migrating to the UK system, it is assumed the pattern is the same. Attendance at the hospital may be increased because of the lack of a fixed abode which makes registration with a GP difficult, close distance to a hospital or ease of access rather than waiting for 2-3 weeks to get an appointment with a GP for an outcome that requires urgent attention (Jackson *et al.*, 2017).

Saxena *et al.* (2002), in a study assessing self-reported health by different socioeconomic and ethnic groups, reported that Indian and Pakistani children were more likely to utilise GP services than other ethnic groups. The authors found that overall, children of Asian minority groups had better self-reported health and fewer injuries than Afro-Caribbean children. However, children of ethnic minorities were less likely to be referred to outpatient services. The authors observed that the findings may be limited by parents reporting information on behalf of children less than 13 years old and that some older children may not understand fully the information about how to use health services. Saxena *et al.* (2002) also suggested that further research was needed to see if general practitioners were less likely to refer to ethnic minority children to outpatient services.

Low hospital attendance with burns may be due to a range of factors. Some ethnicities may fear that burns may be blamed on cultural practices rather than being accepted as unintentional. This reason may be the case with refugees who have sought asylum in developed countries but live in poor quality, overcrowded accommodation, an environment known to be associated with increased risk of burn injuries (Dempsey and Orr, 2006). A proportion of ethnic minority populations may be immigrants, and some may have illegal status. Therefore, they may not be willing to report burn injuries for fear of being identified and deported. Others cannot afford travel costs to places of treatment (Shenassa *et al.* (2004), Hayes and Groner (2005), Nazroo and Williams (2006)). Studies show that minority ethnic groups are more likely to be deprived because of high unemployment and inadequate housing (Kramer *et al.* (2010), Karimi *et al.* (2015), Moller *et al.*, (2015), Nazroo and Williams (2006) and Shavers (2007)) though other authors disagree and state that deprivation is only an outcome of poor socio-economic status (Saridi *et al.*, 2015).

No study in the literature review reported findings of health-seeking behaviour, ethnicity and burn injury outcomes. Three of the 32 (9.4%) studies reported their findings on the use of first aid. There were no ethnic or racial differences highlighted by the authors of any of these studies about first aid use or application.

#### 6.7.1.3 Bias due to measurement:

There was marked variation in the way authors classified ethnicity. Thirteen out of 32 (40.6%) studies measured the inequality in ethnicity and burns using racial classifications, six studies used ethnic classifications, seven studies used indigenous status, five studies used parental nationality while one used language fluency (English versus Spanish speaking). Studies higher in the hierarchy of evidence tended to use indigenous status to identify minority groups. These studies largely came from Australia, Canada or were multi-regional. Researchers, therefore, merged several ethnic groups into a single 'indigenous' category. Studies lower in the hierarchy of evidence tended to use racial categorisations and were mostly from the United States.

Thirteen of the 32 (40.6 %) studies did not provide a rationale for the choice of ethnicity classifications in their studies. Six of the 32 (18.8%) studies mentioned that participants were categorised using ethnic/racial classifications from censuses. Three of the 32 (9.4%) studies used a combination of self-identification from participants, with linkage to censuses and vital statistics merged with censuses. The remaining ten studies (31.3%) each used country systems, national registries, authors' classification, vital statistics, burn registry methodology and previous literature. Papers published before 2000 were less likely to describe the rationale for ethnicity group classifications.

There was marked heterogeneity in the methods and analysis used in the studies. Twenty-two of the 32 (68.8%) papers examined burns only while 10/32 papers examined burns along with other injuries. Nineteen of the 32 (59.3%) papers examining ethnicity used inferential statistics. Eight of the 10 (80%) mixed injury papers used more inferential statistics to show the association between ethnicity and burns (mostly logistic regression, then Cox, Poisson and finally binomial regression). Eleven of the 22 (50%) burns-only papers used descriptive statistics (pictorials, percentages, Chi-square, Mann-Whitney Test or T-test) then logistic or Poisson regression to report ethnicity. All 32 papers (except Petridou *et al.* (1998) and Saridi *et al.* (2015)) seem to point towards an association of increased burn risk and belonging to a minority ethnic group or being of indigenous status. This association was irrespective of the different years of study, different populations and if the data analyses were descriptive or inferential.

Studies higher up the hierarchy of evidence (cohorts and case controls) reported the association between minority ethnic group/indigenous status and burn risk (in some cases, the strength of the association was eight times the risk of people from other ethnic groups (or the ethnic majority)). This observation was also like that seen in studies lower in the hierarchy of evidence (cross-sectional studies). Two studies showed a reduced risk within their study of some minority ethnic groups in different context. These were Duke *et al.* (2011) and Karr *et al.* (2005). Duke *et al.* (2011) reported that Aboriginals' admissions reduced by 42% over the study period, IRR: 0.58 (0.52-0.84) although Aboriginals had three times the hospitalisation rates of for burns than non-Aboriginals, IRR: 3.17 (2.95-3.39). This finding suggests that though burn injuries may be falling, the absolute risk of having burn injuries may still be high for minority ethnic groups compared to majority groups. Karr *et al*. (2005) reported a reduced RR for fire-related injuries in Hispanics compared to non-Hispanic Whites, RR= 0.7(95% C.I: 0.2-2.2). Descriptive studies gave a range of minority ethnic groups having burns as 9.8% to 57%. Studies higher up the hierarchy of evidence that gave a 95% CI interval tended to have narrow confidence intervals with differences from between 0.21-1.02 suggesting a reasonable estimation of effect. However, those at the bottom of the hierarchy of evidence seem to have a reduced estimation of effect as the 95% CI interval presented in some studies were wider (i.e. the difference between the lower and upper confidence interval limits) with differences from between 0.32-51.1.

Older studies seemed to report smaller odds ratios/rate ratios for minority ethnic groups and burn injury than more recent studies. These odds ratios suggest there could be increasing inequalities amongst minority groups and their burn risk.

#### 6.7.1.4 Bias due to study design:

Regarding study designs, there was one systematic review (examined ethnicity using indigenous status), two prospective cohort studies (examined ethnicity using parental nationality and indigenous status respectively), three retrospective cohort studies (one examined ethnicity using racial classifications while the two used indigenous status). Also, there was one case-control study (used ethnic classification)) and 25 were cross-sectional studies (12 used racial classifications, five used ethnic classifications, three used indigenous status, four used parental nationalities and one used language fluency). In all, most of the studies at the top of the hierarchy used indigenous classifications while those at the bottom used racial classifications. Of the nine papers that explicitly tried to examine ethnicity and burns in their aims, there was: 1 systematic review, one prospective cohort study, one retrospective cohort study and six cross-sectional studies.

Regarding the quality of the study, the cohort studies, case-control study and two cross-sectional studies were given a "good" rating using the CASP tool. Only 40% of the cross-sectional studies had a "good" rating, with the rest scored as "fair". However, one of the retrospective cohort studies, Hayes and Groner (2005) scored unsatisfactory on the CASP tool. The authors mention not having a clear recruitment strategy and not following up those who left or dropped out. There was also no information about confounding and bias from exposures and outcomes. Based on these ratings, the results of studies higher up the hierarchy of evidence were less at risk of bias than the cross-sectional studies. The systematic review, cohort studies and case-control study all reported an association between minority ethnic groups and increased burn risk.

The only systematic review, Moller *et al.* (2015) reported consistency across 14 papers describing that rates of hospitalisation (1.3-4.4:1) and mortality (1.2-6.1:1) from burns were higher in indigenous groups (ID) compared to non-indigenous groups (NID). Only one paper reported no difference in hospitalisation regarding scalds in both groups.

For the two prospective cohort studies, Karimi *et al.* (2015) reported that the hazard ratio for having fatal burns were higher in foreign-born children than Swedish born ones, HR=1.62 (95% CI: 1.15-2.27). Randall *et al.* (2017) mention the most affected children were male and from an indigenous ethnic background (13.7%). All the three retrospective cohorts Duke *et al.* (2015), Hayes and Groner (2005) and Spady *et al.* (2004) report minority groups having higher rates of burn injury. However, only Hayes and Groner (2005) mentioned it in their aims to examine the relationship between ethnicity and burns. They observed that burns were the leading injury in minority ethnic groups (RR= 6.44, no confidence interval reported by authors). Spady *et al.* (2004) reported that people belonging to the First Nations ethnic group were the most affected by burn injury OR= 1.35 (1.25-1.46). The only case-control study by Petridou *et al.* (1998) reported that 92.9% of cases had an ethnic group as other Greek (unspecified) and 7.1% Gypsies or recent migrant with greater risk ascribed to the latter group. This classification was poorly reported and did not help the reader value the contribution of who are “other Greek”, “Gypsies” or “recent migrant”.

Two cross-sectional studies with information regarding ethnicity and burns were Brudvik *et al.* (2011) and Saridi *et al.* (2015). Brudvik *et al.* (2011) observed a greater proportion of foreign-born children being admitted following a burn (28.6%) than Swedish born children (3.9%). The OR for foreign-born children in having a burn compared to Swedish children was 9.84 (95% CI 1.8-52.9). In contrast, Saridi *et al.* (2015) had data on ethnicity but found no differences between ethnic groups for admissions with burns. The authors did not explain possible reasons for this lack of difference.

The remaining 23 cross-sectional studies consistently reported an increased risk of burns in children from minority ethnic groups. However, only 6 of the 23 studies mentioned examining this association in their aims. Barrow *et al.* (2005) noted that the children with the highest burn risk were below three years old and in the following order: White Boys, Black Girls and Hispanic Girls. Bernard *et al.* (2007) reported that burns were the leading cause of death in Black children aged 1-9 years (RR=2.7; 95% CI=2.3-2.8). They also report that death rate from burns for Black children aged 1-9 years old was 3.0 per 100,000 population, about three times that of White (0.9 per 100,000) and four times that of Hispanic (0.7 per 100,000) children of the same age. Karr *et al.* (2005) report that hot objects caused more burn injuries in Hispanics than in non-Hispanics in their study- the relative risk of Hispanics having contact burn injury compared to non-Hispanic whites was 2.3 (95%CI: 1.3-4.1). However, the authors observed a reduced RR of Hispanics having a cooking or house fire injury compared to non-Hispanic whites was 0.7 (95%CI: 0.2-2.2). Kramer *et al.* (2010) reported children from minorities with burns were younger than Caucasians, with Asians having the youngest mean age for burn injury, 4.4 years. This study thus shows that at presentation to hospitals for treatment, victims from minority ethnic groups tend to be younger than the majority ethnic group. Kramer *et al*. (2010) also mention that 46.1% of burn cases were from minority ethnic groups. Shenassa *et al.* (2004) reported areas densely populated with Blacks as having higher burn risk (RR=2.64, 95%CI: 1.84-3.79) than areas less populated with Blacks. Tan *et al.* (2012) report that ethnic minority children are more likely than White children (34.1%) to have burns in the kitchen (Chinese, 53.8%, Black, 62.5% and Arabic, 100%;). They also report ethnic minority children had larger total burn surface area (TBSA) (mean TBSA: all ethnic minority groups, 7.1%, Asian, 8.2% and Chinese, 10.2%) than White children (mean TBSA: 5.6%). Tan *et al.* (2012) also reported that hot food scalds were most common in Chinese patients (hot beverages, 26.7%; hot food, 60%) compared to hot beverage scalds in White children (hot beverages, 35.8%; hot food, 13.4 %).

Three of the other 17 retrospective studies that examined ethnicity as a co-variate and had inferential results. Duke *et al.* (2011) reported that Aboriginals' admissions reduced by 42% over the study period, IRR: 0.58 (0.52-0.84) although Aboriginals had three times the hospitalisation rates for burns than non-Aboriginals, IRR: 3.17 (2.95-3.39)**.** The authors speculated that this finding could be due to improved first aid reducing the need for hospitalisation, an increase in receiving care in outpatients or a real reduction in burn injuries. This trend of the heightened risk of the injury yet an overall decreasing incidence of burn admissions in some ethnic minorities was also reported in a study spanning 35 years' worth of data in Texas, the USA by Saeman *et al.* (2016). Here, Hispanics and African-Americans were shown to have a reduced incidence of 0.26 and 0.16 injuries per 100,000 children per year respectively. Saeman *et al.* (2016) suggest that the reductions seen in their study may be due to decades of improved safety standards and community education programs. Hjern *et al.* (2001) reported high burn risk in children with mothers from outside Western Europe, AOR=1.7, (95%CI: 1.4-2.1). In all, it seems that the cross-sectional studies that investigated ethnicity report higher risk for children being < 5 years of age and belonging to an ethnic minority.

#### 6.7.1.5 Bias due to missing data:

Ethnicity information is often missing not at random. Reasons for missing ethnicity include people considering this information to be sensitive, or they may not feel that any of the options available matches the race or ethnic group with which they self-identify (Jack *et al.*, 2006).

Twenty-one of the 32 (65.6%) studies did not mention how they handled any bias from missing data- ten of which purely gave descriptive analyses of SES measures. Six of the 32 (18.8%) studies mention using complete case analysis. Soleimani *et al.* (2016) however used a complete case analysis and compared findings to that from analyses of all available data. Only three studies used sensitivity analysis to control for bias from missing data. These studies were Saeman *et al.* (2016), Spady *et al.* (2004) and Duke *et al.* (2015). One study, Karr *et al.* (2005) used linkage with census data to account for missing data from questionnaires. Alnababtah *et al.* (2011) mentioned checking for data completeness but did not specify how this was carried out. However, it seems the authors only used those with complete data from hospital computer databases. Carlsson *et al.* (2006) report that their results may be biased as there was 8-29% internal dropout in their study. Saeman *et al.* (2016) tried to fill in missing data from free text in patient files and carried out analyses of all available data, arguing that the missing 1% may not distort their findings. Hendricks *et al.* (1999) did not control for the 20% of cases with missing ethnicity information. Karimi *et al.* (2015) reported that using national population registers gave their study enough power for the effect of missing or misclassified ethnicity to affect the precision of their study.

All the papers that used sensitivity analysis were given a "good rating" on the CASP tool, and these studies were both retrospective cohort studies. All the papers that used complete case series were cross-sectional (except for Hayes and Groner (2005) which was a retrospective cohort study and had a "poor rating"). The cross-sectional studies all had a "fair rating" except for Dempsey *et al.* (2006) and Shenassa *et al.* (2004) which had a "good rating". It is unclear whether controlling for missing data in the studies in this review would have influenced the consistent finding across studies of an association between children from minority ethnic groups/ with indigenous status with increased burn risk.

The association between increased burn risk and minority ethnicity/indigenous status for studies that used complete case series was expressed as descriptive percentages ranging from 11.4% to 42.6%. The exceptions were Bernard *et al.* (2007) and Shenassa *et al.* (2004) that both showed the rate ratios for burn injuries in Blacks compared to other ethnic groups as 2.7 (95%CI: 2.3-2.8) and 2.64 (95%CI: 1.84-3.79) respectively. The two studies that used sensitivity analysis expressed the association between being of minority ethnic/indigenous status and increased burn risk as odds ratios of 1.35 (1.25-1.46) in Spady *et al.* (2004) and as a percentage of 19.7% in Duke *et al.* (2015). Alnababtah *et al.* (2011) used data completeness and reported that 37% of cases were of minority ethnicity and had burn injuries.

#### 6.7.1.6 <u>The mediating effect of socioeconomic status:</u>

The mediating effect of social deprivation complicates the relationship between ethnicity and burns. Minority ethnicity status is strongly associated with SES background. Socio-economic status may also mediate attitudes and behaviours which may influence the different exposures to burn risk within each ethnic group.

Braveman *et al.* (2005) and Shavers (2007) argue that studies which tend to posit that the association between one's ethnicity and health outcomes are independent of their socioeconomic status do so erroneously. Braveman *et al.* (2005) and Shavers (2007) state that authors may arrive at this conclusion if adjustment for SES in multivariate analyses shows no association between ethnic groups and health outcomes. Braveman *et al*. (2005) and Shavers (2007) also suggest authors should remember to specify what form of SES was used (and how it was measured) in their study.

Eight of the 32 (25%) papers adjusted for the mediating effect that may result from SES and other covariates when analysing the relationship between ethnicity and burn risk. These were Cheng *et al.* (2016), Duke *et al.* (2015), Hjern *et al.* (2001), Kramer *et al.* (2010), Lehna *et al.* (2016), Quayle *et al*. (2000), Shields *et al*. (2007) and Soleimani *et al*. (2016). The authors mentioned that both adjusted and unadjusted results showed minority ethnicity had increased burn risk irrespective of socio-economic status.

In conclusion, this review has shown that multiple studies have reported that children from minority ethnic groups/indigenous status had a higher risk of burn injuries compared to the majority population. The strength of the evidence reporting the association between ethnicity and increased burn risk was considered moderate. The reason was 18 out of the 32 studies (56.2%) were rated as of "good" quality via CASP and included all those with study designs at the top of the hierarchy of evidence (except one retrospective cohort, Hayes and Groner (2005) rated as "poor"). The remaining 13/32 studies had a "fair" CASP rating. Biases were intrinsic in study design, missing data and the different measures of ethnicity.  Also, across multiple studies, authors mentioned that children from minority ethnic/indigenous backgrounds often had more extensive and more in-depth burns, more severe burns, and higher hospitalisation rates or longer length of stay (LOS) if admitted. However, only a limited amount of evidence was identified to understand the relationship between ethnicity and burn risk in children in the UK; e.g. Tan *et al.* (2012). Where present, evidence was often descriptive and combined children with other age groups, e.g. Brewster *et al.* (2013). The exploration of this association in UK children is, therefore, an objective of this thesis. A better understanding of the association between ethnicity and burns in UK children may inform the development of effective prevention and treatment interventions.

### **6.7.2** Discussion on ethnicity and burns in children

The results from studies in this thesis show that all ethnic minority groups had an increased risk of paediatric burns compared to the white population, with Black families having the highest risk.

In terms of the classification of race and ethnicity, this thesis utilised the format of the 2011 UK Census ethnic categorisations. These categorisations are reliable as they have been validated over time. Dorling (1995) mention how migration and globalisation changed the ethnic profile of the UK over time, and this has caused an update of the ethnic categorisations of the country as well. The ONS in 2018 and 2019 also report how further updates have been made regarding ethnic categorisation in the UK since then and plan to do so for the next census. The UK categorisation uses a combination of racial and ethnic features in creating ethnic categories. These categorisations have been based on feedback from different ethnic groups at every census and the numbers counted as enough to create new ethnic categories or "demote them if their numbers have gone down". Thus, ethnic categorisation in HES and BaSAT data is not based on self-reported entries but the UK Census classification system. That said, some individuals may not self-identify with the UK 2011 categorisations or may not fully understand the need for collating this data. However, the level of completeness for the variable in both datasets is 86-88%. This number is quite good compared to previous studies that struggle to collate this amount for ethnicity studies in the UK. Thus, the findings of ethnicity in this study are valid in describing burn risk in children in the UK. However, caution may need to be applied to those who identified as "Other" as they may be a mixture of people whose ethnicities are not described openly in the 2011 UK census and those who do not wish to disclose their ethnic identity as they fear its use in identity politics.

In terms of representativeness, the ethnic measures used in both HES and BaSAT reflect good internal and external validity since they are based on the measures used to collate this information in the UK nationally. BaSAT shows better internal validity for the burn outcomes since this dataset was created to collect clinical information on burn injuries as seen in the England and Wales and associate these with sociodemographic factors that influence burn risk in children. HES, on the other hand, collates burn outcomes as a subset of all admissions data in England but has wider coverage. It would have been excellent to see what the results would have been if this study was carried out in Northern Ireland, Scotland and Ireland given they have different datasets like HES and BaSAT but that was beyond the scope of this current thesis.

Regarding measurements and description of the results, this thesis presents findings on ethnicity and its association with burns in children using both descriptive and inferential analyses. As mentioned in section 6.7.1, most of the literature reviewed on ethnicity and burns in children in this thesis describe this association using descriptive means. Descriptive analyses revealed that most burn admissions were from the White majority ethnic group. However, when compared to the distribution of ethnic categories in the general population, there was an over-representation of ethnic minorities in burns admissions wards. This observation on over-representation was also reported in studies done by Brewster *et al. (*2013) and Tan *et al. (*2012). In this thesis, multivariable logistic regression of HES data indicated that children from ethnic minority groups had higher odds of admission for burns than other admissions compared to the White majority (even after adjusting for all available individual, family and environmental factors). These results are supported by few similar findings in previously reported literature like Alaghehbandan *et al.* (2012), Barrow *et al.* (2005), Duke *et al. (*2015) and Kramer *et al. (*2010).

The descriptive analyses from BaSAT on ethnicity and burns were similar to the HES data although there was less ethnic group data available (43.7% of all attending cases had ethnic group recorded). The multivariable logistic regressions of ED burn attendance by ethnicity revealed no associations between ethnicity and burn type, burn depth and or the use of cool running water first aid. These results, therefore, differ from some previous findings reporting ethnic differences in burn outcomes. The reasons for this difference may be because the published studies measured different burn outcomes or types of burn to those collected in BaSAT which recorded a lot of minor burns and scalds presenting to ED but not needing admission. For instance, Shai and Lupinacci (2003) revealed in their US-based study that the rate ratios of children that were involved in house fire fatalities were from ethnic minorities (Asian, Latino and Black) and 3-4 times that of the majority (White). This trend was like two other US studies; Mallonee *et al. (*2003) reported that fires and burns were the 4$^{th}$ leading cause of death among 0-9-year-old and 5$^{th}$ leading cause of death among 10-14-year-old Hispanics between 1990-1998 and Shenassa *et al.*, (2004) who showed children from Black populated areas had high burn risk. However, BASAT did not include any fatal burns, and burns secondary to house fires represent a very small proportion of admissions to hospitals in Bristol and Cardiff. Tan *et al.*, (2012), a UK study, reported ethnic differences in the location of the burn event; of those that happened at home; ethnic minority groups were more likely to have burns in the kitchen (Arabic, 100%; Black, 62.5%; Chinese,53.8%) compared to White, non-ethnic majority children (34.1%). BaSAT data contained information on the location of burn events, but 81% occurred in the home with the rest occurring out of the home, Ethnic comparisons were not made as that was not one of the aims of this thesis. It is also worth stating that some of these results were descriptive. E.g. as in Mallonee *et al. (*2003) and Tan *et al.* (2012). Studies with similar inferential analyses were Shai and Lupinacci (2003) and Shenassa *et al.* (2004). It would have been excellent to carry out burn specific analyses with HES data regarding burn type, application of first aid and burn depth but this information was either non-existent or not properly collected to test for associations with the sociodemographic variables in that dataset.

Data from HES, supported by the literature review, indicate that ethnic minority children are more likely to be admitted for their burns. Attendance at ED with burns is also likely to be influenced by other factors such as distance to the hospital, or a tendency to use ED over primary care, which was not possible to explore through the BaSAT dataset. These are examples of factors that would have been investigated if the data was available. Laursen and Nielsen (2008) adjusted for the effects of distance to hospital and injuries in their inferential analysis but unfortunately did not present any ethnic findings only socioeconomic findings that were still significant before and after adjustment. However, the findings from the BaSAT data can illustrate health-seeking behaviour, such as the application of cool running water first aid post-injury in children from ethnic minority backgrounds. The literature review on ethnicity and burn injuries in children observed that only 3 (9.4%) of 32 studies descriptively reported first aid application, but none of these results was examined from an ethnic point of view. The reason for this was that the studies collected no ethnic data or did not consider this issue as one of the main aims. This thesis examined the contributions of ethnicity to the application of cool running water first aid (via BaSAT), but there was no association showing statistical significance before and after adjusting for individual, family and environmental factors. These findings may be due to the sample size of the study and an underestimation of those who apply alternate forms of first aid than cool running water. Chirongoma *et al.* (2017) conducted a cross-sectional study in first aid knowledge among caregivers in Zimbabwe where the authors found that application of non-adequate first aid (ice, eggs, margarine and traditional herbs) had a significant association with complications of burn injuries in children. However, some parents in the study admitted that knowledge of adequate first aid practices would have helped them prevent using wrong practices and prevent injury complications in children. Mytton *et al.* (2017) also reported how adequate first aid education is needed in the UK to ensure parents/carers and the general public understand the correct action to take when children have injuries. That said, it is important to remember that some ethnic minorities in the UK may struggle with knowing and applying adequate safety practices if they are not aware of these or influenced by their cultural backgrounds and attitudes that may lead to negative outcomes in injured children, e.g. applying eggs to the burn injury and so. In the BaSAT data analyses, ethnicity did not show any association with burn type after adjusting for all individual, family and environmental factors. This finding supports that reported by Tan *et al.* (2012) in their study of ethnic differences in burn patients attending the Alder Hey hospital in Liverpool.

Regarding study design, injury research tends to be mostly carried out using cross-sectional studies. 72% of the studies reporting ethnicity and burns findings were cross-sectional studies-46% of these were of good quality following critical appraisal. The research in this thesis was based on cross-sectional data spanning 4 to 5 years from well-established datasets; thus, their quality is of good standing. The results have examined socio-demographical contributions to the risk of burn injuries by ethnic groups which are not well documented in the literature especially when it involves inferential results. For example, BaSAT was designed to meet some of the shortcomings of existing proformas regarding the collection and collation of variables relevant to studying the effects of ethnicity and burns. However, given their status on the hierarchy of evidence, cohort studies may have been used, but the individual data used in this thesis did not follow up the same individual over the 4-5 years data was collated. That said, it is also possible that some children included in the analyses had been admitted to hospital for sequelae of burn injuries. Much was done to ensure the data used in this thesis came from children who had burns for the first time in the year data was collected, but there was no way to tell if the same child had been reported in the following years for burns since individual data had their identifier codes for the year of collection. E.g. if the same child came the following year, they got a different code.

The literature review on ethnicity and burns risk was inconclusive on the contributions of ethnicity to burn risk where missing data was concerned. This issue was because 66% of the 32 studies reviewed mentioned nothing about controlling for the impact of missing data on their findings. 19% of the studies used complete case series (CCS) analyses, 9% used sensitivity analyses, 1%

used linkage, and the rest tried to look for the missing data or added them as a category in all available data analyses. Given that ethnicity is an MNAR variable (see section 7.4.1.1.4), accounting for missing data was done using AAD and CCS analyses and not multiple imputation. Results from both results were compared to each other. For HES, the differences were infinitesimal, and CCS analyses were not reported given the large sample sizes in both analyses. For BaSAT, any significant result in the AAD analyses became insignificant in the CCS analyses. Thus, it is very likely that the reduced power and small sample size has underestimated the contributions of one's ethnicity to burn outcomes in children. This latter issue buttresses earlier points of the importance of adequate ethnic data collection and preservation. This collection will help in further investigations of health inequalities across ethnic groups in the UK setting.

By following the good advice given by previous authors to control for the effects of deprivation when examining ethnicity and burn outcomes in children, this thesis controlled for deprivation (via IMD) when carrying out analyses in HES and BaSAT data. Like 25% of 32 studies reporting this adjustment in the literature review, this thesis also confirms that the association was still significant before and after controlling for deprivation. The weakness of controlling for IMD is that it looks at deprivation from an environmental point of view rather than household income: the latter was not collected in HES and BaSAT. This finding further supports the fact that most ethnic minorities tend to live in greater deprivation in high-income countries. Factors responsible for this association may be due to unskilled/low skilled abilities, inadequate education, poverty (especially if these ethnic minorities are from asylum seekers/refugees background), a lack of opportunity or access to such opportunities to move up the ladder of social mobility in their new-found country of residence and so on.

### 6.7.3 Potential mechanisms, mediators and confounders and effect modifiers in the relationship between ethnicity and burns in children

This section will explain the relationship that occurs between the different groups of variables when ethnicity is the exposure and burns in children is the outcome.

It follows the layout of the conceptual diagram for this relationship as highlighted in Chapter 3.

1. Urban/rural divide: This variable is a mediator in the relationship between ethnicity and burns outcomes in children. The review in chapter 2 shows that this urban/rural divide will influence the demographic patterns of ethnic minority groups. For example, in Australia, there is a macro-level effect at play where most Aboriginals have been restricted to rural outlands in the past as part of the policies of the time. Although these restrictions are not in effect anymore, a whole lot of this ethnic group can be predominantly found in such rural areas that have high levels of deprivation. Free movement is possible for those who move to the cities for work and so on. However, due to close cultural ties, some may feel inclined to stay amongst their people whether in the rural or urban areas (Shepherd *et al.*, 2017).

   Within the UK setting, many ethnic minority communities have grown as a result of migration and globalisation. However, on arrival, most of these groups will settle in urban than in rural areas. Some individuals from these ethnic minorities may be manual low skilled labourers who work for seasons in agricultural businesses for short term periods, e.g. harvest season and may instead move to rural areas for work. However, some of these workers may be based in urban areas or towns on the borders of urban/rural areas (Sumption and Fernández-Reino, 2018). That said, most of the burns seen in the UK as reported from this thesis occur in urban areas. The risk for ethnic minorities and burns in children was still significant even after adjusting for the urban/rural divide.

   Given that most ethnic minorities have strong cultural and family ties, there is the likelihood of them living in urban areas where they are likely to have large communities (Zhang *et al.*, 2017). E.g. London, West Midlands (Birmingham), South East (Luton) and so on. It is also likely that burns occur more in urban areas than rural areas due to the population density, distance to the hospital (hence overreporting) and another environmental risk that occurs due to competition for space (Brewster *et al.*, (2013), Lyons *et al.*, 2006). This thesis could not adjust for the effect of these extra factors as they were not collected or available in both HES and BaSAT.

The mechanisms underlying increased burn risk from the place of residence are largely through increased exposure to hazards. For example, children living on a farm in the countryside may be exposed to bonfires leading to flame burns and agricultural products leading to chemical burns (Scheven *et al.*, 2012 and Woodbridge *et al.* (2010)). Children living in poor urban environments are exposed to burn hazards because of the poor-quality housing and overcrowding-e.g. contact burns from heaters, cookers or hair straighteners, scalds from hot drinks or hot food (not served at a table) (Duke *et al.*, (2011) and Sarginson *et al.*, 2014).

2. Deprivation (IMD): This variable is a mediator in the relationship between ethnic minority status and burns in children. Most published literature agree that greater deprivation is a risk factor for poor health outcomes, and this is not different for burns (Fourjoh *et al.* (1995), Marmot and Bell, (2012)). It has also established that ethnic minorities in high-income countries may be concentrated in areas with greater deprivation due to the various circumstances they find themselves it (Zhang *et al.*, 2017). It is not an obvious choice, but if they do not have the resources to afford or live in areas with lesser deprivation, they may have no option but to compete for resources with natives that already struggle for scarce needs in areas with greater deprivation (Balan and Lingham (2012), Dempsey and Orr (2006). As such, children from these backgrounds are exposed to environments with low-quality education, high crime rates, housing with little or no safety equipment and so on (Shepherd *et al.*, 2017). Much of the increased risk of burns to children living in deprived areas is mediated through poor quality housing, resulting in increased exposure to hazards in the home environment (Shenassa *et al.*, 2004). Other potential mechanisms include inadequate supervision, lack of understanding of hazards and low health literacy of the parents, and additional needs of the child.

3. Supervision: This variable is a mediator in the increased burn risk associated with ethnicity. Ethnicity influences the belief and methods of supervising children. In some cultures, supervision is seen as an adult responsibility (18 years and above) while in others, it involves anyone seen as "mature" enough to have common sense. Thus, in some families, older siblings not yet an adult can supervise children (Jaffe *et al.*, 2011). Issues around finances may also complicate this fact- e.g. if the family understand an adult is a better option for supervising children but have no close friend or relative to do so, they may have to hire help (Ingram and Emond, 2009). If they can't afford to hire nannies/house helps, then the older children are put in charge of younger siblings when parents are away at work (Ablewhite *et al.* (2015) and Ingram and Emond (2009). This culture is common with many African and Asian families (Allport *et al,* 2019). While this is done to also encourage independence in such children, for some, it's a burden too early to bear and may increase the risk of injury since they are still developing as well and do not understand the risks (Allport *et al,* 2019). In other instances, older adults, e.g. grandparents with limited mobility or energy can be asked to step in as carers (Allport *et al,* 2019). Culture also influences family dynamics. Thus, if the family is one that is close-knit and believes in the saying "it takes a village to raise a child", then such families offer their on and off support in helping parents overwhelmed with the concerns of raising children (Allport *et al.*, (2019) and Navarrette *et al.* (2018)). If, however, the culture is individualistic, this may prove difficult for its members or ethnic minorities that must adjust to the major changes in the support system (Allport *et al.*, (2019)).

   As mentioned in chapter 2, the definition of supervision also differs between individuals and families. Thus, not all reported supervision will be adequate: continuous monitoring is what is needed. If this is suboptimal, burn injuries may occur in children.
4. Additional needs of the child: This variable is a mediator in the relationship between ethnicity and burns risk. There are complex associations between having a disabled family member, being from an ethnic minority and living

in deprived circumstances (Rowe *et al.*, 2004). Allport et al (2019) reports that some ethnic minorities in the UK especially of Somali and other African descent have elevated risks for some behavioural and neurodevelopmental disorders in the UK. These vulnerable children may be prone to the additional risk of burn injuries because of mobility or coordination issues or cognitive difficulties.

5. Parental age: This variable is also a mediator in the relationship between ethnicity and burns in children. If the cultural norms of the family promote early marriage or children bearing the children born as a result may be more vulnerable than children born of adult women (Cemlyn *et al.*, (2009) and Hjern *et al.* (2009). In other instances, if the parents are not yet mature and have no stable plan or goals for the future, the child is at risk of neglect or abuse which will increase the risk of injury. These issues may apply to older parents especially if they are older mothers as some are at risk of having some additional needs themselves which could limit mobility and impair supervision. Thus, their children are at risk of burn injuries. There is also the issue of parental health literacy: Younger parents and those without experience are often less aware of burn risks and appropriate first aid, resulting in higher risk of the injury (Laursen and Nielsen (2008)).
6. Parental education, parental health literacy, parental income and housing type: These factors are mediators in the relationship between ethnicity and burns. Published literature has reported educational inequalities between ethnic groups in the UK. Although these gaps are narrowing down, some children from ethnic minorities and greater deprived backgrounds may still struggle to keep up with the academic pathway if factors contributing to such inequalities are unresolved (Marmot, 2010). Parental income will influence the type of housing parents will be able to afford for their children as well as other family needs. For instance, if the parents are unskilled or refugees/asylum seekers, they may be limited by the kind of jobs they get and the kind of housing which may be low quality or insufficient to meet their family size (Vargas-Silva, 2013).

Also, there is the issue of parental health literacy: although separate from parental education, it is believed that education enhances health literacy (Cheng *et al*, (2016), Laursen and Nielsen (2008)). Thus, if parents are from ethnic minorities where English is not the first language, and they cannot engage with recommended health and safety practices, the likelihood of them understanding how things work in the UK context may be compromised. Thus, it is essential for recent migrants who are from ethnic minority groups to ensure their knowledge and application of health literacy is acceptable in the UK health care system. Some families with close cultural ties may get colleagues who can help most of the time to improve their understanding of the system, but this may be an issue when not they are unavailable (Allport *et al.*, 2019). The NHS does provide interpreters if these are needed and available when such parents seek to access healthcare in the hospital. Thus, parental education and health literacy will also influence health-seeking behaviour as most ethnic minorities may find themselves rushing to the hospital for everything. This may be easier for them due to similar structures that operate in their country of origin, but it may also be out of worry to avoid any child welfare issues occurring if they delay in treatment of their child (Saxena *et al,* 2002).

7. <u>Many siblings and overcrowding:</u> Some families are large, either many children or having extended family members co-existing together with nuclear families raising the children, e.g. grandparents, uncles, aunts (Mallonee *et al*, (2003)), Allport *et al* (2019). Burn risk is thus elevated for younger children if enhanced supervision is not provided for this group in the home. Thus, more needs to be done in ensuring that if the ratio of adults to children is high, these adults make sure the home is safe enough for the children living there, e.g. keeping thermal equipment's like mobile heaters or hair straighteners out of reach of children (Natterer *et al,* 2009). However, if the ratio of children to adults is more, the parents of such children may need to get extra help to assist with supervision and care.

Income and belief systems often compound these issues (Laursen and Nielsen, 2008).

In all, the investigation of ethnic contributions to burn risks in children could help improve health prevention and or intervention efforts (Hjern *et al.*, (2001[b]), Lehna *et al.*, (2016) and Mallonee (2003)). This contribution may involve several different concepts used in medical sociology and anthropology. For example, cultural relativism (i.e. understanding that every culture has developed ways to solve their problems, and cross-cultural comparisons shouldn't be viewed as better or worse but different) and holism (i.e. seeing the "bigger picture" whenever health researchers wish to implement a prevention or intervention strategy in a community and avoid "upsetting the balance") (Scrimshaw, 2006). These concepts may help health researchers/professionals to provide the evidence to help reduce inequalities in health outcomes in ethnic minorities while still respecting their belief systems/culture (Ekeus *et al.* (2004), Scrimshaw (2006), Shoufani and Golan (2003)).

## 6.8 The relationship between ethnicity and deprivation in health

This relationship is complex and contested. Bhopal (2014) states that to talk about ethnic minority health involves discussing immigrant health (especially those that are recently settled and or are poorer) because this concept involves the relationship between race, ethnicity, migration and socioeconomic status. However, Davidson (2015) and LaVeist *et al.* (2008) report that some schools of thought do not believe in ethnic inequalities in health and believe observed differences are entirely explained by low socioeconomic status or high deprivation levels. Davidson (2015) also cited Deaton and Lubotsky (2003) who state that racial inequalities (brought about by the systemic disadvantage of ethnic minorities in US history) highly confounded inequalities in the United States. Garner *et al.* (2010) as cited in Davidson (2015) reported that despite controlling for proximal and intermediate factors, they still observed ethnic inequalities in health outcomes between Aboriginals and non-Aboriginals. They concluded that their observations were due to distal determinants (such as access to primary care or distance to a hospital) and not necessarily racial differences, but due to the conditions, ethnic minorities have found themselves residing in over time. Davidson (2015) found that off-reserve Aboriginals, though poorer than non-Aboriginal Canadians, had better health than on-reserve Aboriginals. Thus, the opinion of some schools of thought is that if people "work hard" and get money, it will lift them out of poverty and give a better quality of life irrespective of their ethnic group (Davidson (2015), Galea, 2017). Davidson (2015) cites the 2011 Pew Centre report findings where approximately 30% of Americans and 60% of Germans believed that social position, life prospects and health determinants were outside of the control of individuals and their choices. Also, a 2008 Pew Centre report states that 80% of wealthy US republicans believe they are the only architects of all their success (Davidson, 2015). These arguments fail to consider three key issues.

Firstly, change is a process where parts occur suddenly while others develop with time. A sudden change in a family's financial fortunes may mean they can or cannot afford the necessities for good health and wellbeing - better housing, education, clothing and so on (Davidson (2015), Lovasi *et al.* (2009)). A good example is Petridou *et al.* (1998) finding an association between increased burn risk in children who lived in houses with too little or too many rooms. At one end, some children live in overcrowded, unsafe and poorly maintained housing (Chin *et al.* (2007), Williams and Collins (2001). Supervision may be "easier" if children are near parents, but if the space in which a child lives is tight, the risk of injury is increased since children may not be so easily prevented from accessing areas of the house with burn hazards, e.g. kitchens, boilers, radiators, and baths. At the other end, children who live in homes with lots of bedrooms, e.g. above three in number, have space to explore burn hazards away from parental view (Petridou *et al.* (1998), Lovasi *et al.* (2009).

Davidson (2015) quotes the work of the economist Gerry Rodgers (1979) who states that a sudden increase in individual incomes does not have a linear relationship with better health and is at best asymptomatic. However, Davidson (2015) further quotes Rodgers (1979) who stated that small marginal improvements in life expectancies and health outcomes occur once an individual has attained a certain level of wealth.

Secondly, the relationship between parenting and injury prevention is moderated by deprivation. Increasing personal finances is an important component of moving up the ladder of social mobility (Galea, (2017), Murray (2003)). However, if a parent or carer is not able to utilise their improved finances such that they address their family needs, new found wealth may not do much to change the social situations of a family (Williams and Collins (1995). As such, one can see that culture and behaviour within a family can influence opportunities to reduce health inequalities.

Thirdly, there may also be contextual or environmental influences on the relationship between deprivation and health. For example, if a family finds themselves with better income, but this occurs during a period of economic depression or does not take them out of a deprived environment, their opportunities to benefit from the improved income may be limited. Also, if priorities are misplaced among individuals with new wealth such that the wealth is spent within a short time frame, they may similarly fail to benefit in health terms (Davidson (2015)). The search for better income has led to the mass migration of people from rural to urban areas, especially in LMICs (Yach *et al.*, 2006). Unfortunately, the risk of burn injuries and other poor health outcomes remains high if such individuals and their children find themselves only able to afford living in low-quality housing in the city (Hong *et al.*, 2010).

These changes, of course, are stochastic and multivariable. Braveman *et al.* (2005) state that just because studies do not find an association between SES and health outcomes, it doesn’t mean there may not be ethnic confounding of this relationship or mediation of ethnicity via SES in the relationship with burn outcomes. The authors report how crucial it is to read in between the lines of the study reporting associations and check what measures of SES were used. i.e. if they were appropriate, the level of completeness, the study design and interpretation. Laveist *et al.* (2008) and Mendoza *et al.* (2019) state that the absence of data measuring these variables leads to small sample sizes which may be too little to estimate the true effect of SES or ethnic inequalities. This sentiment is also echoed by Stronks *et al* (2013). However, they report that several questions need to be raised in order to further understand the relationship between ethnicity, SES and health outcomes. For instance, have the variations in socioeconomic characters been accounted for across different ethnic groups and if it is valid to measure SES across different ethnic groups knowing such variations occur. This issues need further research.

Good quality homeownership has been shown to have positive associations with good health outcomes. Given that migration is one of the reasons for increasing numbers of ethnic minorities in developed countries, Vargas-Silva (2017) found that recent migrants (0-5 years in the UK) were twice as likely to be renters (80% in the private sector) than homeowners in that same period. Injuries in preschool children are known to be higher for those living in private rented accommodation. These findings were influenced by the age, salary, type of visa, length of visa, household size and restrictions to social housing (Vargas-Silva (2017)). Vargas-Silva (2017) reports that housing prices in the UK were seen to go down when migration increases, and this was due either to immigrant houses being of low quality (inexpensive housing at the bottom of the housing market) or UK born people leaving areas with increasing migration rates. Marmot *et al.* (2010) state the importance of having houses with updated health and safety equipment, e.g. hard-wired fire alarms and thermostatic mixer valves which can reduce the risks of house fires and scalds respectively. These fixtures are mandatory in all new build homes but may not be accessible to deprived families and ethnic minorities who live in older, more affordable, housing stock (Marmot *et al.* (2010), Vargas-Silva (2017)). Furthermore, Kendrick *et al.* (2005) stated that children living in private rented accommodation were twice as likely to attend primary care services, ED and be admitted to hospital for injuries than those of homeowners. This association remained for primary care and ED attendance even after the authors controlled for deprivation, smoke alarm ownership, age and distance from the hospital.

Understanding historical events through the lens of social dominance theory can explain the impact of deprivation on indigenous people/ ethnic minorities in places such as America, Australia and South Africa (Galea, 2017, Davidson 2015). Many ethnic minorities who find themselves in developed countries may start within the refugee or asylum seeker system (Bhopal (2014), Jayaweera (2014)). Having little or nothing, they find themselves on the bottom rung of society's ladder. Moving up the ladder of social mobility is a herculean task especially when they compete for social opportunities with the poorer or deprived natives of the developed countries they now reside (Bhopal, 2014). Those who have uncertain/irregular status or undocumented status, and even those from skilled occupations, may be subject to laws which limit their freedom to become employed, develop and access healthcare (Jayaweera (2014), Zoni *et al.* (2018) and Migration Observatory (2018)). For example, working hours may be restricted, right to rent or own better properties that meet their family sizes are harder to obtain (Bhopal, 2014, Davidson (2015), LaVeist and Isaac (2012)). These latter examples are a clear form of inequity which then means some ethnic minorities cannot improve their lives even when they can afford it. Thus, their children are also exposed to disadvantages that expose them to poor health outcomes including burn injuries.

Families from ethnic minorities in the UK are more likely to live in deprived urban areas. Children in the HES dataset were more likely to be admitted with burns if they were living in areas with the highest deprivation (5$^{th}$ quintile). This fact is no surprise given that Marmot and Bell (2012) report that individuals living in the most impoverished socio-economic and environmental areas tend to have worse health outcomes. Residential properties in deprived areas are more likely to be in poor condition (older, smaller, colder, less equipped with fire safety equipment/designs). These houses may include more injury hazards than their counterparts in less deprived areas (DiGuiseppi *et al.* (2002), Marmot and Bell (2012) and Shenassa *et al.* (2004).

Parenting practices may be influenced by those more impoverished conditions especially if there is overcrowding or not enough funds to hire extra help around the home if required (Marmot and Bell (2012), Shai and Lupinacci (2003)).

Different ethnicities or cultures may have different views on parental practices (e.g. supervision techniques, fire safety and first aid) and deprivation levels may moderate this relationship. For example, families from minority ethnic groups may be more used to having extended family members or neighbours contributing to supervision for their children, which they do not have here in the UK. However, if the cultural ties are strong in the UK setting, some families from the same ethnic minority groups may create familial bonds that mimic cultures from their ancestral homes. (Ablewhite *et al.* (2015), Cheng *et al.* (2016) and Mallonee *et al.* (2003). There is also the influence of parental educational levels which is often low among individuals from deprived and ethnic minority backgrounds (Marmot and Bell (2012)). Some studies have found that parents with low levels of education and or health literacy are more likely to have children at risk of burns (Lehna *et al.* (2016), Emond *et al.* (2017) and Shenassa *et al.* (2004)). Therefore, the interplay between ethnicity, deprivation and burns are complex and include several additional factors like poor living conditions, overcrowding, parental practices, and cultural behaviour.

In all, the evidence strongly supports an association between ethnicity and deprivation. The fact that some studies didn't account for the effect of deprivation on ethnicity (and vice versa) is worrisome (Gaskin *et al.*, 2008, LaVeist and Isaac (2012)). This thesis has shown an association between both ethnicity and deprivation and increased burn admissions and attendance at ED even after controlling for each other in their models. Chapter three has described possible confounders, moderators, mediators and covariates that affect the different burn models described in Chapter 4 and 5 of this thesis. LaVeist *et al.* (2008) state the importance of understanding that socioeconomic differences are not the only reasons for health inequalities across ethnic or racial groups, but also, other sociodemographic factors that are engaged with differently by all ethnic groups. Bhopal (2014), Jayaweera (2014), LaVeist *et al* (2008) and Mendoza *et al* (2019) argue that to understand how these dynamics come into play, we need to ensure that there is good quality data collection on ethnic groups, migration status and health outcomes to enable analyses that can inform policies that will improve their experiences. The Migration Observatory (2018) also stated via its commentary that polices around immigrant data, services and usage need to be fairly monitored and evaluated to ensure that legal migrants do not face discrimination and ill-treatment due to propaganda or political dissent.

For inequalities to be reduced and improved health for all to be obtained (especially those who are at risk of poor health outcomes), interventions need to operate at the individual, familial and environmental level (Chin *et al.*, 2007). For example, tackling socio-economic disadvantage in minority ethnic groups may contribute to reducing ethnic inequalities in burn risk in children in the UK. Also, current legislation and policies on house safety have made thermal injury prevention efforts much better now compared to previous years (DiGuiseppi *et al.* (2002) and Marmot *et al.* (2010)). In all, these actions require the support of the individuals involved, their culture, governments and health establishments for child burn injury prevention and intervention strategies to work (Chin *et al.,* 2007, Jayaweera (2014)). More research is needed in this area.

# **CHAPTER 7** : DISCUSSION

## 7.1 Brief Restatement of Findings

The literature review (Chapter 2), concluded that there was limited evidence on the contribution of various risk factors to paediatric burn injury incidence or outcome, including deprivation, ethnicity, geographical location, pre-injury impairment, supervision levels and health-seeking behaviour (particularly appropriate first aid application after a burn injury). These findings informed the generation of research questions and subsequent data analyses from two secondary data sets: Hospital Episodes Statistics (HES) and the Burns and Scalds Assessment Template (BaSAT) data set.

Analyses of HES data found that children from areas with higher levels of deprivation, with a minority ethnic background and resident in an urban area, were more likely to be admitted to hospital for burns. The BaSAT analyses showed no relationship with the child's additional needs, but persistent associations between suboptimal supervision and greater deprivation reducing the likelihood of parents using cool running water (CRW) first aid on children immediately after a burn injury.

## 7.2 Strengths and Limitations of HES Dataset

### 7.2.1 Strengths

- The HES database has massive strength in numbers as it covers NHS admitted patients from all over England. These numbers also take into consideration private patients treated within the NHS; patient's resident outside of England (who may have visited for work or leisure and unfortunately had to attend hospital) and care delivered by treatment centres funded by the NHS as well as patients treated in privately owned hospitals. As of 2015, the HES database holds about 125 million records annually for admitted patient care (APC), outpatients and ED attendances (HES, 2016).

- The HES database collects clinical information about diagnosis and operations information about the patient. This information is detailed for primary diagnoses which are coded using the WHO ICD-10 codes as well as secondary diagnoses and routes for treatment, after treatment and discharge (HES, 2016).
- The HES database is also reliable for collecting some socio-demographic factors such as age group, gender, ethnicity, a region of residence and urban/rural address and other administrative information relevant to the research questions. There were few missing data for these variables, which were all more than 80% complete

### 7.2.2 Limitations

- As with all secondary data, there are cases of missing data or errors in coding data. However, the impacts of the latter are mitigated by the data analyses guidelines published by data analyst and administrators to guide researchers working with the data. E.g. the guidelines give general information for each variable, how it was collected and coded, and considerations as well step by step instructions on how to recode or clean a particular variable (if necessary) (HES, 2016)
- Some variables may seem complicated regarding their definition and coding, e.g. after changing over the years and may create conflict for researchers using multiple years of data. Again, this issue is resolved with the provision of data dictionaries to guide users of APC, outpatients and ED data (HES, 2016).
- Not all questions of interest have answers within the data sets. This issue is familiar with secondary data where one makes do with what is available or re-code or index what their interests from what is available.
- Burns as secondary diagnoses were not defined. It was not clear if these were minor burns not worthy of being the primary cause of admission or were previous episodes for that one individual. As such, their removal brought clarity.

- HES could not be used in investigating the contribution of a child's additional needs status to burn risk. This analysis was undertaken using the BaSAT- Burns and Scalds Assessment Template (BASAT) dataset.
- The HES dataset does not categorise the outcome of interest for this thesis, i.e. burn admissions by severity, the degree of burn or the type of burn, its agents and mechanism. However, these variables are available in the BaSAT

## 7.3 Strengths and Limitations of the BaSAT Dataset

### 7.3.1 Strengths

1. BaSAT collects information on all children under 16 presenting with a burn to EDs. On average, only 10% of these attendances are on admission.
2. BaSAT collects more detailed socio-demographical information that is missing from HES or is not readily available on the general proformas used in collecting information when children present to hospital with thermal injuries. This fact allows consideration of a broader range of exciting research questions that are relevant to burn epidemiology especially around suspected abuse cases, pre-injury impairment, supervision levels and burn type.
3. The level of completeness for BaSAT ED data is better than HES ED data for burn injuries research.
4. BaSAT collects information from both England and Wales compared to HES that only covers England.
5. BaSAT data collection occurs as soon as the child presents to the ED, rather than on a monthly/quarterly basis. The proforma is completed at the time of presentation, minimising recall bias.
6. BaSAT data is reviewed annually to improve the quality of questions within the template. This revision ensures changing trends in burn epidemiology undergoes incorporation into the dataset.
7. BaSAT provided more burn outcome variables useful for investigating inequalities. These three outcomes not available in HES: burn type (scald

versus non-scalds) burn severity (burn depth) and use of cool running water (CRW) first aid.

8. The BaSAT dataset is purely burn focused and did not have any secondary diagnoses record for each patient (as with HES). Thus, there is an assurance that the main reason for ED attendance were thermal injuries.

### 7.3.2 Limitations

1) As with HES, there were issues with the completeness of specific variables. These issues were complicating for variables that were not mandatory with earlier versions of the dataset.
2) There were a few complex variables regarding definition and coding. However, like HES, there was a description booklet which helped researchers understand the context of specific variables. This booklet helped with re-coding and indexing where necessary.
3) Some questions could not yield answers with BaSAT data. However, this is where the HES dataset proved a useful complement, e.g. the relationship between geographical location and burn injury attendance.
4) BaSAT is not nationally representative of the whole of England like HES. However, it is a suitable sample for ED attendances for burns in England and Wales (Kemp *et al.,* 2014).

## 7.4 Strengths and Limitations of Methods used in Collating Datasets

This thesis employs two secondary datasets. These datasets were created by the coordinated efforts of healthcare staff and coding clerks (Baker *et al. (*2016) and Kemp *et al.* (2014)). The methods used during the collection of these data may have affected their quality and impacted on the results seen (Davies *et al.* (2015) and Garratt *et al.* (2010)). Dataset quality is assessed by consideration of the completeness, accuracy, representativeness and timeliness of the data.

### 7.4.1 Completeness

Both the HES and BaSAT datasets are records of reports made by parents/carers and clinical diagnoses by clinicians about the burn injury in children presenting to hospital for burns. There may have been some misinterpretation bias of variable specific information (e.g. responses to demographical questions asked when parents report with injured children.) on the part of the administrative staff. This issue may lead to human errors if coded inaccurately or being missed if it was not clear to the coder (Baker *et al.* (2016) and Purdy *et al.* (2009)). There may have also been issues with recall bias if the parents/carers forget events that transpired during the incident before attending hospital (Ablewhite *et al.* (2015) and Ingram & Emond (2009)). In BaSAT data, there were instances where some of the EDs utilising the BaSAT proforma where more conscientious in collecting all the necessary details per burn case compared to other centres (Kemp *et al.,* 2014). This variation may have been due to training or heightened clinician's interest in the importance of information BaSAT could provide, or it may be due to the motivation each ED team has, depending on how well funded and organised it is to conduct clinical research studies. A further variable is funding for the employment of clerks who could attend to administrative issues related to collating the datasets (Garratt *et al.* (2010), HES (2016) and Thompson *et al.,* (2004)). Thus, if a trust tries to make savings by reducing costs of clerk recruitment, salaries, training for the use of IT systems or set unreasonable deadlines for coders or use new coding staff, this may bring in biased results that may be incomplete or inaccurate due to errors. It may not make these administrative staff compile or code patient notes appropriately if they are stretched thin (CAPITA-CHKS 2014)

There is also the issue of how patients conceptualise understand and respond to questions used in collecting data for each dataset. This issue may then in turn influence how complete details for everyone will be (HES (2016) and Jack *et al.* (2006)). Questions that are deemed too personal or "invasive" may receive little or no reply. E.g. ethnic information, sexual orientation, annual income per year, history of domestic violence in the home and the type of pre-injury impairment. These factors may be missing not at random (Emond *et al.* (2017), and Mallonee *et al.* (2003)). Thus, it is unlikely these data are missing by chance but rather a conscious effort by parents/carers to avoid the question or for some administrative staff not to ask altogether (Bellis *et al.* (2011) and Mallonee *et al.* (2003)).

If the ED or ward is very busy, there may be little time to answer all questions on a proforma, resulting in only mandatory questions being filled in for each dataset (Davies *et al.* (2015) and Jack *et al.* (2006)). One approach to solving this problem is the use of electronic forms rather than paper forms, so the clinician cannot proceed to mark an entry as complete if necessary questions are unanswered (Davies *et al.* (2015) and NHS Digital (2017)). In the HES dataset, critical socio-demographic questions are mandatory. Thus analyses involved an almost complete record for most of these variables (HES (2016) and Thompson *et al.,* (2004)). Also, data uploaded into HES are linked to funding for the hospitals/trusts that supply complete information. This action ensures that hospitals/trusts earn some income from pushing for data quality and completeness (Farrar *et al.* (2009), HES (2016) and Jack *et al.* (2006)).

In summary, reasons for poorly completed data may include recall bias, motivation and understanding of staff regarding the data requests and usage, staff capacity and capability to collect data required, asking participants to report sensitive or personal information they may not wish to disclose. As there is no direct information in either HES and BaSAT as to the concrete reasons for any missing data observed, one cannot conclude reliably on the resulting bias each reason may bring into the dataset. However, what one can comment on is that the level of “missingness” was much lower in HES across most of the variables used than in BaSAT. In HES, all available data (AAD) were used for the analyses. Where “missingness” may have affected findings (e.g.in BaSAT), complete case series (CCS) analyses were chosen. However, most of the results did not differ significantly from that of the all available data (AAD) analyses (see next sub-section for more detail).

#### 7.4.1.1 Dealing with Missing Data

Missing data is an issue that complicates the data analyses stage of most quantitative based research. Data can be missing in three different ways. First, Missing Completely at Random (MCAR), where there is no relationship between whether a data point is missing and any other values in the dataset. Secondly, Missing at Random (MAR)- where observed data can explain differences between observed data and missing values. This means that the probability for the data to be MAR is dependent on another variable in the dataset (Pedersen *et al.*, 2017). Thirdly, missing not at Random (MNAR)-where the value of the variable that's missing is related to the reason its missing; i.e. differences between observed data and missing values cannot be precisely explained by the observed data. This also means that the probability for the data to be MNAR is dependent on unobserved data in the dataset of interest (Pedersen *et al.*, 2017).

A good example of this is IMD which is dependent on the postcode in calculating the deprivation score an individual lives in. Families with no fixed abode/visiting may be more likely not to provide postcode which leads to difficulty in calculating IMD scores.

There are two primary methods of dealing with missing data: complete case series analyses and multiple imputation (Sterne *et al.,* 2009).

Complete case series (CCS) analyses only utilise individual-level data that are complete with all exposures, covariates, mediators, moderators, confounders and outcomes of interest ((Pedersen *et al.*, 2017) and Sterne *et al.,* 2009). In other words, everyone in the CCS data must have complete data for all variables of interest. While this may take away the problem of any missing data, it reduces statistical power and the precision of any resulting outputs from models executed, since the size of the remaining sample is likely to be much smaller than the original dataset.

CCS analyses may be considered unbiased when the following assumptions are met. Firstly, the outcome variable of interest is not a repeated measure per individual. E.g. taking several measures of blood pressure from one individual. In this thesis, burn outcomes are not repeated measures. Secondly, all variables associated with the outcome are MAR and are covariates. This is not the case with this thesis as some of the covariates are MNAR, e.g. IMD. Lastly, the predictor variables and their missing data are not related to the outcome (Sterne *et al.,* 2009). This, however, was not possible in this thesis given the conceptual diagrams in Chapter 3 which show how some of the predictor variables have an intertwined relationship with burns in children. Thus, caution should be applied in using CCS analyses for data that are MNAR.

Multiple imputation (MI) aims to reduce the uncertainty resulting from missing data by imputing data values that are missing in the dataset, creating several new imputed data sets and then combining results obtained from each imputed dataset (Sterne *et al*., 2009). It is an increasingly used technique with large datasets, but the underlying assumption is that data are MAR. Several principles ensure an adequate imputation process. Sterne *et al.* (2009) warn that multiple imputations should not be a routine additional analysis but involve following the necessary principles and seeking expert statistical assistance where available. MI was not used for this thesis for two main reasons: the data were not normally distributed, and the missing data were mostly MNAR, both of which could have introduced bias. Although it is possible to re-organise the data into a normal distribution fit for imputation, the process can be quite burdensome and involves technical manipulation. As such, erroneous results occur if there is a technical misapplication during the process (Pedersen *et al.*, 2017).

The analyses presented in this thesis were undertaken using both all available data (AAD) and CCS. For clarity, the results of both the AAD and CCS analyses are presented in chapter 5, to illustrate any relationship that shows a different result in each analysis. Differences were observed for the following associations: any defined impairment and CRW first aid (subsection 5.5.2.1), the type of impairment and burns depth (sub-section 5.5.3.2) and ethnicity and burn depth (sub-section 5.5.10). All other CCS analyses are in the appendices.

The key variables have been listed below, with the adjustments made for missing data

#### *7.4.1.1.1* ***Age:***

This variable was either a covariate or confounder in both HES and BaSAT datasets: 0.5% of it was missing in BaSAT, but it was complete in HES. From the definitions above, it seems to be a variable that is missing at random (MAR). Because the amount of missing data on age was very small, it was considered unlikely to introduce bias into the analyses using BaSAT.

#### *7.4.1.1.2* ***Sex:***

This variable had missing data ranging from 0.02% to 0.7%. Sex also was considered a MAR variable and the amount of missing data was considered too small to cause any significant bias.

#### *7.4.1.1.3* ***IMD:***

This variable acted as a predictor, covariate, moderator, mediator or confounder depending on the models using it. IMD is MNAR, as one cannot assume to which quintile missing data may belong to from the observed data. Missing IMD data may be due to those who forgot or failed to put down a postcode, were nomadic or had no fixed abode. As with age and sex, the missing amount in HES (0.97%) was considered too small to have an effect, and so multivariable analyses on IMD from HES used all available data. BaSAT, however, had approximately 20% missing IMD data for those included in multivariable analyses, and so CCS analyses were carried out. However, the results were like those from the AAD analyses. Differences in odds ratios (ORs) were minimal and did not change any interpretation of the data.

#### *7.4.1.1.4* ***Ethnicity:***

This variable was also considered MNAR, with missing data which ranged from approximately 12% to 14%. There may be several reasons why ethnicity was missing. Individuals may not have been asked (as some staff may consider it too sensitive or not relevant), may have been asked but didn’t respond (because they did not self-identify with the categories given); or may not have wished to give that information on record. Due to its MNAR nature, ethnicity was not impute, and AAD and CCS analyses were carried out. Findings in the AAD analyses became non-significant in the CCS analyses. Results from the final model (controlling for the necessary variables) remained the same. Thus, it is likely that missing data have underestimated the effect of ethnicity and its relationship with burn outcomes.

##### *7.4.1.1.5 Urban/Rural divide:*

This variable was only present in HES and was based on the postcode of residence of the patient. It had 0.6% of missing data which was classed as MNAR and considered too small to affect any relationship in its models.

##### *7.4.1.1.6 BaSAT burn-related outcomes:*

As mentioned in chapter 5, these include burn type, burn depth and if cool running water first aid was applied. Missing data ranged from 0.9% to 8.3% and were classed as MNAR. Data for these outcome variables may have been missing due to the questions not being asked, or clerical/coding errors within the clinical environment. Analyses were carried out with these outcomes based on AAD and CCS, but CCS analyses did not show any critical differences from AAD analyses. Thus, AAD analyses were used for interpretation because of the larger sample size.

##### *7.4.1.1.7 BaSAT family-oriented variables:*

These included the history of domestic violence, supervision, and social worker. These had a range 16% to 44% of missing data which were classed as MNAR. It is possible that clinicians did not ask the questions because they were considered too sensitive, or that parents did not answer them if they found the questions irrelevant, or possibly feared judgement by the clinician or consequences to them and their families.

The results of CCS analyses were similar to those of the AAD analyses (especially for supervision). There were minimal changes among the ORs which decreased by 0.04 in some models or increased by 0.01-0.06. These changes did not influence the associations observed or interpretation made in their respective AAD analyses models. Findings from the AAD analyses were presented as the CCS analyses had a smaller sample size and reduced power.

### 7.4.2 Accuracy of Coding

Both datasets had a good system of coding with relatively few problems which are discussed in the following paragraphs (where appropriate). Both datasets utilise the ICD-10 coding system for clinical outcomes (Kemp *et al.* (2014) and Richards *et al.* (2017)). However, the coding systems for the predictors of interest vary by dataset and each predictor (Baker *et al.* (2016) and Groom *et al.* (2006)). This variation slowed down the cleaning and coding process but was a necessary inconvenience. Coding accuracy was ensured by reviewing the data dictionaries' criteria for each variable in both BaSAT and HES. Errors or confusing data were discussed with the respective data managers of both datasets for more clarity/corrections of such issues, e.g. using free text/tick boxes responses in checking for pre-injury impairment in BaSAT- the latter of which was deemed accurate and used. Some of the coding systems used for the predictors are from valid and reliable measures used in other datasets or coding systems. E.g. for the variable looking at the urban/rural divide in HES, this builds on the categorisation used in the UK 2011 Census data. Also, both HES and BaSAT use the IMD and ethnic categorisation systems used in the UK 2011 Census data (HES (2016) and Jack *et al.* (2006)).

However, when it comes to information on pre-injury impairments (available only in BaSAT), a simple coding system was used based on parent/carer's self-report of their children's impairments. These build on previous diagnoses from health professionals or parent/carer concerns. The options presented in the pre-injury impairment question were also not based on a valid/reliable system like the ICD10 or DSM IV. Instead, the options are a broad list of types of impairment, e.g. if it affects the eyes, then it's coded as visual. (Emond *et al.* (2017) and Kemp *et al.* (2014)). Note that variables relying purely on self-reports may have some selective reporting and misclassification bias (Morrongiello *et al.,* (2012) and Roman *et al.,* 2012).

BaSAT is better than HES when it comes to the coding of not– routinely collected socio-demographical factors. E.g. history of a social worker, domestic violence, supervision and burn-specific questions (especially those with contested measures). HES is superior to BaSAT in the coding of routine socio-demographical information like IMD, ethnicity and the updating of codes over its more than 30-year existence to suit the changing trends in clinical and non-clinical research (Garratt *et al.* (2010), Kemp *et al.* (2014) and Thompson *et al.* (2004)).

### 7.4.3 Representativeness

HES capture all hospital admissions for England, and therefore are representative of admissions in children in England under 15 years. The fact that the system collects outcomes of all conditions made it possible to compare burn admissions to admissions for other conditions (HES (2016) and Groom *et al.* *(*2006)).

BaSAT is not a nationally-used data collection system. However, it is designed to capture all hospital ED attendances with burns and scalds in children. Also, published analyses have shown it to be broadly representative of children under 16 years old attending EDs for burns in both England and Wales (Kemp *et al.*, (2014)). However, due to the distribution of ethnic groups living within the catchment areas of the hospitals using the BASAT tool, it is unlikely to reflect the ethnic diversity of the broader population of England and Wales.

### 7.4.4 Timeliness

Both datasets differ in the frequency of collection of data. HES collect data monthly or quarterly which are collated and released every financial year (HES (2016) and Groom *et al.* (2006)). However, BaSAT collects data as soon as they are reported to study centres. Paying hospital/trusts for HES data may help ensure hospitals/trusts total data returns promptly (Garratt *et al.* (2010) and Thompson *et al.* (2004)).

At the time of analyses, HES data were available for 2009-2015, and the BASAT data used were Jul 2012-Nov 2016. Thus, although the two datasets overlapped in the time covered, the BASAT data were the most recent. Both datasets are likely to reflect the lived experience of children <15y in England and Wales at the time of analyses. Therefore, both may be said to reflect current risks for burn injuries among children in England and Wales from 2009-2016.

## 7.5 The justification for the choice of analytical method

Most of the previously published literature reviewed and utilised in this thesis carried out descriptive data analyses. The few that carried out inferential analyses used logistic regression and other methods like Cox regression analyses or

Poisson regression analyses (Baker *et al.* (2016), Bellis *et al.* (2011), Hjern *et al.* (2001[a]) and Kemp *et al.* (2014).

A logistic regression analysis was deemed to be the best approach to analysing the data from HES and BaSAT. This choice is due to the following advantages:

1. Logistic regression has popular usage for analysis of binary outcome variables. It works with the assumption that the outcome variable either has the outcome of interest (1) or not (0) (Kirkwood and Sterne (2010)).
2. Logistic regression also assumes that there are no effects on study findings due to differences in follow up time (i.e. if collated over a period as with cohort studies) (Callas *et al. (*1998)).
3. Logistic regression is also readily available in most statistical software and easy to carry out hence their popularity in health research. Also, the relationship between exposures and outcome is measured via odds ratios (OR). (Callas *et al. (*1998); Kirkwood and Sterne (2010)).
4. Some studies argue that logistic regression results often give slightly bigger ratios than Poisson regression but trusted the latter to be more precise (Coxe *et al.* (2009) and Guo *et al.* (2000)). Others argue that this is because logistic regression measure ORs while Poisson regression measures IRRs (Callas *et al. (*1998) and Coutinho *et al. (*2008)). Some studies that carried out a comparison of regression methods agree with the points mentioned above. However, these studies also state that findings were still the same for the research questions. That is, they all showed an association or not (where applicable), and interpretation of results did not change with each method (Callas *et al. (*1998), Coxe *et al. (*2009) and Coutinho *et al. (*2008)).
5. Some authors, however, argue that the choice of analytic technique is a subjective judgement of what works best for one's research (Bellis *et al.* (2011), Mather *et al.* (2017) and Peng *et al. (*2002)). The authors also mention that this method should produce the best

fit for their analyses: e.g. Guo *et al.* (2000) combine logistic and Poisson regression in their studies for two different research questions that had the available data.

In summary, logistic regression is the choice of analytical method for this thesis. The reasons are the use of binary outcomes used in both HES and BaSAT data. Secondly, the categorical form of most of the exposure variables and the no time differences in data collated for both datasets. Logistic regression is often considered suitable for analysing dependent variables with binary outcomes. This method is easy to carry out compared to the other regression methods listed above. This regression does not have statistically technical issues that may challenge non-statistical experts when modelling data. The method also tends to create good fit models with data and or is suitable for their research questions (Coutinho *et al. (*2003), Kleinman and Norton (2009) and Localio *et al. (*2007)).

In retrospect, it may have been possible to use alternative methods in analyses, but these must be considered using methodological principles, available time and resources. For example, these include the following:

1. <u>Case-control:</u> Some previously reported literature primarily those published before 2000, e.g. Petridou *et al.*, (1998), tended to use a case-control design for their study while utilising a logistic regression. The data used in this thesis were in their original cross-sectional "state". Case-control was not used as there were more than enough numbers to carry out analyses and burns are not rare events- a crucial factor to consider when carrying out a case-control analysis (Kirkwood and Sterne, (2010); Webb and Bain (2010)). The creation of a matched control group may have been possible for HES data, but not for BaSAT which only records burn injuries.

2. <u>Inferential analyses</u>: Although some studies (Barros and Hirakata (2003), Coutinho *et al. (*2003) and Sleeman *et al.* (2016)) advocate for other forms of inferential methods. E.g. Poisson or Cox regression because they give

a more precise estimate of risk or odds when carrying out inferential analyses that have multiple variables.

Poisson regression is often used to examine rates, counts and or incidences of injury by time events (e.g. annually) and counts of events or types of burn injuries (Baker *et al.* (2016), Laursen and Nielsen (2008) and Orton *et al.* (2014)). Poisson regression tends to assume the outcome is recorded as count data, i.e. the number of times an outcome variable occurs, e.g. parity, the number of asthma attacks a person has per year, years spent in education (Coxe *et al. (*2009) and Guo *et al. (*2000)). The outcome is usually not binary, nor does it favour counts with a zero. When the latter occurs, a negative binomial regression occurs instead. These issues make the use of Poisson regression technical to execute even if they are available in statistical software (Callas *et al. (*1998) and Coutinho *et al.* (2008)). The relationship between exposure and outcome for a Poisson regression is expressed as incidence rate ratios (IRR).

## 7.6 Discussion on Themes of Inequalities

This section will discuss in detail findings from the research done in this thesis under four central themes namely deprivation, ethnicity, urban/rural divide and pre-injury impairment. The secondary issues of supervision and application of adequate first aid were also investigated and are discussed as two additional minor themes.

### 7.6.1 Deprivation

The research question for this theme was: Is there a consistent relationship between burn injury in childhood and social disadvantage?

The results suggest that the answer is yes and that the burden of burn injuries disproportionately affects the most deprived social groups

Deprivation means the lack of necessities required for the proper or continued functioning of an individual, family, community or groups of people (Dorling (1995), Galobardes *et al.* (2006[a]) and Shavers (2007)). Several measures can be used to assess deprivation. However, for this thesis and in the UK, the most traditional measure of deprivation is the Index of Multiple Deprivation (IMD) (Cheng and Goodman (2015) and Galobardes *et al.* (2006[b])). This composite measure takes into consideration seven factors namely: income, employment, health deprivation and disability, education skills and training, barriers to housing and services, crime and living environment around an individual which exposes them to continued deprivation throughout their life course. Thus, IMD is usually a geographical measure of deprivation (Garratt *et al.* (2010) and Galobardes *et al.* (2006[a])).

IMD comes from patient's postcode which is a mandatory variable in the HES dataset and as a recommended variable in the BaSAT (Galobardes *et al.* (2006[b]), HES (2016) and Shavers (2007). In HES, it was available for over 85% of all admitted cases with burns as the primary diagnosis. Descriptive analyses revealed a social patterning in burns admissions, i.e. the more deprived children were more likely to be admitted. These observations reflect in other studies like Orton *et al.* (2014), Jack *et al.* (2006) and Thompson *et al.* (2004) examining IMD and health outcomes in HES have reported. When the multivariable logistic regression of burns admissions on IMD occurred, the odds ratios confirmed this social patterning even after adjusting for all available individual, family and environmental factors. These findings are consistent with the previously reported literature showing a social patterning in most conditions including injuries, with individuals from the most deprived backgrounds having greater risks (Hong *et al.* (2010), Kramer *et al.* (2010) and Petridou *et al.* (1998)).

The findings from the BaSAT data showed similar patterns, with the proportion of cases attending ED for burns being highest in the most deprived quintiles (see Chapter 5). However, when multivariable logistic regression examined the relationship between burn type or burn depth and IMD respectively, no association was found between IMD and burn type or burn depth. These findings fill in the gaps found in the published literature reviewed for this thesis on the associations between IMD on burn type and burn depth respectively. Thus, one may conclude in general, that with the BaSAT data; odds of children below 16 years attending hospital for having a scald over a non-scald, deeper burn or CRW first aid (except for the 5$^{th}$ quintile) is not related to the deprivation quintiles of their residence. Associations have only been shown in previous literature when comparing burns in children to other conditions in children or healthy children (Bellis *et al.*, (2011) and Hughes *et al.* (2014).

The association between deprivation and poor health outcomes is multi-faceted and detailed in previous literature on other conditions (Braveman *et al.*, (2005) and Orton *et al.* (2014)). With burns, published literature has tried to break this down by examining different units of deprivation. E.g. unemployment, inadequate housing, illiteracy and poor lifestyle/behavioural choices that may lead to higher risk of injury in the home and amongst the most vulnerable groups (Laursen and Nielsen (2008), Quayle *et al.* (2000) and Shenassa *et al.* (2004)). Some argue that an influx of wealth could also lead to having no time for children. Hence, proper supervision if unavailable may lead children to explore critical risk factors and behaviours (Morrongiello *et al.* (2009), Petridou *et al.* (1998)). Though available to all, children who come from backgrounds that are heavily more deprived may be more likely to present to hospital. The reason is the no cost of consultation or charge for attendance. Also, some families "trust" in the UK or a developed country health care system. This occurrence may be shared among families from less developed countries that expect to give their children the best medical care they may not be able to afford otherwise (Booker *et al.* (2015), Propper *et al.* (2008) and Tammes *et al.* (2015)). Furthermore, the distance of residence to hospital and availability of private transport (if affordable) may influence this relationship as well but were not available in both datasets (Hjern *et al.* (2001[b])).

In all, findings from HES and BaSAT support the fact that children from more deprived backgrounds are at more risk of burn attendance/admission in the hospital (whether results are descriptive and or inferential). This finding may have been expected seeing children of such backgrounds experience exposures to adverse childhood experiences that put them at risk of developing poor health and non-health outcomes as seen in previous literature (Hughes *et al. (*2014), Orton *et al.* (2014) and Duke *et al.* (2015)). BaSAT data, however, shows no association between IMD and burn type or burn depth. The findings on IMD and burn type is similar in Tan *et al.* (2012).

Greater deprivation is often associated with the more inferior quality housing (e.g. old housing without proper fire safety equipment). There is also the likelihood of overcrowding and homes with increased injury hazards (due to poor maintenance) for children (Bellis *et al.* (2011), Fernandez-Morales *et al.* (1997) and Graham *et al.* (2010)). However, these issues have not been explored within both datasets as they were not available.

### 7.6.2 Urban/Rural Divide

The research question in this theme was: Do children living in rural regions have a higher risk of burns than those that dwell in urban regions? Results from the descriptive and inferential HES analyses suggest that children dwelling in urban areas are over-represented in hospital burn admissions than those from rural areas. This observation could be because children living in rural areas (who tend to live far away) will be kept in hospital unlike their urban counterparts that live close by, who could quickly go home and often return for dressing changes. These actions may be done to reduce the length of stay in hospital and overcrowding in wards. These suggestions need future research to investigate.

This factor is often used in health research to describe if there is a spatial difference in areas occupied by most patients of interest (Becares *et al. (*2011), Dorling (1995) and Hart *et al.* (2005)). It is thus a geographical measure of the socio-demographical development of an area and what this augur for its occupants (Hale *et al.* (2010), Poulos *et al.* (2009) and Williams *et al.* (2003)). There is also the region of residence, but as much ambiguity may be expected to occur at regional levels, this area was not explored in detail as it is not part of the research questions of interest of this thesis. There may be several reasons for such differences, e.g. variation in health service delivery and utilisation, an excess of admissions due to more injuries, or a different configuration of burn services. These issues need further investigations in future research.

After controlling for all present individual, family and environmental factors in the HES analysis, the association between living in an urban area and having a burn admission persisted, though it was weak. The explanation for this could merely be ease of access to the hospital for urban patients and the fact that most of the

UK population stay in urban areas. This observation occurs in studies from the Scandinavian region that preferably examine “distance to the hospital” as a geographical measure in their studies (Hjern *et al.* (2001[a]), Hjern *et al.* (2001[b]) and Laursen and Nielsen (2008)). With good public transport links to urban areas and available emergency services; children from rural areas may not suffer as much as some of their counterparts in other HICs like Canada, Australia. Thus, some unknown underlying factors contribute to children from rural areas in some HICs having worse burn outcomes that are not present in the UK. For example, a different ethnic pattern and culture of supervision or risk-taking behaviours that are not present within UK rural regions (Alaghehbandan *et al.* (2012), Lam *et al.* (1999) and Pym *et al.* (2013)). Also, some published literature hint of how some guidelines/laws/policies meant to reduce risky behaviours/factors are observed lightly in some rural areas even within some HICs like Australia, Canada and Greece. This observation is quite different to the UK scene where such guidelines/laws/policies may be stricter or well-observed (Duke *et al.*, (2015), Mah *et al.*, (2013) and Saridi *et al.*, (2015)). Another important factor that may explain why the UK has higher odds of admission for paediatric burns from urban areas than rural areas is the concept of “urbanisation of poverty”. The mass migration of people from rural areas to urban areas for work, better housing, schools and ease of access to necessary infrastructure is well known. There is also some migration of poverty itself away from rural areas to urban areas (Balan and Lingam (2012), Burrows *et al.* (2010) and Dorling (1995)).

Most families who have a low socio-economic status thus have no choice but to dwell in deprived areas which tend to have pockets around urban areas in England. Here, they find living and the survival they can afford which most times are not ideal for a child’s development and security (Burrows *et al.*,(2010), Lehna *et al.,* (2016) and Riva *et al.* (2009)). There is also the issue of competing for a better life with those already present in such deprived areas. Also, there are other incoming groups with similar poverty levels from outside the UK, e.g. refugees, asylum seekers (Cronin *et al.* (1996), Dempsey and Orr (2006) and Ingram and Emond (2009)). There are also low levels of social mobility and widening inequalities (driven by direct and indirect individual and political decisions) within the UK. These issues may contribute to the increased risk of burn admission for children in urban areas compared to those in rural areas (Graham (2010), Green and Collins (2006) and Riva *et al.*, (2009)). However, controlling for deprivation did not cancel out the association between burn admissions and children living in an urban area. One should remember that the proxy for socioeconomic status in this thesis was IMD which is more of an area measure rather than an individual measure of socioeconomic status. As such, it is subject to pockets of variation that plagues most area/group measures as described in Chapter 2, section 2.6.3.1 (on inequalities by deprivation) and 2.6.3.3 (on inequalities by geographical variation). Thus, this serves as a confirmation that a larger population of children in urban areas and ease of access to hospitals may be the primary contributors for the observed over-representation.

### 7.6.3 Pre-Injury Developmental Impairment

The research question for this theme was: Do children with additional needs have a higher risk of burn injury than children with no additional needs?

Although associations occur in univariate analyses, these disappeared after adjustment.

Impairment can be described as any group of factors which may impede a person's functioning to the best of their ability. In the longer term, impairment may lead to morbidity and mortality throughout a person's life course (Hyder and Morrow (2006), Papworth Trust (2016) and Sayal *et al.* (2015)). Impairment could be congenital or result during the postnatal developmental stages of an individual. However, most impairments can result from genetic predispositions in an individual's family history. These conditions may also result from risky parental lifestyle choices having an after-effect on an individual during their pre-natal developmental stages (Emond *et al.* (2017), Ghanizadeh (2008), Oldfield *et al.* (2015), Wigelsworth *et al.* (2015)).

In this thesis, analyses were carried out to test for associations between pre-injury impairment and risk of burn injuries in children. However, suitable data were only available in the BaSAT dataset. As outlined in the sub-section describing pre-injury impairment in Chapter 5 above (section 5.3.4.1), this information on developmental and behavioural impairments was collected by clinicians from parents/carers of children presenting to EDs with burn injuries. Selections were then grouped to form two broad categories namely behavioural and non-behavioural (motor, neurological, hearing, visual and learning) impairments.

Descriptive analyses showed approximately 5% of children attending EDs for burn injuries were reported to have a pre-existing impairment. According to a national report by the Papworth Trust (2016), the number of children nationwide with a form of disability or impairment was 7% of the child population in the UK from 2012/13. After adjusting for individual, family and environmental factors, multivariable logistic regressions showed no association between having a pre-injury impairment and type of burn (scald vs non-scald) compared to children with no impairments. This finding is interesting as it tells us that a child having pre-injury impairment does not put them more at risk of having scalds over non-scald injuries over unimpaired children. This result has no previous mention in published literature. The descriptive analyses of pre-injury impairment and burn type do not show any missing data for children with impairment (only for 1.17% of unimpaired children). Thus, the bias of missing data may not have influenced inferential results for this relationship. An explanation of the non-association between pre-injury impairment and burn type could be that enhanced parental support among children with impairments and or monitoring from disability social workers that help to keep children with disabilities safe from injuries, (Cheak-Zamora and Farmer (2015); Papworth Trust (2016)). Thus, when an injury occurs, it may have been entirely due to chance.

Published literature shows children have scalds more than any burn type (Brownscombe *et al.* (2004), Ghanizadeh (2008) and Yates *et al.* (2011)). Also, these studies do not show impairment status as driving the risk of getting scalds over non-scalds as they did not examine these comparisons. Emond *et al.* (2017) and Ghanizadeh (2008) however did show that having some behavioural/developmental impairment put children at risk of having a burn injury but this was against children who had no burn injuries. In a study of 278 children admitted to a burn centre in the US, children with ADHD were more likely to have non-flame burns than flame burns (Mangus *et al.,* 2004). However, this study was purely descriptive (chi-square analysis) and did not look at the impact of other behavioural and non-behavioural impairments on scald risk to non-scald risk (Mangus *et al.,* 2004). As impaired children have additional needs that require extra special care, the place of optimal supervision for this vulnerable group cannot be overstressed (Cheak-Zamora and Farmer (2015), Emond *et al.*, (2017) and Papworth Trust (2016)). In the UK, every medically registered child with a disability is assigned a disability social care worker to support the child and their (Emond *et al. (*2017) and Papworth Trust (2016).

Other variables analysed included supervision by parents/carers and the use of adequate first aid (defined as using cool running water (CRW)

### 7.6.4 Supervision

Supervision was made from three variables within BaSAT. These variables were the presence of others when the burn injury happened. Secondly, parents/carers who are witnessing the burn event happening. Thirdly, the clinician's subjective judgement on whether adequate supervision took place when the burn happened (see Chapter 5- section 5.3.4.2 on supervision). All three variables are based on the parents/carers version of the events that took place when the child was injured. These variables are subjective or flawed from recall bias and fear of judgement as a lousy parent (Ablewhite *et al. (*2015), Ingram & Emond (2009) and Joseph *et al.* (2002)). Supervision is a contested area, and these three variables mentioned above are subjective measures (Ablewhite *et al.* (2015), Morrongiello *et al.* (2009) and Natterer *et al.* (2009)). The derived variable for supervision used in these analyses has two options: suboptimal and optimal supervision. Descriptive data show that more children had optimal supervision (71.8% of all cases with information on supervision levels). Multivariable analyses showed no association between children who had sub-optimal supervision and burn type (scalds than non-scalds) after controlling for individual, family factors and environmental factors. Also, multivariable logistic regression of burn depth on supervision levels did not yield any association after adjustment for all individual, family and environmental factors. These findings have not been reported inferentially in previous literature before; thus, this is a welcome addition to the area of supervision levels and burn injury research. Patel *et al.* (2016), a U.S based study on severe burn cases in Mexican-resident children mentioned descriptively that relationship between burn types and supervision occurred for 60% of children with flame burns and 61% of children with scald injuries. Furthermore, of flame burn cases with no supervision, 70% played with matches before the injury and 50% played with fireworks. However, these results were not conclusive as they were descriptive.

Despite the above findings, i.e. the quality of supervision is not associated with burn type or burn depth; its role should not be underestimated (Cheak-Zamora and Farmer (2015), Prasad *et al.* (2014) and Stewart *et al.* (2016)). It is likely that these neutral outcomes for the relationship between supervision and both burn type and burn depth respectively are because BaSAT data is comparing different burn types.

### 7.6.5 First aid

Appropriate first aid is also another factor investigated within BaSAT. For the sake of this thesis and based on recommendations from previous literature (Gill and Falder (2017), Richard *et al.*, (2017)), cool running water (CRW) on a burn injury is considered the most appropriate first aid in the first instance. However, this is limited in that the variable did not examine if the recommended guidelines for applying CRW for 20 minutes occurred. Descriptive analyses showed that 1,440 cases (52%) out of 2779 cases used CRW. This observation is unusual compared to previous literature on proper first aid that mentions a dearth of its use especially in HICs (Brudvik *et al.* (2011) and Tevin *et al.* (2017)). However, Richard *et al.* (2017) reported 67% of cases in their study used proper, adequate first aid. Multivariable logistic regression analyses show no association between children with any defined impairment (i.e. both behaviourally and non-behaviourally impaired) and having CRW first aid applied on their wounds post-injury compared to unimpaired children. However, this was after adjusting for all individual, family and environmental factors. Despite this finding, there is a need to ensure proper first aid application for all children who get burn injuries especially those who need “extra care” like children with complex needs. Previous literature has not reported findings of this nature. Thus, this is an excellent addition to the current literature on knowledge about burn types, pre-injury impairment and the application of CRW first aid. In all, one should take caution in the interpretation of the findings from BaSAT data due to its small numbers, lesser geographical coverage compared to HES and the fact that only scalds vs non-scald burn analyses were feasible.

There is an expectation that proper supervision would correlate with adequate first aid (Richard *et al.,* (2017), Tevin *et al.*, (2017)). In this analysis, children with suboptimal supervision were less likely to have had CRW first aid applied after burn injuries. This effect strengthened after controlling for the individual, family and environmental factors. This change was most prominent with environmental factors. Thus, more needs to be done in ensuring there are proper knowledge and availability of adequate first aid among carers/handlers/parents of children (especially impaired children). This action should consider variations in location, e.g. At home, schools, public places and other environmental settings (Mytton *et al.*, (2017), Richards *et al.,* (2017) and Tevin *et al.*, (2017)). Previous literature reporting first aid and measures of supervision is limited and tends to be descriptive, E.g. Colins *et al.,* (2006) report that 66.7% of children with injuries in their study were unsupervised when the injury occurred. Brudvik *et al.*, (2011) report 95% of cases received first aid cooling. Richards *et al.*, (2017) reports only 67% of cases received first aid but weren’t sure if it was adequate.

An association occurred between the application of cool running water (CRW) first aid and only children from the 5$^{th}$ quintile (most deprived). Children from the most deprived quintiles were less likely to have CRW first aid applied to their thermal injuries compared to children from the least deprived quintiles, even after controlling for all the necessary variables in the model. Given that the inferential analyses showed no association between the other quintiles of deprivation and CRW first aid application, one cannot comment on a “dose-response” type effect in this relationship. Furthermore, it may be possible that other socio-demographical factors that may influence this relationship are at play here, e.g. parental education status, parental health literacy status. However, these variables were not collected and thus not measured in BaSAT and HES. Another explanation for findings between children in the 5$^{th}$ quintile and CRW first aid application after burn injury is observed from the descriptive results of this relationship in BaSAT. Within each quintile, children whose parents/carers had applied CRW first aid, the least numbers (49.7%) were in children from the most deprived quintile (5$^{th}$ quintile) while those with the most numbers (61.9%) were in the least deprived quintile. However, the quintile with the largest numbers who had answered the question on CRW first aid application (yes or no) was the 5$^{th}$ quintile, 40% (435/1088 children).

Furthermore, across all quintiles with recorded use of CRW first aid, 36.1%(216/598 children) of these were from the 5$^{th}$ quintile. These percentages suggest that the differences observed in the inferential results regarding the 5$^{th}$ quintile and CRW first aid application is trustworthy as children/their families from the most deprived quintile supplied the most descriptive information on this relationship. The latter statement occurs in Cronin *et al.* (1996), Cheng *et al.* (2016) and Goltsman *et al.* (2016)

Ethnicity and deprivation did not show any association with the application of first aid after controlling for all individual, family and environmental factors except for children from the most deprived quintile (5$^{th}$ quintile) in BaSAT dataset. These children were less likely to have CRW first aid applied to their burns post-injury. The findings for ethnicity and applying CRW first aid is like findings in Richards *et al.*, (2017). However, the findings differ for IMD and CRW first aid where Richards *et al.*, (2017) show no association in any of their IMD quintiles; this research shows only association in the 5$^{th}$ quintile.

In conclusion, the research in this thesis presents novel evidence of an association between supervision levels, pre-injury impairment and application of CRW first aid.

## 7.7 Recommendations for Future Research

Findings from previous literature (Baker *et al.* (2016), Kemp *et al.* (2014), Margesson and Gray (2017) and Prasad *et al.* (2014)) and the research presented in this thesis emphasises the need for more evidence-based interventions to prevent burns and scald injuries. Given that burns are one of the top 5 conditions that affect children under 5 in the UK (Orton *et al. (*2014), PHE (2014)), it is essential that more be done to reduce these high numbers. The State of Child Health report (RCPCH, 2017), states that inequalities in the UK are still growing and hurting health outcomes in children. Thus, findings from this thesis may have contributed some knowledge to reduce these inequalities especially in burn injuries in children. Previous research has called for further interventions to reduce inequalities and for research into the lifestyle or behavioural changes that may mitigate the burn risk of children irrespective of their background or environment (Scheven *et al.* (2012), Stewart *et al.* (2016) and Tevin *et al.* (2017)). In other words, trying to build positive prevention/intervention strategies that can be adapted to fit the various backgrounds found in UK communities rather than a one for all approach (Hong *et al.* (2010), Hutchings *et al.* (2010), Margeson and Gray (2017)).

Recommendations for future research include:

1. <u>Researching burn risk and experiences of recent migrants in HICs</u>: This recommendation is made because of the findings in this thesis that ethnic minorities were over-represented in UK hospitals for burns. This finding was similar to that in some previous studies mentioned above in this thesis. Given the increase in globalisation and migration, it is very likely that there is a “transference of risk” or behaviours/attitude that put ethnic minorities more at risk than the white majority despite a change in environment. Future research may wish to consider doing qualitative research with migrants- for example, studies on children of recent migrants who end up in UK hospitals for burns. These children and their carers could answer questions regarding the previous occurrence of burn injuries in their native countries; and their attitudes toward prevention. This group could also answer questions on any obvious risk factors that led to their children’s injuries in different countries; i.e. similarities and differences.

Quantitative research could compare in-hospital data of specific age groups of the children from minority ethnic groups in their home countries with their peers who migrated and those of the same ethnic group born in the UK. This research could help further the understanding of why ethnic minorities in the UK seem to be at higher risk for hospital attendance given they live in one of the most developed countries in the world which has better healthcare facilities and policies than their countries of origin.

2. Research into burn injuries in the home environment: Some previously published literature mention that in the burn injury pyramid, about 85% of burns that happen occur in the community. These injuries are often quite minor and rarely ever get reported at healthcare centres/hospitals. This occurrence may sound like “good” news in reducing the population of people reporting to EDs and reducing the need for a hospital bed (a significant issue that currently plagues the NHS). However, it is worth remembering other significant issues that may prevent parents from reporting some more significant injuries to the hospital. This action may lead to infection, preventable scarring and prolonged physical/psychological discomfort for the injured child. This suggestion stems from previous literature that shows parents from rural, more deprived backgrounds and or from ethnic minority backgrounds have different health-seeking behaviour patterns. It may be worth investigating how health-seeking behaviour applies to children with higher burn risk that tend to come from these backgrounds. This action, in turn, may reveal the “hidden or true” knowledge of any other potential risk factors for burns in children be they minor or major.

Suggestions for the best way forward with this could be setting up a household/community survey of retrospective burns in children (especially in hard to reach groups where possible). The timescale could be set to six months before filing an online/telephone/post survey. However, problems arising include issues of recall bias, low response rates or possibly a lack of cases over a 6-months time frame. Also, some parents/carers may choose not to disclose this information. Possible fears could resolve using health visitors and health workers to communicate with such communities where they are available.

Another idea could be adding burns prevention onto already established applications that provide an online guide to expectant/nursing mothers about proper child care. If not available, the designers of such applications could make a section for burns that is user-friendly and interactive; gives easy access to first aid information and making their surroundings “baby-proof” if not already done so. A key feature could include prompts for parents to record any incidence of scald or non-scald injuries. However, possible problems will be funds to do this work, acceptance by those who design such applications, willingness/interest of expectant/nursing parents in using burn information provided as well as supplying any info of incidence on burns that will not get medically reported.

3. Behavioural/attitude interventions for families of children with burns (especially those from ethnic minorities to prevent burns): Findings from this research suggest that inequalities in some socio-demographical factors increase the risk of burn injuries in children. Children within the UK and other countries do not earn their living, pay bills, get their housing and are very much dependent on an adult carer/parents. These adults also form part of society and are nested within several experiences and capabilities that further makes them bear the brunt of inequalities if they are at the lower end of the social hierarchy. It may be commonplace to suggest that there is a transgenerational effect of poverty, illiteracy, unemployment on children who are bound in the adverse experiences their carers/parents face. Unfortunately, one might also argue that some of the adult experiences/circumstances are as a result of individual/cultural decisions that only bring out the worse for them and their children. Thus, an understanding of cultural beliefs/ practices associated with burn risk can be investigated to see whether they are modifiable or not.

If they are modifiable, an assurance is needed, so their deletion or transformation has no negative consequence on positive behaviours (if applicable). Next, an educational or lifestyle intervention to change the mindset of parents/families to inculcate positive attitudes and cultures that lower the risk of their children getting burned may help. This research may be something that will be qualitatively based on participant-reported outcomes. These outcomes may detail significant changes in applying positive behaviours. Other outcomes include future occurrences of burn injuries in their children  OR if they have passed what they learned to a colleague who did not take part in the intervention (long community building or change). Again, this may be difficult seeing that despite environmental and political changes, if an individual is unwilling to change their mindset to something positive and helpful, the cycle of adverse health outcomes will abide for them and their families. These issues make this suggestion one that will require thorough thinking and planning before it is executed.

4. <u>In-depth analysis of distinct ethnic minorities and burn injury/risks:</u> In this thesis, ethnic categories are in broader groups following the format of the 2011 UK Census data. This action was to reduce exposure of participant data in individual ethnic groups that had little numbers presenting or attending hospitals. It also gives a more statistically robust result one can trust. However, some may argue that the fusion of the distinct ethnic minorities into broader groups will wipe away results that could tell us what risk factors are more familiar to an individual ethnic group or do not respect their identities. For example, it may be that within each broad category, let’s say children from “Asian” background; there may be differential risk factors (or interestingly protective factors) in Indians or Pakistanis than Bangladeshis (or vice versa) which will all disappear after fusion occurs. Thus, qualitative in-depth focus groups discussions across individual ethnic groups will shed more light on issues that are specific to them, or linkage may further enrich quantitative data with other

national datasets that have complete information on individual ethnic categories. This research will better inform them of the contribution of individual ethnic groups rather than broad categories of burn risk in children within the UK.

5. Research into medically reported burns that present to GP centres: Given that HES and BaSAT collect data from injuries that present to the hospital, it is likely that there are a few/small minor numbers that get picked up by GP centres especially in more rural/remote areas of the UK. Since they did not make it to the hospital, they may have been missed and may form an essential but unrecognised level in the burning pyramid. Thus, a scoping study of GP datasets like CPRD/THIN may help in the future. If the numbers are adequate, more in-depth analyses could investigate if inequalities abound within these datasets and if they are like HES and BaSAT. Correctly, the research may be about the burden or accessibility to the treatment of minor burn injuries on GP centres (if the necessary variables are available). Depending on the resulting findings, this may influence legislation to divert certain kind of conditions to GPs (but this will require 24/7 access and funding for more healthcare staff) or to establish a minor injury unit in areas where EDs overrun with people presenting with other health complaints.
6. Research into the linkage of burn datasets with other population-based datasets: An increasing amount of studies has cited linkage as a potential solution to deal with missing data and create more robust data. This research may be beneficial for the BaSAT or HES ED/outpatient datasets that have information on burn attendances in ED/outpatient units. It could also help raise information on how burn injuries affect other outcomes of a child during the healing process, e.g. educational capabilities, numbers of days lost in not attending school, not attending outpatient appointments (if applicable). The findings of this thesis have shown children from most deprived and or ethnic backgrounds as having higher admission odds for burns. This finding

naturally leads to lower quality of life from injury to total healing for this group. It is possible this may have affected other parts of their lives and that of their families during this period. This research could further expose the added disadvantages the “most at risk” groups for burns face due to their injury and healing.

7. Developing a more standard measure to assess supervision before burn injury: This recommendation is on findings from the BaSAT data analyses. In the first instance, the development of a variable that takes parental and clinical reports on adequate supervision in this thesis is a first seen in paediatric burn research and quantitative data analyses. The results have shown children with suboptimal supervision are less likely to have proper CRW first aid. Experts on supervision measures have mentioned how hard it is to measure seeing there is no visual recording of events leading to injuries that could corroborate carers/parents’ stories when presenting their children to the hospital for burns. Thus, child health specialists, clinicians, researchers and psychologists need to come up with a more robust and objective measure that could retrospectively quantify supervision levels before the burn injury happened.
8. The constant need for proper first aid education: This recommendation is also from BASAT data findings where children from the most deprived communities or with sub-optimal supervision had lesser use of CRW first aid. It calls for the need to keep encouraging adequate CRW first aid as recommended by several guidelines from health/injury organisations. Parents/carers should also be openly engaged with to understand the reasons behind using wrong first aid treatment. Also, the UK healthcare industry should be open-minded about other “alternative forms of first aid” if CRW is not available near a child with burn injuries. Evidence about issues with delays in healing time when poor first aid is applied should also be passed across to parents/carers to reduce the incidence of their use.

9. Replication of this research specifically for Scotland and Northern Ireland: As mentioned in previous sections of this chapter, the findings from this thesis are directly applicable to England (HES and BaSAT) and Wales (BaSAT). It may be easy to imagine the odds ratios found for burns admission and attendance may be the same for Scotland and Northern Ireland. However, studies could be done using their replicas of the HES dataset in the first instance. For example, for studies into odds for burn admissions in Wales, the Patient Episode Database (PED) can be used. PED was established in 1991 and is quite smaller than HES but should have enough information on burn admissions. The same can occur with Northern Ireland's Hospital Activity Statistics and Scotland's equivalent of HES, Scottish Morbidity Record (SMR) which precedes HES by five years (1981).

In all, these recommendations are just a tip of the iceberg. The findings in this thesis will not have solved all the problems associated with paediatric burn epidemiology in the UK nor has the researcher been able to include all reasonable recommendations that might reduce burn inequalities in children. However, these points listed above may form a stepping stone in the path that leads to narrowing health inequalities affecting children as outlined in the countrywide and international reports like the 2017 State of Child Health report from the RCPCH, NICE recommendations PH29-31, PHE and WHO. One should remember that this is a collective effort between parents/carers, healthcare professionals, researchers and policy/lawmakers to ensure burn risks for children reduce in society and protective factors build on to safeguard an individual's future.

## 7.8 Implications for Policy and Practice

Marmot and Bell (2012) mention that the health sector alone cannot tackle all health inequalities. These authors support policy development for programmes to support parents/caregivers in ensuring positive developmental outcomes for children. This life stage is crucial because if they are negatively affected by surrounding adverse conditions/experiences, they may carry the scars all through their life course igniting a trans-generational effect (Marmot and Bell (2012)).

The findings in this thesis suggest that the origin of paediatric burns are deeply seated (along with other health outcomes) in the socio-economic and environmental inequalities seen in our everyday world. Marmot and Bell (2012) argue that applying the theory of proportionate universalism, i.e. policy and change to reduce inequalities across all tiers of society (with extra support on those who suffer most) and focusing on social factors that determine positive health outcomes will narrow the social gradients over time. However, changing policy and practice is not a straightforward process. It requires time, funding and efforts of public and private individuals and or officials in providing evidence to implement new regulations or update existing ones.

This section on policy has two parts. The first part is a commentary on public policies and practice that may influence burns research or mitigate the risk of such injuries in children while the second part outlines the issues arising from this thesis that can contribute to strengthening current policy and practice.

### 7.8.1 Commentary on current policy and practice on burns prevention in children

Research findings from any piece of work is often a building block towards the development of a summary, review, report, guideline that may eventually become law/policy in the area, region or country they represent. This process also applies to findings from injury-based research. The National Institute for Health and Care Excellence (NICE) in 2010 published prevention and intervention guidelines in reducing unintentional injuries in the home and on the road for children aged 15 years and below in the UK (NICE (2010[a]), NICE (2010[b]), NICE (2010[c])). These guidelines are the NICE PH29, PH30 and PH31 and are made from public research preceding the time of the guidelines. However, at the time of writing this thesis chapter, seven years had elapsed from the publication of the NICE guidelines. Updates were made in 2013 as its customary for NICE to update their guidelines every three years if any published research gave rise to evidence that suggested strong impact. The additional guidelines for PH29 were published in

2014, but all the evidence presented from that review were considered noteworthy but not enough to upgrade the guidelines (NICE (2010[a]), NICE (2010[b]) and NICE (2010[c])).

Further reviews of the literature took place in 2015, but no supplementary have been published, nor the guidelines changed as most of it is still found to be relevant. NICE did have a feature where they report how many local authorities/health boards have taken up their recommendations or implemented a change in injury prevention since publication. Out of 21 recommendations, only four have been acted upon across the country, e.g. home safety equipment, training of healthcare staff and community champions in preventing unintentional injury, and this ranged from 19%-43% of all local authorities/health boards in the UK. These numbers seem like a far cry from achieving targets set seven years ago and maybe a hindrance for future research to measure trends that change annually and see if implemented recommendations are working, i.e. their monitoring and evaluation (Garratt *et al.* (2010), NICE (2010[c]) and Scrimshaw (2006)).

There is also the issue of the guidelines being general to all types of injury rather than burn specific. While this may help for issues that are shared across burns and other injuries, it does not help reduce problems that prevent the execution of burn prevention and intervention strategies (DiGuiseppi *et al.* (2002), Orton *et al.* (2014) and Tevin *et al.* (2017)).

The current guidelines also seem to recommend and list points that should improve prevention and intervention strategies. While NICE have a feature monitoring what has been executed, a more efficient way to ensure these recommendations function nationally is by setting up these targets as mandatory across all local authorities and health boards. These targets may take the style described by Propper *et al.* (2008) used by the English government in enforcing a reduction in waiting times. Again, in an ideal world, this would seem easy, but unfortunately, the constant changes in the political fabric of the UK and its partisan decisions have a lasting impact on how quickly these recommendations are taken up and followed (Green and Collins (2006)). If necessary, committees and report monitoring bodies can be set up to whip into shape any defaulters in these recommendations. These committees can also ensure that if there is a political transition to another party, these projects do not truncate (Green and Collins (2006)). The issue of lack of continuity is one of the significant barriers that plague research and development in most LMICs (Green and Collins (2006)). Thus, it would be encouraging if this habit does not become the new face of the UK political climate.

Successful recommendations for policy and practice are often as a result of unified consultations between the government, healthcare experts, academia and the populace (Green and Collins (2006), Propper *et al.* (2008) and Scrimshaw (2006)). It is therefore essential that there is a bridge in any communication gaps and all essential groups are to be carried along if burn prevention and intervention strategies for children are to work efficiently. Indeed, there is a need to prioritise set goals based on the availability of funds — also, those needing the most care/change. Successful continuity and proper communication ensure all affected and interested parties are in full support of each other. These steps ensure a fair and mutual understanding in the execution of these goals (Marmot and Bell (2012)). These actions will avoid the additional set up of numerous projects, committees and research all doing the same thing over again with no actual conclusion (Farrar *et al.* (2009), Purdy *et al.* (2009) and Scrimshaw (2006)). Repetition of already established projects delay changes in practice which will worsen inequalities. They also create new problems if previous ones are not dealt with efficiently.

A classic example is the development of the Emergency Care Data Set (ECDS) when the already established HES EDs/outpatients datasets are yet to be fine-tuned to meet the standards of the HES inpatient dataset. Another example is the NICE publications that mention a general impact of social inequalities that increase burn risk but mentions no recent revelation of new policies from the government in reducing these broader inequalities for the most affected groups in the UK (Green and Collins (2006), Propper *et al.* (2008) and Purdy *et al.* (2009)).

In all, one cannot speak of useful changes in policy and practice if funding and support are not given in full doses to academic and research bodies to solve the many gaps in research. Another issue of concern is the ignorance of expert advice and evidence by some policymakers that have the power to push for them to become law (Propper *et al.* (2008), Purdy *et al.* (2009), Scrimshaw (2006) and Sidanius and Pratto (1999)). It is hoped that the recommendations made in this thesis can support the drive to develop policy based on existing evidence, and has helped question some gaps seen in the above mentioned NICE guidelines on inequalities in paediatric burn injuries.

### 7.8.2 Issues arising from the thesis that may contribute to or influence policy and practice for burns in children

The following suggested implications are not all original findings previously unreported on burn injuries in children. However, they show that in the 21st Century, UK children still have different health experiences. The main implications arising from this thesis are focused on prevention and are as follows:

1. The findings from the HES analysis showing persistent associations between IMD and burns as well as minority ethnic groups and burns are the stand-out messages. The author suggests that policies be set up for healthcare staff, health visitors and family support workers. These professionals need to be aware of the persistent inequalities (especially among at-risk groups). They also need to take action (e.g. carry out a home safety assessment or refer such to the appropriate authorities like housing authorities or councils.). The latter may be the case if professionals have reason to believe children in a family are at risk of injuries.
2. Policy makers and advocates (such as Public Health England (PHE), the Royal Society for the Prevention of Accidents (ROSPA) ) need to be aware of these findings. These results can be used as additional evidence to maintain burns and scalds as one of the top '5 injuries for the under 5s'. This issue is one that needs continuous attention within the UK and globally.

3. More needs to be done to address the need for awareness, education, knowledge and application of adequate first aid application after burn injury and adequate supervision of children especially among the most at risk groups mentioned in the first point.
4. The need to make a collection of critical socio-demographical variables as a routine in the NHS. E.g. supervision measures, impairment status and ethnicity, could help professionals better understand how these influences burn injury risk within the UK.

## 7.9 Conclusion

Despite advances in research on burn epidemiology and burn care in the UK, the initial searches for evidence of inequalities in children's burns at the beginning of this thesis revealed a surprising limit on what was known/ reported. Most of the literature was descriptive or did not examine in more detail the reasons for the observed differences. A lot was seen on what drove these differences for the broader spectrum of all injuries but not much specifically on burns. Thus, the focus of this project was to investigate further the driving forces of these inequalities (where applicable) or who was most at risk for burn attendance/admission among UK children since 2009.

Findings from the HES data analyses confirm reports in the previous literature on other paediatric injuries. These include that children (compared to their counterparts in optimum situations) who are from the most deprived backgrounds, those from ethnic minorities and or dwell in urban areas within the UK are at the highest risk for admission in UK hospitals for burn injuries. These results were still relevant after adjusting for all individual, familial and environmental factors.

Findings from BaSAT data analyses focused on complementing the shortcomings of the HES inpatient data and examined what dynamics were at play at the home level for burn injuries in children. However, after adjusting for all individual, family and environmental factors, the only associations which persisted were between children having suboptimal supervision and the lesser likelihood of having CRW first aid, and children from most deprived backgrounds and the lesser likelihood of having CRW first aid.

Interpretation should take into account that most injury research done quantitatively come from cross-sectional studies, which have the issue of reverse causality. The findings from this thesis have now further confirmed that seven years from the publication of the NICE guidelines PH 29-31 on unintentional injury in children, inequalities in the groups above persist for burns. While we can not take away all the inequalities in the world, it is high time that action is taken to meet the needs of people irrespective of their social or ethnic status. More needs to happen in ensuring that we do not take one approach for all but be ready to design policy (legislation, housing modifications) or interventions (education, first aid training) that will firstly cater to those who are at most at risk especially in their home environment. Then, to design policy/interventions that would enable individuals/families create positive and protective behaviours/attitudes that prevent burn injury in the first place and lastly ensure that these steps are taken and applied to even those who are least affected. That way, inequalities will hopefully be narrowed down and ultimately disappear in future years.

BaSAT data analyses also show us that more needs to occur in educating families/carers/parents on supervision and first aid. This observation is most accurate for expecting and young parents. This group need advice on how to adequately supervise a child especially if they have some form of impairment. Proper first aid education and application need to be widely disseminated to ensure all parents can apply the right formats of burn prevention and treatment. This step will help reduce burn severities/complications when the children present to hospital.

In conclusion, by tackling the issues at the root of inequalities in burn injuries in children (especially those from the most socially deprived and ethnic minority groups); the overall health of children in the UK will improve over time.

CHAPTER 7 : DISCUSSION

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# APPENDICES

List of Contents



KEY: AS= Appendix Section, AT= Appendix Table, AF=Appendix Figure

## A.S 1.1 UOB FHS-REC ETHICS FORM

**Faculty of Health Sciences Research Ethics Committee**

University of BRISTOL

**APPLICATION FORM FOR ETHICAL APPROVAL**
**Reference Number (for office use):**

**Date of Submission (for office use):**

**Please refer to the GUIDELINES AND CHECKLIST for assistance when completing this application form.**

**On completion, the application form and accompanying documents should be submitted as attachments via the [online ethics tool.](online ethics tool.)**

**Copies of the following must accompany this application:**

- ☐ **questionnaires,**
- ☐ **information sheets,**
- ☐ **focus group topic guides,**
- ☐ **consent forms etc,**
- ☐ **and anything else that will be going to participants e.g. recruitment e-mails**

**Links to useful guidelines concerning ethics of research involving human participants**

ESRC Research Ethics Framework
http://www.esrc.ac.uk/ESRCInfoCentre/Images/ESRC_Re_Ethics_Frame_tcm6-11291.pdf#search='esrc%20research%20ethics%20framework

National Research Ethics Service (NRES)
http://www.nres.npsa.nhs.uk/

Medical Research Council Guidelines on Good Research Practice
http://www.mrc.ac.uk/pdf-good_research_practice.pdf

**Below are the most frequent omissions or amendments requested by the FDMCE. Please check your application against this prior to submission.**

- ☐ Title (same as that of project) and University Logo must be included on the Participant Information Sheet and Consent Forms.
- ☐ Consent Form boxes require initials, not just ticks.
- ☐ If audio or video-recording, you are required to provide the following:
  - Details of the transcriber (if applicable)
  - Confirmation that a confidentiality agreement is in place.
  - Information regarding recording, anonymity and use of quotes must be included on participant information sheet.
  - Specific consent for recording on consent forms.
- ☐ Copy of introductory emails.
- ☐ Questionnaires
- ☐ Topic guides for focus groups.

1. **Title of the research:**
An Investigation of Inequalities in Paediatric Burns

2. **Name of Applicant, with job title and contact details including email:**
Moses Ikpeme, PhD student, Centre for Child and Adolescent Health (CCAH), School of Social and Community Medicine, Oakfield House, BS8 2BN. Tel: [redacted] Email: mi14551@bristol.ac.uk

3. **Name of Supervisor (if applicant is a postgraduate or undergraduate student), with job title and contact details including email:**
Prof Alan Emond, Centre for Child and Adolescent Health, School of Social and Community Medicine, Oakfield House, BS8 2BN. Email: Alan.Emond@bristol.ac.uk. Telephone 0117 331 4099

4. **Other investigator(s) involved, with job title:**
Dr Julie Mytton, Centre for Child and Adolescent Health, School of Social and Community Medicine, Oakfield House, BS8 2BN. Email: Julie.Mytton@bristol.ac.uk. Telephone 0117 331 4034

5. **Source of funding:**
Healing Foundation/University of Bristol PhD studentship

6. **Start date and duration of the project:**
May 2016-Dec 2018

7. **Where will the study take place?**
Centre for Child and Adolescent Health, School of Social and Community Medicine, Oakfield House, BS8 2BN.

8. **Background and aims of the study:**
Unintentional injuries are common to children and young people and are associated with an 'inequality gradient'. A recent review of unintentional injuries of young people (0-25yrs) in the UK between 2008-2013 by ROSPA, PHE and CAPT reported that many injuries occur in children under 5 years (mostly at home); with those aged 1-2 years reporting 140,000 cases of injuries annually. The male: female ratio of reporting an injury was 1.3:1 while most deprived: least deprived ratio was 1.4:1. Thermal injuries were the 4th largest A and E cause of admissions and 6th leading cause of mortality in under 5 years old.

The aim of this study is to examine any observable inequalities in accidental burns of children and young people (0-16 years) in England and Wales. This will be achieved via secondary data analysis of admissions data from Hospital Episodes Statistics (HES) databases in England, and attendance data from A and E departments across England and Wales collected as part of routine clinical care using a specialised tool called BASAT (Burns and Scalds Assessment Template).

Research questions include:
• Do children from families within most deprived quintiles tend to have more burns and scalds than children from the least deprived quintiles?
• Do children from ethnic minorities have a greater risk of having a burn injury compared to children from the ethnic majority group?
• Do children from crowded homes or large families tend to have more burns?
• Are children from rural residences more likely to have a burn than those from urban residences?

• Do children with developmental impairments tend to have more burns compared to those without?

**References**

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Orton, E., Kendrick, D., West, J., & Tata, L. J. (2014) Persistence of health inequalities in childhood injury in the UK; A population-based cohort study of children under 5, PLoS ONE,
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PHE, Child Accident Prevention Trust (CAPT) and Royal Society for the Prevention of Accidents (ROSPA) 2014, Reducing unintentional injuries in and around the home among children under five years.
World report on child injury prevention (2008) Edited by Margie Peden, Kayode Oyegbite, Joan Ozanne-Smith, Adnan A Hyder, Christine Branche, AKM Fazlur Rahman, Frederick Rivara and Kidist Bartolomeos

9. **Outline the design of the study and list the procedures to which the participants will be subjected, the anticipated testing time and any treatments administered:**
   Secondary analysis of paediatric admissions to hospital, and attendances at Emergency Departments. No contact with participants and no primary data collection.

10. **Please outline how study data will be analysed.**
   For each dataset of interest, we will utilise a cleaned dataset categorised into boys and girls. For each gender group, the associations of admission to hospital with a burn will be explored using STATA with socio-economic status (IMD quintile), geographical factors (urban/rural residency) and family ethnicity (categorised using census criteria). Descriptive statistics like Chi-square, 2 x 2 tables, summary tables and graphs etc via STATA and Microsoft Excel will be used to provide a general description of the dataset

   As these factors are inter-correlated, multivariate models will then be produced to understand the interactions between these co-variates and to clarify any independent effects. Simple comparative statistical tests will be used where appropriate. The bias introduced by missing data will be assessed by a series of sensitivity analyses, and multiple imputation techniques will be employed if appropriate.

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11. **Does your study involve the collection or use of any human tissue or exudate? If yes, what is the material to be collected?**
   No

12. **If you have answered ‘yes’ to Q11, has confirmation been obtained from your Departmental Human Tissue Act Advisor that collection and storage of this material will be undertaken under an appropriate licence?**
   N/A

13. **Has a reviewer been contacted? It is the applicant’s responsibility to do this. The peer review form must be submitted with this application and any comments noted in the review must be actioned prior to submission.**

Toity Deave from UWE has provided a peer review. She questioned whether I would be given any statistical support, and I can confirm that Linda Hollen, the research statistician at the Children's Burns Research Centre will provide expert advice and support.

**14. Who will be recruited to participate in this study?**
No, secondary data analysis only. No recruiting or exclusion of participants.

**15. Are there any potential participants who will be excluded? If so, what are the exclusion criteria?**
No, secondary data analysis only. No recruiting or exclusion of participants.

16. **How many participants will be recruited**
N/A

**17. How will the participants be recruited?**
N/A

**18. How will informed consent be obtained from all participants or their parents/guardians prior to individuals entering the research study?**
All data to be used have been collected without consent.
The HES data are routinely collected on all admissions to hospital.
BASAT has CAG approval to collect information without consent (15/CAG/0203)

**19. How long will potential participants have to decide whether to give consent?**
N/A

**20. Will participants be kept informed of new information that becomes available during the study which may influence their continued participation?**
N/A

**21. Will the study involve actively deceiving, or withholding information from, the participants?**
N/A

**22. Will participants be made aware that they can withdraw from the study at any time without having to give a reason for doing so?**
N/A

**23. Describe potential risks (physical, psychological, legal, social) arising from these procedures:**
N/A

**24. How will participants be informed about the outcome of the study?**
N/A

**25. How will the results of the study be disseminated and reported?**
The results will form part of my PhD thesis, will be published in peer reviewed scientific journals, and presented at conferences and seminars.

**26. Is any payment other than reimbursement of expenses to be made to participants?**

N/A

**27. Will personal data, beyond that recorded on the consent form, be used in the research?**
No

**28. Will the participants be audio-recorded or video - recorded?**
N/A

**29. What arrangements have been put in place to ensure confidentiality and security of data gathered in the study?**
All data will be stored securely on a password-protected folder on a server at the University of Bristol, which is regularly backed up.
Confidentiality will be ensured as only non-personalised anonymised data will be used. Small numbers will be suppressed and aggregated prior to publication to avoid any potential for identification of participants.

**30. Has this proposal been seen by another ethics committee?**
No.

**31. Do any of the investigators have any actual or potential conflict of interest in this study?**
No

**32. How will the data be made available at the end of the project?**
No data will be made available to third parties

**33. Is there any other relevant information you would like to make known to the committee?**
No

**34. Have you read and understood the guidelines for filling in this form and the Committee Statement?**
Yes

**Submit by** via the online ethics tool. **Date:**

**Remember:**
Please attach (where appropriate)

- ☐ Recruitment adverts / messages / forms
- ☐ Information sheet / transcript
- ☐ Consent form
- ☐ Debriefing sheet / transcript
- ☐ Any other relevant material (e.g., an unpublished questionnaire enquiring about possibly sensitive topics or collecting personal data).

## A.S 1.2 UOB FHS-REC Peer Review statement

University of BRISTOL

**Faculty of Health Sciences Research Ethics Committee**

**PEER REVIEW STATEMENT**

Notes to **peer reviewer**:

- The information you provide on the scientific quality and validity of the project will help the committee make a decision about the ethical acceptability of the study.
- The information and opinions you provide on this form are confidential. Any discussion with the applicant about your recommendations would only be with your agreement.
- Please return this form to the applicant so that they can action any required changes prior to their submission. The peer review form needs to be included with the ethics application by the submission deadline for the ethics application to be valid and ready for review.
- All fields should be completed in full.

Notes to **applicant**:

- Peer review is mandatory for all studies submitted to the FMDCE for ethical review. This form should be completed by a suitably qualified reviewer of your choice.
- For staff projects, peer review should be by an independent researcher ie. someone not involved in the project. For student projects, review by a supervisor is sufficient.

1. *Project Title:* **An Investigation of Inequalities in Paediatric Burns**

2. *Applicant's Name:* **Moses Ikpeme**

3. *Please comment on the value of the project in the field being researched*

   Paediatric burns are an important problem in the UK, resulting in a lot of distress to children and their families, and considerable use of health care resources.
   Whilst social and demographic inequalities are recognised to be associated with injuries in general, the evidence for a social gradient in burns is mixed, and the proposed analyses should

make a useful contribution to the literature. It will also provide recommendations for possible target groups for interventions.

4. *Is the project feasible within the allotted time?*
   Yes

5. *Please comment on the clarity of the aims and objectives of the project*
   Clear research questions around 4 different areas associated with children's burns- SES, urban/rural residence, ethnicity and additional developmental needs.

6. *Please explain whether, in your opinion, the methods proposed will meet the aims of the project.*

   The proposed analysis uses two complementary datasets- the HES which collects information on inpatient stays and the BASAT which records A&E attendances.

   HES will have good quality information on postcode, to facilitate analysis of burn injury against place of residence and deprivation score (IMD quintile). I suspect the ethnicity data in HES will be patchy.

   The BASAT will also have postcode data but will also be more complete on ethnicity and associated developmental impairments of the injured children. Together the two datasets should complement each other.

7. *Where quantitative data analysis is required, please comment on the suitability of the methods of analysis proposed. Where complex analysis is required, should the advice of a departmental statistician be sought?*

   The analytic plan appears sensible- the main difficulty will be dealing with missing data. Will Moses Ikpeme have the support of Linda Hollen, the research statistician at the Children's Burns Research Centre?

8. *Where qualitative data analysis is required, please comment on the suitability of the methods of analysis proposed.*
   N/A

9. *Are there any areas in your opinion where the study could be improved?*
   None

10. *General comments. If you would like to make any other comments on this study, please do so here:*

    I do not think there will be any ethical dilemmas associated with this research, as it will use routine hospital data and the BASAT. These data have been collected without consent as part of routine clinical care. Moses has specified that small numbers will be dealt with by suppressing and aggregating them and this should maintain anonymity and therefore confidentiality.

10. *Name of Reviewer:*

Toity Deave

11. *Position:*

Associate Professor for Family & Child Health, centre for Child & Adolescent Health.

12. *Qualifications:*

PhD, MSc Epid, MMedSci, PGDipHV, SRN

13. *Contact details, including email address:*
[redacted]
Tel: [redacted]

14. *Date of peer review:*
04 April, 2016.

*Thank you for completing this review.*

## A.S 1.3 UOB FHS-REC Ethical Approval

Research and Enterprise Development University of Bristol

## Application Review

Logout

| ID | Name | Faculty | Department | Supervisor |
|---|---|---|---|---|
| 34661 | Mr Moses Ikpeme | Faculty of Health Sciences | Child and Adolescent Health, School of Social and Community Medicine | Professor Alan Emond |

**Status**
Signed off
**Date added**
April 4, 2016
**Signed off date**
April 18, 2016
**Is this a student project?**
Postgraduate Phd
**Project title**
An Investigation of Inequalities in Paediatric Burns
**Estimated start date**
May 1, 2016
**Duration (months)**
32
**Project outline**
The aim of this study is to examine any observable inequalities in accidental burns of children and young people (0-16 years) in England and Wales. This will be achieved via secondary data analysis of admissions data from Hospital Episodes Statistics (HES) databases in England, and attendance data from A and E departments across England and Wales collected as part of routine clinical care using a specialised tool called BASAT (Burns and Scalds Assessment Template).
**Supporting information**
N/A
**Files**
Peer Review ethics/34661/ikpeme-ethicspeerrev_tdeave.docx (22.5 KB added on April 4, 2016 )
Full Ethics Application ethics/34661/uob-rec-fac-health-form_ikpeme_v2.rtf (189.2 KB added on April 4, 2016 )

**L1 - Does your research involve any of the following?**

- Medical devices, ionising radiation, drugs, placebos or other substances to be administered to participants.
- Adults (over 16) who lack capacity to consent for themselves including participants, who will be retained in the study following loss of capacity.
- Recruiting or using client data from NHS patients, nursing home/independent hospital/clinic or medical agency patients, users of social care services or prisoners. For more details on definitions please see 'Does my project require NHS review': http://www.nres.nhs.uk/applications/approval-requirements/ethical-review-requirements/requirements-for ethical-review-under-legislation/ (this link opens in a new window).

No

**L2 - Does your research involve any of the following:**

- Human Blood or Tissue Samples (Tissue means any relevant material consisting of or including cells - for definition of 'relevant material', please see the Human Tissue Authority website at http://www.hta.gov.uk/ - this link opens in a new window.

No

**L3 - Does your research involve any of the following** No

- Animals (either use or observation)

### L4 - Does your research involve any of the following?

- Has or will your research be submitted to another ethics committee?

No

### L5 - Does your research involve any of the following?

- Working or travelling overseas

No

### L6 - Does your research involve any of the following?

- Trials outside the UK
- Pregnant research subjects
- Conception/Contraception
- Children under 5
- More than 1500 research subjects
- Genetic engineering
- Hepatitis/CJD/HIV & Aids related research

No

### 1. Does the research involve human participants?

If you answered No, please go to question 2.

No

### 1a. Does the research involve participants who are particularly vulnerable or unable to give informed consent?

Examples of vulnerable participants or those unable to give informed consent are children, people with learning difficulties, patients, people experiencing emotional distress or mental illness, people living in care or nursing homes, and people recruited through self-help groups, participants in a dependent or unequal relationship with the researcher(s) or research supervisor.

### 1b. Will it be necessary for participants to take part without their knowledge and consent at the time?

Examples include the covert observation of people

### 1c. Will the research involve actively deceiving participants?

Examples include deliberately falsely informing participants, withholding information from participants or misleading participants in such a way that they are likely to object or show unease when debriefed about the study.

### 1d. Will the research involve discussion or collection of information on sensitive topics?

Sensitive topics under the Data Protection Act 1998 include:

- The racial or ethnic origin of the data subject;
- Their religious beliefs or other beliefs of a similar nature;
- Whether they are a member of a trade union (within the meaning of the Trade Union and Labour Relations (Consolidation) Act 1992);
- Their physical or mental health or condition;
- Their sexual life;
- Their commission or alleged commission by them of any offence;
- Any proceedings for any offence committed or alleged to have been committed by them, the disposal of such proceedings or the sentence of any court in such proceedings.

If the research is in relation to any of the sensitive topics listed under the DPA 1998 then the legal issue requiring such scrutiny in such cases that 'explicit consent' must be obtained.

### 1e. Does the research involve invasive procedures?

Invasive procedures may include:

- Administration of drugs placebos, or other substances (e.g., drinks, foods, food or drink constituents, dietary supplements) to study participants;
- Biological samples from participants be obtained;
- Pain or more than mild discomfort likely to result from the study.

**1f. Does the research involve scans or x-rays of research participants?**

**1g. Does the research involve photographs, videoing, recording or similar of research participants?**

**1h. Will financial inducement (other than reasonable expenses and compensation for time) be offered?**

**1i. Will the study involve the use or storage of information about living people whose personal identity could be discovered from that information?**

**1j. Does the study risk causing psychological stress or anxiety or other harm or negative consequences beyond that normally encountered by the participants in their life outside research?**

**2. Will the research involve politically and culturally sensitive funding sources?**

| | |
|---|---|
| Examples include the defence sector, projects with potential environmental effects and other internationally regulated or protected industries. For more information, please follow the link to the 'Research Governance and Integrity Policy': http://www.bris.ac.uk/red/support/governance/RGI.pdf (this link opens in a new window). | No |

**3. Will the research involve politically, culturally or socially sensitive topics?**

| | |
|---|---|
| For more information, please follow the link to the Faculty of Arts Ethics Committee Guidance Note (PDF 78kb) (this link opens in a new window). | No |

**Supporting information**
(maximum 3000 characters)

| | |
|---|---|
| Please provide any additional information in relation to your study such as adhering to a particular SOP or confirming if your study is a service evaluation/audit as opposed to research. | N/A |

Flesch Reading Ease (http://www.readabilityformulas.com/free-readability-formula-tests.php)

| **Material** | **Reading ease score** |
|---|---|

| **Date** | **Name** | **Comment** |
|---|---|---|
| April 18, 2016 | Allison Fulford | The applicant should pay close attention to the advice of the peer reviewer who makes valid comments on the proposed research. |

**Faculty guidance and ethics application**

http://www.bristol.ac.uk/fmd/ethics/

**Users guides** Submitter Approver Reviewer Signatory

Updated 20 December 2012 by Research and Enterprise Development | Feedback
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# APPENDIX FOR CHAPTER 2

# AS: 2.1. Example of a Critical Appraisal Skills Programme tool used to appraise a systematic review (Moller *et al.* (2015))

## 10 questions to help you make sense of a review

### How to use this appraisal tool

Three broad issues need to be considered when appraising the report of a systematic review:

- **Are the results of the review valid? (Section A)**
- **What are the results? (Section B)**
- **Will the results help locally? (Section C)**

The 10 questions on the following pages are designed to help you think about these issues systematically.

The first two questions are screening questions and can be answered quickly. If the answer to both is "yes", it is worth proceeding with the remaining questions.

There is some degree of overlap between the questions, you are asked to record a "yes", "no" or "can't tell" to most of the questions. Several prompts are given after each question. These are designed to remind you why the question is important. Record your reasons for your answers in the spaces provided.

**These checklists were designed to be used as educational tools as part of a workshop setting**

There will not be time in the small groups to answer them all in detail!

## (A) Are the results of the review valid?

<u>Screening Questions</u>

### 1. Did the review address a clearly focused question? Yes Can't tell No

HINT: An issue can be 'focused' In terms of

- The population studied
- The intervention given
- The outcome considered

The authors' main aim of this review was to assess differences in unintentional injury rates between indigenous and non-indigenous children (aged 0-19) in Australia. They planned to achieve this by measuring:

a.) The size of unintentional injuries rates in both groups
b.) Variations in the difference according to the cause of injury? and
c.) What underlying risk factors contribute to these differences.

### 2. Did the authors look for the right type of papers? Yes Can't tell No

HINT: 'The best sort of studies' would

- Address the reviews question
- Have an appropriate study design (usually RCTs for papers evaluating interventions)

The authors state they considered the following criteria when selecting papers for the review:

children (0–19 years), indigenous status and unintentional injuries which seems to follow their research question.

They only included papers from primary research (descriptive studies e.g. hospital records review, ecological studies) with no limit to the year of publication.

They also included papers reporting results as rates and ration and not only numbers.

There is no mention of RCT's or systematic review papers included.

## Is it worth continuing? **Yes.**

**©Critical Appraisal Skills Programme (CASP)** Systematic Review Checklist 2
31.05.13

Detailed questions

### 3. Do you think all the important, relevant studies were included?

Yes Can't tell No

HINT: Look for

- Which bibliographic databases were used: The authors claim to have used 10 databases related to child and indigenous health namely (Scopus, Pubmed, CINHAL, PSYCINFO, Web of Science, Pro Quest Social Science, INFORMIT (ATSI Health, RURAL, Indigenous collection and Health Collection), SafetyLit, Cochrane Library Databases, Native Health database of the University of Mexico). [Under Methods, Pg 1]

- Follow up from reference lists: The authors claim to have used this method as well as electronic database search and searching of institutional websites [Under Methods, Pg 1]

- Personal contact with experts: The authors did not mention using this method for searching the literature, but state colleagues were contacted to verify difficult papers that needed to pass inclusion criteria. [Penultimate paragraph: Methods]
- Search for unpublished as well as published studies: The authors mention that 4 records followed the inclusion criteria from this area and were included. [Results: 1st paragraph]
- Search for non-English language studies: The authors did not make any reference to language limits, but all included papers were from USA, Australia, New Zealand and Canada.

### 4. Did the review's authors do enough to assess the quality of the included studies?

Yes Can't tell No

HINT: The authors need to consider the rigour of the studies they have identified. Lack of rigour may affect the studies' results. ("All that glisters is not gold" Merchant of Venice – Act II Scene 7)

The authors claim to have used the LQAT – Liverpool University Quality Assessment Tool to assess the papers' quality and obtain the following info: sampling, exposure/intervention, outcome, analysis and impact. They claim the tool has been validated and assessed against others (but did not mention which).

### 5. If the results of the review have been combined, was it reasonable to do so?

Yes Can't tell No

The authors state they did not do a meta-analysis due to heterogeneity from the 39 different papers, hence a narrative analysis.

HINT: Consider whether

- The results were similar from study to study: The authors state that the 39 papers presented their outcomes as follows: 23 presented mortality data only, 8 reported both mortality and morbidity, 7 reported on morbidity only and 1 on Years of Potential Life Lost. Most studies were descriptive, used routinely collected mortality and/or hospital morbidity data and did not investigate the effect of potential confounding or explanatory variables in the analysis. Only 5 studies adjusted for the latter.

- The results of all the included studies are clearly displayed: The authors did not mention any of the included papers not displaying results properly [Result section]. However, in the discussion, they state some papers did not give the CI's.

- The results of the different studies are similar: 27 studies worked on age 19 and below, the remaining 12 worked on both adults and children- in some cases, the children data was not split into separate age classes.

- The reasons for any variations in results are discussed: 24 of the studies included were based on data collected before 2002. The rest were based on data afterwards.



# (B) What are the results?

**6. What are the overall results of the review?** The authors' state the following on Pg. 3 (results):
13 out of the 39 papers reported all unintentional injury rates combined. Morbidity rates of Indigenous (ID): non-Indigenous children (NID) (1.2-2.3:1) while Mortality rates of ID: NID (1.8-8.2:1). 1 USA study showed years of life lost to injury ratio as ID: NID = 1.6-1.8:1

The largest differences in ID: NID injury rates were observed in 4 Canadian papers.

Papers showing a comparison of both groups and injury rates based on age classes agree that higher ratios were found in below 5 yrs. of age

Burns cases were examined in 14 papers (shared 2$^{nd}$ place with drowning) after motor vehicle/transport cases (24 papers) out of all 39 included papers.

All 14 papers referring to burns agree that higher rates of hospitalisation (1.3-4.4:1) and mortality (1.2-6.1:1) were higher in ID: NID. Only 1 paper reported no difference in hospitalisation regarding scalds in both groups.

Australian and New Zealand papers report a higher hospitalisation rate for burns in younger age groups compared to older ones. (Pg. 4)

HINT: Consider
- If you are clear about the review's 'bottom line' results
- What these are (numerically if appropriate)

- How were the results expressed (NNT, odds ratio etc): The authors report results in most of the papers were expressed as rate ratios or these were derived from associated data if available.

### 7. How precise are the results?

HINT: Look at the confidence intervals, if given

The authors do not spell out the results for burn cases in each of the 14 papers individually. However, they do mention the results were combined as reported in Q6. From the chart on page 5 of the paper, the authors' forest plot for burns suggests 2 papers had a small sample size? (Mentioned in Results and Discussion)

The authors say some papers failed to report their CI's



## (C) Will the results help locally?

### 8. Can the results be applied to the local population? Yes Can't tell No

HINT: Consider whether

- The patients covered by the review could be sufficiently different to your population to cause concern: The authors seem to conclude that no matter how different another population would be from theirs, there is likelihood of inequalities occurring between ID and NID groups in relation to unintentional injuries.
- Your local setting is likely to differ much from that of the review: It's likely the case is the reverse since most research in the UK have shown indigenes health status fare better than those of non-indigenes for variety of reasons.
- 

### 9. Were all important outcomes considered? Yes Can't tell No

HINT: Consider whether

- Is there other information you would like to have seen

I would have liked if the authors had possibly listed the individual RR and confidence interval for each study by the side of their forest plots.

### 10. Are the benefits worth the harms and costs? Yes Can't tell No

The authors mention in their discussion that a comparison between studies from the late 80's to the recent papers shows little change in closing the inequality gap of unintentional injuries in the last 35 years.

The authors admit there is little previous literature to see underlying factors of unintentional injuries in indigenous children and further research into this area would help future knowledge in this area. The authors suggest that their work is the first of its kind examining this topic.

The authors agree that the heterogeneity in study design could not help in producing a meta-analysis of all included papers.

The authors agree despite their “rigorous” search strategy, there could be publication bias via missing some areas were information could be obtained. They also mention that some papers had poor methods e.g. not adjusting for confounding; not reporting CI’s, ecological fallacy in 5 ecological studies.
The authors mention that some individuals failed to report their “ethnicity” when attending for treatment. Hence, there is underreporting of incidents based on this criterion. They do however state that algorithms used to enhance recording this criterion via linked health records influence results.

The authors agree some legislation and risk awareness of most injuries including burns have happened at the population level in Australia e.g. installation of smoke alarms, regulation of hot water temperature.

The authors agree that there should be a prioritisation to begin culturally accepted prevention programmes for injuries with the most inequalities first among indigenous groups will help.

The authors mention that doing mixed methods will give a qualitative look into underlying risk factors in hard to reach groups while multi-level modelling will compare between individual and population level factors and see how these widen or reduce the inequality gap.

HINT: Consider

- Even if this is not addressed by the review, what do you think?

## A.S.2.2 List of papers used for narrative synthesis in Chapter 2 by section

A. Papers used for inequalities by deprivation levels (29)

- Alnababtah *et al.* (2011)
- Bachier *et al.* (2015)
- Baker *et al.* (2017)
- Brehaut *et al.* (2003)
- Cheng *et al.* (2016)
- Cronin *et al.* (1996)
- Duke *et al.* (2015)
- Eich *et al.* (2009)
- Emond *et al.* (2017)
- Goltsman *et al.* (2016)
- Hjern *et al.* (2001)
- Hughes *et al.* (2014)
- Kramer *et al.* (2010)
- Laursen and Nielson (2008)
- Lehna *et al.* (2016)
- Marsden *et al.* (2016)
- Orton *et al.* (2014)
- Poulos *et al.* (2007)
- Prasad *et al.* (2014)
- Pratt *et al.* (2016)
- Quayle *et al.* (2000)
- Randall *et al.* (2017)
- Shah *et al.* (2013)
- Shields *et al.* (2007)
- Soleimani *et al.* (2016)
- Spady *et al.* (2004)
- Tan *et al.* (2012)
- Williams *et al.* (2003)
- Zoni *et al.* (2016)

B. Papers used for inequalities by ethnicity (32)

- Alaghehbandan *et al.* (2012)
- Alnababtah *et al* (2011)
- Bachier *et al* (2015)
- Barrow *et al* (2005)
- Bernard *et al* (2007)
- Brudvik (2011)
- Carlsson *et al* (2006)
- Cheng *et al* (2016)
- Dempsey *et al* (2006)
- Duke *et al* (2011)
- Duke *et al* (2015)
- Hayes and Groner (2005)
- Hendricks *et al* (1999)
- Hjern *et al* (2001)
- Karimi *et al* (2015)
- Karr *et al* (2005)
- Kramer *et al* (2010)
- Lehna *et al* (2016)
- Martin *et al* (2014)
- Moller *et al* (2015)
- Petridou *et al* (1998)
- Quayle *et al* (2000)
- Randall *et al* (2017)
- Riedlinger *et al* (2015)
- Saeman *et al* (2016)
- Saridi *et al* (2015)
- Shai and Lupinacci (2003)
- Shenassa *et al* (2004)
- Shields *et al* (2007)
- Soleimani *et al* (2016)
- Spady *et al* (2004)

- Tan *et al* (2012)

C. Papers used for inequalities by geographical variation (18)

- Dedovic *et al* (1996)
- Duke *et al* (2011)
- Duke *et al* (2015)
- Fernandez-Morales *et al* (1997)
- Goltsman *et al* (2016)
- Hjern *et al* (2001)
- Lehna *et al* (2016)
- Martin *et al* (2014)
- Mercier and Blond (1996)
- Morrow *et al* (1996)
- Patel *et al* (2016)
- Poulos *et al* (2009)
- Quayle *et al* (2000)
- Rajan *et al* (2011)
- Randall *et al* (2017)
- Roberts *et al* (2002)
- Saridi *et al* (2015)
- Soleimani *et al* (2016)

D. Papers used for inequalities by additional/complex needs of the child (8)

- Brehaut *et al.* (2003)
- Colin *et al.* (2006)
- Emond *et al.* (2017)
- Mangus *et al.* (2004)
- Nayeb-Hashemi *et al.* (2009)
- Prasad *et al.* (2014)
- Rowe *et al.* (2004)
- Thomas *et al.* (2004)

E. Papers used for inequalities by supervision levels (13)

- Cheng *et al.* (2016)
- Choo *et al.* (2002)
- Colin *et al.* (2006)
- Cronin *et al.* (1996)
- Eich *et al.* (2009)
- Henderson *et al.* (2003)
- Mercier and Blond (1996)
- Natterer *et al.* (2009)
- Patel *et al.* (2016)
- Shai and Lupinacci (2003)
- Stockton *et al.* (2015)
- Street *et al.* (2002)
- Wallis *et al.* (2008).

F. Papers used for inequalities in vulnerable families (12)

- Andronicus *et al.* (1998)
- Emond *et al.* (2017)
- Hjern *et al.* (2001)
- Hutchings *et al.* (2010)
- Laursen and Nielsen (2008)
- Lehna *et al.* (2016).
- Natterer *et al.* (2009)
- Petridou *et al.* (1998)
- Rowe *et al.* (2004)
- Shah *et al.* (2013)
- Shai and Lupinacci (2003)
- Williams *et al.* (2003)

These remaining 12 studies not listed above contain age and sex inequalities which are well documented in the previous literature and have not been expanded on in this review. The following sections outline all the literature used in this review in full detail by their methods and results respectively as well as their appraisals.

# AS.2.3 TABLES SHOWING CASP TOOL APPRAISALS OF INCLUDED STUDIES BY STUDY DESIGN

## AT 2.1: SYSTEMATIC REVIEWS

| S/N | AUTHOR | CLEAR FOCUSED AIM/ RESEARCH QUESTION? | INCLUDES RIGHT PAPER TYPE? | INCLUDES RELEVANT STUDIES? | GREAT PAPER ASSESSMENT? | REASONABLE TO COMBINE RESULTS? | OVERALL RESULT? | PRECISE RESULTS? | RESULTS APPLICABLE TO POPULATION OF INTEREST? | HAS ALL OUTCOMES? | STUDY BENEFITS WORTH COST/HARMS? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Moller et al. (2015) | YES | YES | NOT SURE | YES | YES | GOOD | YES | YES | YES | YES |
| 2 | Burd et al. (2005) | YES | YES | NOT SURE | NOT SURE | YES | GOOD | YES | YES | NOT SURE | YES |

AT 2.2: CASE CONTROLS

| S/N | AUTHOR | RESEARCH RIGHT FOR CASE CONTROL? | PROPERLY RECRUITED CASES? | PROPERLY RECRUITED CONTROLS? | BIAS MINIMISED EXPOSURES? | IDENTIFIED CONFOUNDERS? | RESULTS? | ARE RESULTS PRECISE? | RESULTS APPLICABLE TO POPULATION OF INTEREST? | RESULTS AGREE WITH GENERAL EVIDENCE? | RELEVANT TO SR/PhD THESIS? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Petridou et al. (1998) | YES | YES | YES | YES | YES | GOOD | YES | YES | YES-most of them with new/odd findings | YES |
| 2 | Shah et al. (2013) | YES | YES | YES | YES | YES | GOOD | YES | YES | YES-most of them with new/odd findings | YES |
| 3 | Dedovic et al. (1996)- Czech Republic | YES | YES | YES | NOT SURE | NO | GOOD | YES | YES | YES-most of them with new/odd findings | YES |

## AT 2.3: PROSPECTIVE COHORT STUDIES

| S/N | AUTHOR | CLEAR FOCUSED AIM/ RESEARCH QUESTION? | PROPERLY RECRUITED COHORT? | Did BIAS minimise EXPOSURES? | Did BIAS minimise OUTCOMES? | IDENTIFIED CONFOUNDERS? | PROPER FOLLOW UP? | PRECISE RESULTS ? | RESULTS APPLICABLE TO POPULATION OF INTEREST? | RESULTS AGREE WITH GENERAL EVIDENCE? | RELEVANT TO SR/PhD THESIS? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Orton et al. (2014)-UK | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| 2 | Karimi et al. (2015)-Sweden | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| 3 | Emond et al. (2017)-UK | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| 4 | Randall et al. (2017)-Australia | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |

## AT 2.4: RETROSPECTIVE COHORT STUDIES

| S/N | AUTHOR | CLEAR FOCUSED AIM/ RESEARCH QUESTION? | PROPERLY RECRUITED COHORT? | BIAS MINIMISED EXPOSURES? | BIAS MINIMISED OUTCOMES? | IDENTIFIED CONFOUNDERS? | PROPER FOLLOW UP? | PRECISE RESULTS? | RESULTS APPLICABLE TO POPULATION OF INTEREST? | RESULTS AGREE WITH GENERAL EVIDENCE? | RELEVANT TO SR/PhD THESIS? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Verey et al. (2014)-UK | Yes | Yes | Yes | Yes | Yes-identified some and tried to reduce the effect | YES | Yes | Yes-Compared South West with national data available | Yes | Yes |
| 2. | Hutchings et al. (2010)-UK | YES | YES | YES | NOT SURE-analysed known intentional cases with accidentals | Yes-identified some and tried to reduce the effect | YES | YES | YES | YES | YES |
| 3. | Prasad et al. (2014)-UK | YES | YES | YES | YES | Yes-identified some and tried to reduce the effect | YES | YES | YES | YES | YES |
| 4. | Duke et al. (2015)-Australia | YES | YES | NOT SURE | YES | Yes-identified some and tried to reduce the effect | YES | YES | YES | YES | YES |
| 5. | Hayes and Groner (2005)-United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | NO | YES | YES | YES | YES |
| 6. | Spady et al. (2004)-Canada | YES | YES | NOT SURE | NOT SURE | NO | YES | YES | YES | YES | YES |
| 7. | Baker et al. (2016)-UK | YES | YES | NOT SURE | YES | Yes-identified some and tried to reduce the effect | YES | YES | YES | YES | YES |

## AT 2.5: CROSS-SECTIONAL STUDIES (PART 1)

| S/N | AUTHOR | CLEAR FOCUSED AIM/ RESEARCH QUESTION? | PROPERLY RECRUITED SAMPLE? | BIAS MINIMISED EXPOSURES? | BIAS MINIMISED OUTCOMES? | IDENTIFIED CONFOUNDERS? | PRECISE RESULTS? | RESULTS APPLICABLE TO POPULATION OF INTEREST? | RESULTS AGREE WITH GENERAL EVIDENCE? | RELEVANT TO SR/PhD THESIS? |
|---|---|---|---|---|---|---|---|---|---|---|
| | Natterer *et al.* (2009) | YES | YES- questionnaires also sent to small GP centres around the hospitals that may treat little burns | NOT SURE | NOT SURE | YES- Important ones like few burns treated outside the hospital, sex, ethnicity, thermostats, under/over representation | YES | YES | YES-most of it | YES |
| | Kemp *et al.* (2014) | YES | YES | YES- | YES- via data recruitment | YES-like exclusion of non-accidental cases | YES | YES | YES | YES |
| | Fernandez-Morales *et al.* (1997) | YES | YES-used stratified sampling | YES- | YES | YES | YES- well detailed | YES | YES-most of it | YES |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rowe *et al.* (2004) | YES | YES- | YES-most of the important ones | YES | YES | YES | YES | YES-most of it | YES |
| | Cokkinides *et al.* (2009) | YES | YES | NOT SURE | NOT SURE | YES | YES | YES | YES | YES |
| | Brudvik *et al.* (2011) | YES | YES | YES | NOT SURE | YES | YES | YES | YES | YES |
| | Hughes *et al.* (2014) | YES | NOT SURE | NOT SURE | YES | YES | YES | YES | YES | YES |
| | Saridi *et al.* (2015) | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| | Stockon *et al.* (2015) | YES | YES | NOT SURE | YES | YES-most of them | YES | YES | YES | YES |
| | Lam *et al.* (1999) | YES | YES- Geographically representative of about half the state facilities | NOT SURE-excludes organised sports but doesn't specify what constitutes play | YES-focuses on mortality data over the period | NOT SURE: Some mentioned | NOT SURE | YES | NOT SURE | YES |
| | Brudvik (2000) | YES | NOT SURE - as only reports paediatric burns referred to the hospital in the region and few surrounding towns. | NOT SURE | NOT SURE: reports a burn decline possibly due to an intervention | YES: some mentioned | YES: questionnaire s, staff training and prevention of double data entry | YES | YES | YES |
| | Cronin *et al.* (1996) | YES | NOT SURE - as only reports paediatric burns referred to hospital | YES | YES | NOT SURE | YES | YES | YES | YES |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mercier and Blond (1996) | YES | YES- Geographically representative | NOT SURE- mention selection bias to house fire exposures | YES | NOT SURE: Some mentioned | NOT SURE- not done for those discharged within a day | YES | YES | YES |
| | Dokter *et al.* (2014) | YES | YES | NOT SURE | YES | YES-most of them | YES | YES | YES | YES |

AT 2.6: CROSS-SECTIONAL STUDIES (PART 2)

| S/N | AUTHOR | CLEAR FOCUSED AIM/ RESEARCH QUESTION? | PROPERLY RECRUITED SAMPLE? | BIAS MINIMISED EXPOSURES? | BIAS MINIMISED OUTCOMES? | IDENTIFIED CONFOUNDERS? | PRECISE RESULTS? | RESULTS APPLICABLE TO POPULATION OF INTEREST? | RESULTS AGREE WITH GENERAL EVIDENCE? | RELEVANT TO SR/PhD THESIS? |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dempsey *et al.* (2006) | YES | NOT SURE | YES | NOT SURE-overrepresentation mentioned | YES-most of them | YES | YES | YES | YES |
| | Martin *et al.* (2014) | YES | YES | YES | NOT SURE-overrepresentation mentioned | YES-most of them | YES | YES | YES | YES |
| | Sarginson *et al.* (2014) | YES | YES | NOT SURE | YES | YES-most of them | YES | YES | YES | YES |
| | Alnababtah *et al.* (2011)-UK | YES | YES | NOT SURE | NOT SURE | NO | YES-excellent | YES | YES-most | YES |
| | Woodbridge *et al.* (2010)-UK | YES | YES | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Mumtaz *et al.* (2011)-UK | YES | NOT SURE | NOT SURE | YES | NOT SURE | YES | YES | YES | YES |
| | Davidson and Eadie (2009)-Ireland | YES | YES | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Yates *et al.* (2011)-Ireland | YES | YES | NOT SURE | NOT SURE | NO | NOT SURE | YES | YES-most | YES |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Macgregor *et al.* (2003)- Scotland, UK | YES | YES | NOT SURE | NOT SURE | NO | NOT SURE | YES | YES-some | YES |
| | Colin *et al.* (2006)-UK | YES | YES | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Nguyen *et al.* (2008)-Wales, UK | YES | YES | NOT SURE | NOT SURE | YES-most of them | YES | YES | YES | YES |
| | Foong *et al.* (2010)- UK | YES | YES | NOT SURE | NOT SURE | YES-some | YES | YES | YES | YES |
| | Tan *et al.* (2012)-UK | YES | YES | YES | YES | YES-most of them | YES | YES | YES | YES |
| | Vermaak *et al.* (2012)-UK | YES | YES | NOT SURE | NOT SURE | YES-most of them | YES | YES | YES-some | YES |
| | Abeyasundara *et al.* (2011)-Australia | YES | NOT SURE-authors mention inpatient data was only used | NOT SURE | NOT SURE | YES | YES | YES | YES-some | YES |
| | Duke *et al.* (2011)-Australia | YES | YES | YES-some | NOT SURE | YES | YES | YES | YES | YES |
| | Trop *et al.* (2015)-Austria | YES | NOT SURE-authors mention inpatient | NOT SURE | NOT SURE | YES | YES | YES | YES | YES |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | data was only used | | | | | | | |
| | Laitakari *et al.* (2014)- Finland | YES | YES | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Kubilius *et al.* (2014)- Lithuania | YES | YES | YES | NOT SURE | NO | YES | YES | YES-some | YES |
| | Viklund *et al.* (2013)- Sweden | YES | YES | YES | NOT SURE | YES-some | YES | YES | YES | YES |
| | Pym *et al.* (2013)- Australia | YES | YES | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Schmertmann *et al.* (2012)- Australia | YES | NOT SURE- authors mention inpatient data was only used | NOT SURE- different recruiting criteria used in different hospitals | YES | NO | YES | YES | YES | YES |
| | Mah *et al.* (2013)- Australia. | YES | NOT SURE- authors mention lots of underrepresentation | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Lipovy *et al.* (2012)- Czech Republic | YES | YES | YES | NOT SURE | NO | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Van Baar *et al.* (2011)- Netherlands | YES | YES | NOT SURE | YES | NO | YES | YES | YES | YES |
| | Vloemans *et al.* (2011)- Netherlands | YES | YES | NOT SURE | NOT SURE | YES | YES | YES | YES | YES |
| | Shah *et al.* (2011)- USA | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Landolt *et al.* (2013)- Switzerland | YES | NOT SURE | NOT SURE | NOT SURE | YES | YES | YES | YES | YES |
| | Alaghehbandan *et al.* (2012)- Canada | YES | YES | YES | NOT SURE | YES | YES | YES | YES | YES |
| | Rajan *et al.* (2011)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Nayeb-Hashemi *et al.* (2009)- United States | YES | YES | NOT SURE | YES | YES | YES | YES | YES-some | YES |
| | Poulos *et al.* (2009)- Australia | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| | Jeremijenko *et al.* (2009)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | YES | YES | YES | YES | YES |
| | Eich *et al.* (2009)- Germany | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | D'Souza *et al.* (2009)- United States | YES | NOT SURE | YES | YES | NOT SURE | YES | YES | YES | YES |
| | Riedlinger *et al.* (2015)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Wallis *et al.* (2008)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Kramer *et al.* (2010)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Celko *et al.* (2009)- Czech Republic | YES | NO | YES-some, REMOVED 2ND TIME CASES | NOT SURE | NO | YES | YES | YES | YES |
| | Tomkins and Holland (2008)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Poulos *et al.* (2007)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Wong *et al.* (2007)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Shields *et al.* (2007)- United States | YES | NOT SURE | YES- mentioned multiple imputations to reduce the | NOT SURE | NO | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | | | effect of missing data but numbers small to affect? | | | | | | |
| | Papp *et al.* (2008)-Finland | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Bernard *et al.* (2007)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Witsaman *et al.* (2006)- United States | YES | NO | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Vollman and Smith (2006)-United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Thombs *et al.* (2006)-United States | YES | NOT SURE | NOT SURE | YES | YES | YES | YES | YES-younger ones had higher death odds than older children | YES |
| | Laursen and Nielson (2008)-Denmark | YES | YES | NOT SURE | YES | YES | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Barrow *et al.* (2005)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Vassilia *et al.* (2004)- Greece | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES-street most location for burns | YES |
| | Thomas *et al.* (2004)-United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Shenassa *et al.* (2004)- United States | YES | NOT SURE | YES | YES | YES | YES | YES | YES | YES |
| | Carlsson *et al.* (2006)- Sweden | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Karr *et al.* (2005)- United States | YES | NOT SURE | YES-a little bit | NOT SURE | NO | YES | YES | YES | YES |
| | Phelan *et al.* (2005)- United States | YES | NOT SURE | YES-a little bit | NOT SURE | NO | YES | YES | YES | YES |
| | Dewar *et al.* (2004)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Brownscombe *et al.* (2004)- United Kingdom | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Abbas *et al.* (2004)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Gulliver *et al.* (2005)- New Zealand | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Williams *et al.* (2003)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Ljungberg *et al.* (2006)- Sweden | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Nelson *et al.* (2005)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Mangus *et al.* (2004)-United States | YES | NOT SURE | NOT SURE | NOT SURE | YES | YES | YES | YES | YES |
| | Roberts *et al.* (2002)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Street *et al.* (2002)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Bishai *et al.* (2002)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Agran *et al.* (2003)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Shai and Lupinacci (2003)- United States | YES | NOT SURE | YES-a little bit | NOT SURE | YES | YES | YES | YES | YES |
| | Brehaut *et al.* (2003)-Canada | YES | YES | YES | NOT SURE | YES | YES | YES | YES | YES |
| | Hjern *et al.* (2001)- Sweden | YES | YES | YES | NOT SURE | YES | YES | YES | YES | YES |
| | Pickett *et al.* (2003)- Canada | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Choo *et al.* (2002)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Quayle *et al.* (2000)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Henderson *et al.* (2003)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Davey (1999)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Streeton and Nolan (1997)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Addor and Santos-Eggimann (1996)- Switzerland | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Hendricks *et al.* (1999)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Andronicus *et al.* (1998)- Australia | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Suominen *et al.* (1998)- Finland | YES | NOT SURE | NOT SURE | NOT SURE | NO | NOT SURE | YES | YES | YES |
| | Morrow *et al.* (1996)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Murphy *et al.* (1995)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Raj *et al.* (1999)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Elisdottir *et al.* (1999)- Iceland | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Sheridan *et al.* (1997)- United States | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Eadie *et al.* (1995)- United Kingdom | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Bachier *et al.* (2015)-United States | YES | YES | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Billock *et al.* (2017)-United States | YES | YES | YES-some | NOT SURE | YES-some | YES | YES | YES | YES |
| | Cheng *et al.* (2016)- USA | YES | YES | NOT SURE | NOT SURE | YES-some | YES | YES | YES | YES |
| | Goltsman *et al.* (2016)-Australia | YES | NOT SURE | YES-some | YES-some | YES-some | YES | YES | YES | YES |
| | Lehna *et al.* (2016)-USA | YES | NOT SURE | YES-some | NOT SURE | YES-some | YES | YES | YES | YES |
| | Mardsen *et al.* (2016)-UK | YES | NOT SURE | NOT SURE | NOT SURE | YES-some | YES | YES | YES | YES |
| | Patel et al. (2016)-USA | YES | NOT SURE | NOT SURE | NOT SURE | NO | YES | YES | YES | YES |
| | Pratt *et al.* (2016)-Canada | YES | NOT SURE | NOT SURE | YES-some | YES-some | YES | YES | YES | YES |
| | Saeman *et al.* (2016)-USA | YES | NOT SURE | NOT SURE | NOT SURE | NOT SURE | YES | YES | YES | YES |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Soleimani *et al.* (2016)- United States | YES | NOT SURE | NOT SURE | NOT SURE | YES-some | YES | YES | YES | YES |
| | Zoni *et al.* (2016)- Spain | YES | YES | NOT SURE | NOT SURE | YES-some | YES | YES | YES | YES |

AT 2.7 TABLES SHOWING METHODS OF PAPERS INCLUDED FOR SYSTEMATIC REVIEW

| SYSTEMATIC REVIEWS<br><br>Key: NRS= Not reported/stated | | | |
|---|---|---|---|
| AUTHOR AND LOCATION OF STUDY | POPULATION (P), SAMPLE NUMBER (SN) AND SELECTION CRITERIA (SC) | STUDY DESIGN | AIM |
| Burd and Yuen (2005)- Global | P: 2004 population across the 6 regions sampled= 6357 million. SN: 505,276 burns SC: Individuals aged 0-20 years reporting for healthcare treatment of burns | Systematic Review/ primary research published from 1990-date of study from Africa, Asia, Middle East, Americas, Europe and Australasia. Databases sources poorly reported. | To extrapolate global burn incidence and regional variation in hospitalised paediatric burns from published data. |
| Moller et al. (2015)- Global | P: NRS SN: NRS SC: unintentional injuries reported by indigenous and non-indigenous children (aged 0-19 years) | Published systematic reviews and observational studies identified through 10 databases. | To assess differences in unintentional injury rates between indigenous and non-indigenous children (aged 0-19 years) globally considering: unintentional injuries rates, injury cause and injury risk factor. |
| PROSPECTIVE COHORT STUDIES | | | |
| AUTHOR AND LOCATION OF STUDY | POPULATION (P), SAMPLE NUMBER (SN) AND SELECTION CRITERIA (SC) | STUDY DESIGN | AIM |
| Emond et al. (2017) | P: NRS SN: 12966 children with burns SC: Individuals aged 0-11 years reported with burn event and pre-injury behaviour and developmental issues. | Prospective Cohort using the Avon Longitudinal Study of Parents and Children (ALSPAC) | To investigate child developmental and behavioural characteristics and risk of burns and scalds. |
| Karimi et al. (2015) | P: 4 884 979 children born between 1961 and 2007 SN: 134 Swedish born deaths and 48 foreign background deaths SC: Children aged 0-17 reporting different injuries across Sweden | Prospective Population-Based Cohort study coursing 46 years created from 6 Swedish national databases. | To compare the risk of fatal unintentional injuries in foreign-born and Swedish children. |

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| Orton et al. (2014)-UK | P: NRS. SN: 979,383 children followed for 2.68 years. SC: Children aged 0-5 years reporting different injuries across 495 GP's across the UK | Prospective Cohort using The Health Improvement Network (THIN) database. | To find national estimates of paediatric injury rates and burden attributable to deprivation |
| Randall et al. (2017) | P: 2.2 million SN: 12966 children with burns SC: Individuals aged 0-11 years reported with burn event and pre-injury behaviour and developmental issues. | Prospective Cohort using state-wide health administrative data for the period 2000–2012 linked to the Western Australian Data Linkage System (WADLS) | To investigate the geographic distribution and temporal trends of burn admissions in Western Australia. |
| RETROSPECTIVE COHORT STUDIES<br><br>Key: WAPBIP= Western Australia Population-Based Burn Injury Project, WADLS= Western Australia Data Linkage System, AHCIP=Alberta Health Care Insurance Plan, CCH= Community Child Health, WBRU= Welsh Regional Burns Unit, CPRD= Clinical Practice Research Data-link, | | | |
| AUTHOR AND LOCATION OF STUDY | POPULATION (P), SAMPLE NUMBER (SN) AND SELECTION CRITERIA (SC) | STUDY DESIGN | AIM |
| Baker et al. (2016) the -United Kingdom | P: NRS. SN: 2 106 420 children and young people over the 13 years. SC: 0-24 years reporting to GP practices/hospitals. | Retrospective cohort using CPRD data of children and young people) registered with a CPRD practice between 1998 and 2011) linked to HES and ONS data. | To describe the epidemiology of poisonings, fractures and burns for children and young people aged 0–24 living in England. Linked data sources and to inform injury prevention strategies. |
| Duke et al. (2015)-Australia | P: NRS. SN: 10,426 cases and 40, 818 control. SC: 0-15 years reporting to hospitals in Western Australia from 1980-2012. | Retrospective Cohort Study of prospectively collected data for 33 years/ WAPBIP data linked with WADLS and Death Register data. Cases: controls were 1:4 (10,426: 40,818). | To quantify burn injury impact on long-term mortality and increased death risk from such. |
| Hayes and Groner (2005)-United States | P: NRS. SN: 5, 793 injuries. SC: 0-16 years of fatal and non-fatal injuries. | Retrospective Cohort Study of prospectively collected data from 1996-2001 from Ohio trauma registry and hospital data. | To compare traumatic injury rates on a state-wide level between the white majority and other minority groups. |
| Hutchings et al. (2010)-Wales, UK | P: 357,769 individuals in Swansea and Neath Port Talbot (2001 census). SN: 145 cases and 145 controls. | Retrospective Cohort Study of prospectively collected data over five years/ WRBU data, ED databases, CCH, school records and social services database. | To examine the presenting features of burned children and their health/developmental outcomes. |

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| | SC: 0-6 years reporting burns to WBRU from Sept 1994-Aug 1997. | | |
| Prasad et al. (2014), UK | P: Primary care database of 12 million people (8% of the UK population) SN: 11934 people with epilepsy and 46598 without (burns only). SC: 1-24 years old reporting injuries of interest throughout the 23-year cohort study period. | Retrospective Cohort Study of prospectively collected data over the 23 years/CPRD Data. Cases: Controls were matched 1:4 | To investigate if children and young adults with incident epilepsy are at higher risk of having fractures, thermal injury or poisoning. |
| Spady et al. (2004)-Canada | P: 2.8 million people (Alberta only) SN: 9556 patients with burns. SC: Children alive at five years who were registered with AHCIP before age one from April 1985 to March 1987 | Retrospective Cohort Study of prospectively collected data from 1985-1987. | To estimate the burden of paediatric injuries in Alberta, Canada |
| Verey et al. (2014) | P: 10,000,000 adults and children, SN: 1480 burns. SC: 0-16-year children reporting burns for the first time from 1st Jan 2010 to 31st Dec 2011 | Retrospective Cohort Study of prospectively collected data over two years/ iBID used at SWCBC since 2007 | To observe the relationship between risk factors and temporal variation in paediatric burn incidence within South West England. |
| CASE CONTROLS | | | |
| AUTHOR AND LOCATION OF STUDY | POPULATION (P), SAMPLE NUMBER (SN) AND SELECTION CRITERIA (SC) | STUDY DESIGN | AIM |
| Dedovic et al. (1996)-Czech Republic | P: NRS SN: 394 children. SC: 0-14 years reporting to Burn centre, Masaryk University, Brno from 1991 to 1993 | Case-Control Study | To identify the epidemiological features of burn accidents and create suggestions for prevention and intervention programmes |
| Petridou et al. (1998)-Greece | P: NRS SN: 239 children reporting with burns. SC: 0-16 years reporting to outpatients ED in two University Children's Hospitals in Athens between Nov 1995 to Oct 1996 | Case-Control Study/ Outpatient ED data from the Emergency Department Injury Surveillance System (EDISS) created by the Centre for Research and Prevention of Injuries among the Young (CEREPRI). | To see if risk factors for childhood burns are environmental, developmental or behavioural. |

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| Shah et al. (2013)-UK | P: NRS SN: 986 children reporting to primary care for burns. SC: 0-16 years reporting to UK primary care and GP's from Jan 1988 to Nov 2004 via The Health Improvement Network (THIN) database | Case-Control Study/ THIN longitudinal data from 255 practices with 3.9 million records. | To identify the first risk factors for burns in children< 5 years using a large nationally based representative of primary care records. |
| CROSS-SECTIONAL STUDIES (PART 1)<br><br>Key: NRS= Not reported/stated, HES= Hospital Episode Statistics, SPPBC= Stuart Paediatric Burns centre, NHDR= National Hospital Discharge Register, DBR= Dutch Burn Repository R3, CBR= Child Benefit Register, BCAMHS-99= 1999 British Child and Adolescent Mental Health Survey, RHA= Regional Health Authority, CPD= common psychiatric disorders, NSW= New South Wales | | | |
| AUTHOR AND LOCATION OF STUDY | POPULATION (P), SAMPLE NUMBER (SN) AND SELECTION CRITERIA (SC) | STUDY DESIGN | AIM |
| Brudvik (2000)-Netherlands | P: 47,750 children (1998) SN: 136 burn injuries out of 6612 mixed injury patients SC: 0-15-year-olds reporting to Haukeland University Hospital from Bergen and surrounding towns | A cross-sectional using EDs data, direct parental interviews and follow up questionnaires. | To describe a survey of medically treated injuries in Bergen and associated risk factors |
| Brudvik (2011)-Norway | P: 46, 333 children in Bergen (2007). SN: 142 cases. SC: 0-15-year-olds reporting burns from Bergen and surrounding towns | A cross-sectional study using A and E data, direct parental interviews and follow up questionnaires. | To look for changing trends by 9-year intervals for burn epidemiology in Bergen. |
| Cokkinides et al. (2009)-USA | P: NRS. SN: NRS. SC: 11 to 18 years reporting skin injuries after use of indoor tanners. | A cross-sectional study using data from 2 national population-based cross-sectional telephone surveys by the American Cancer Society in 1998 and 2004 | To assess changes in indoor tanning use from ages 11-18 especially in states with restrictions on minors using such equipment. |
| Cronin et al. (1996)-Ireland | P: 3.5 million (1996). SN: 336 patients SC: 0-14-year-olds reporting to A and E of Our Lady's Hospital for Sick Children, Dublin. | A cross-sectional study using A and E notes, direct parental interviews and postal follow up questionnaires. | To describe the epidemiology of paediatric burns in Dublin and to identify region-specific hazards. |
| Dokter et al. (2014)-Netherlands | P: 16.75 million (as of 2011). SN: 9031 patients (3890 were below 19 years) SC: first-time admission in a burn centre/hospital in the Netherlands from 1995 to 2011 | A cross-sectional study using NHDR data (non-burns specialised centre) and DBR data (for burns specialised centre) | To describe the epidemiology of severe burns in the Netherlands, including trends and ages in a burn centre and non-burn centre admissions. |

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| Fernandez-Morales et al. (1997)-Spain | P: 1,166,891 (Malaga's population) SN: 1746 people from 500 families. SC: All ages reported to have burned during an interview | A cross-sectional study using population-based interview/survey across Malaga | To quantify the magnitude of burn injuries reported in Malaga, Spain via aetiology, epidemiology and first aid therapy used. |
| Hughes et al. (2014)-UK | P: 3,274,825 reporting to ED's in 1 year. SN: 22,222 reporting burns. SC: 0-15-year-olds reporting across the UK | A Cross-Sectional study using ED data from UK hospitals/ HES service | To use HES to explore ED attendance for critical injuries in 0-14 years and ways of informing prevention targets and strategies. |
| Kemp et al. (2014)-UK | P: NRS. SN: 1215 children with burn injuries reported. SC: 0-16-year-olds reporting to 5 major UK hospitals. | A cross-sectional study using ED data from 5 crucial UK hospitals | To observe the mechanism, agents and clinical presentations of unintentional paediatric burns and their impact on different developmental stages of children |
| Lam et al. (1999) | P: 26657 play-related injuries (1990-1994) SN: 122 deaths (8 burns related) SC: Children aged 0-14 reporting to 20 out of 49 hospitals in NSW. | A cross-sectional study using Child safe NSW injury registry data and NSW Trauma Death registry data for mortality cases | To describe play related deaths and injuries in NSW, Australia |
| Mercier and Blond (1996)-France | P: ~10.04 million children (1990) SN: 937 patients SC: 0-15-year-olds reporting to 14 French burn centres and 18 paediatric surgical centres | A cross-sectional study using a questionnaire across the French burn centres | To describe the epidemiology of paediatric burns in France and associated risk factors |
| Natterer et al. (2009)-Switzerland | P: NRS, SN: 89 children with burn injuries reported. SC: 0-16-year-olds reporting to 2 essential hospitals in Lausanne- the Children's Hospital (minor) and the University Hospital (significant burns) | A cross-sectional study using ED data. | To find the prevalence of children most susceptible to burn injuries in Lausanne and prevention/ counselling groups |
| Rowe et al. (2004)-UK | P: NRS. SN: 10,438 children. SC: All ages reported to have an injury at any time in childhood and possibly have a CPD | A cross-sectional study using population-based interview/survey across the UK via CBR, BCAMHS-99 and RHA. | To show the epidemiology of unintentional injury (including burns) in children with CPD |
| Saridi et al. (2015)-Greece | P: NRS. SN: 2,977 individuals from 2007 and 2010. SC: 9-18-year-olds reporting sunburn and skin injuries as | A cross-sectional study using a population-based random interview/questionnaire survey across Corinth, Greece. | To estimate the sunburn incidence in young pupils in a Greek coastal district and associated risk factors in 2007 and 2010. |

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| | well as having knowledge, attitudes, belief and behaviours on sun exposure | | |
| Stockton et al. (2015)- Australia | P: NRS SN: 758 patients in the year 2013. SC: 0-16 years reporting burn injuries | A cross-sectional study using data from the Stuart Paediatric Burns centre (SPPBC) | To describe the mechanism of injury and outcome for all paediatric burn patients comparing inpatients and outpatients |
| CROSS-SECTIONAL STUDIES (PART 2)<br><br>Key: IRR= Incidence Rate Ratio, LOS= length of stay, IR= incidence rates, OR= odds ratio, CPD= common psychiatric disorders, FB= foreign born, %TBSA= total burn surface area percentage, BCH= Birmingham Children's Hospital, UCH= University College Hospital, CUH= Children's University Hospital, SWPBC= South West Paediatric Burns Centre, RACH= Royal Aberdeen's Children's Hospital, WCBPS= Welsh Centre for Burns and Plastic Surgery, BHCH= Booth Hall Children's Hospital, NSW= New South Wales, ACT= Australian Centre Territory, CHBRI= Children's Hospital Burns Research Institute, NSWBIS= New South Wales Severe Burn Injury Service, WALDS=Western Australia Data Linkage System, HCH= Helsinki University Hospital, OPD= outpatient department, STN= State-wide Trauma Network, CCYPCG= Commission for Children and Young People and Child Guardian, WCH= Women and Children's Hospital, BOQ= Burn Outcomes Questionnaire, TMV= thermostatic mixer valves, NEISS= National Electronic Injury Surveillance System, NBID= National Burn Injury Database, NBR= National Burn Repository, KID= Kids Inpatient Database, NBC= National Burn Centre, ABA-NBR= American Burn Association-National Burn Repository database, BISS= Bath Injury Surveillance System, NZHIS= New Zealand Health Information Service, GIS= geographic information systems, SHDR= Swedish Hospital Discharge Register, OSHPD= Office of State-wide Health Planning and Development, BCLHD= British Columbia Linked Health Dataset, CBD= childhood behaviour disorders, CHIRPP= Canadian Hospitals Injury Reporting and Prevention Program, RCH= Royal Children's Hospital, VIMD= Victorian Inpatient Minimum Database, HUCH= Helsinki University Central Hospital, HUCH= Helsinki University Central Hospital, JBC= Jaycees Burn Centre, | | | |
| AUTHOR AND LOCATION OF STUDY | POPULATION (P), SAMPLE NUMBER (SN) AND SELECTION CRITERIA (SC) | STUDY DESIGN | AIM |
| Abeyasundara et al. (2011)-Australia | P: 8 million from NSW and ACT. SN: 3621 inpatients. SC: 0-15 years reporting to Burns' Unit, CHBRI and NSWBIS from Jan 2003- Dec 2007 | A cross-sectional study/ departmental and state-wide databases | To determine the frequency of different burn modalities in children presenting to a burn's unit in Australia for over five years. |
| Addor and Santos-Eggimann (1996)- Switzerland | P: 37993 children in Canton, Switzerland (1991) SN: 68 burns SC: 0-5-year-olds with injuries in Canton, Switzerland in 1991. | A cross-sectional study using injury data and mailing databases. | To provide population specific incidence rates for preschool injury and prevention strategies. |
| Agran et al. (2003)- United States | P: NRS. SN: 1951 burns SC: 0-4-year-olds with injury from 1996-1998 in the OSHPD database. | A cross-sectional using state-wide injury database. | To estimate injury burden by quarterly year intervals of 0-4-year-olds and peak age for injuries. |

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| Alaghehbandan et al. (2012)- Canada | P: 509,000 (2010). SN: 157 admissions SC: 0-16 years reporting to hospitals over six years (1995-2001) retrieved from provincial Mortality System (MS) and admission data from the Centre for Health Information | A cross-sectional study using provincial vital statistics and admissions data. | To identify childhood, burn epidemiology in Newfoundland and Labrador in Canada |
| Alnababtah et al. (2011)-UK | P: 0-16 child population in West Midlands 497, 170, all population- 5.04 million (2007). SN: 1249 patients reporting with burns. SC: 0-16 years reporting burns to BCH | A cross-sectional study using burn ward data from Birmingham Children's Hospital (BCH) between 2004-2008 | To investigate factors that lead to reported burns and their frequency especially with several socio-demographic factors. |
| Andronicus et al. (1998)- Australia | P: NRS. SN: 507 cases. SC: 0-17 years old admitted for burns at Royal Alexandra Hospital for children from 1994-1996. | A cross-sectional study using hospital injury data. | To see differences in accidental and intentional/neglected burns as well as see if these have been picked up by social services. |
| Bachier et al. (2015)- United States | P: NRS. SN: 308 cases. SC: 0-17 years old admitted for burns at the Paediatric Trauma Centre of Tennessee Health Science Centre, Le Bonheur Children's Hospital, Memphis, Tennessee from 2007 to 2012 | A cross-sectional study using hospital burns injury data. | To determine if cooking-related scald burns result in more significant injuries than non-cooking scald burns and to assess if these injuries produced greater morbidity and required more extensive care. |
| Barrow et al. (2005)- United States | P: NRS. SN: 747 burns. SC: 0-17 years admitted with > 40% TBSA to Shriner's Hospital, Texas from 1985-2005. | A cross-sectional study using burn centre data. | To establish a relationship between mortality and age, gender or ethnicity |
| Bernard et al. (2007)- United States | P: NRS. SN: 2,412 burn deaths. SC: 0-19 years old dying from burns from 1999-2002 retrieved from CDC Vital Statistics systems. | A cross-sectional study using CDC Vital Statistics. | To compare racial/ethnic disparities in injury death rates during 1999-2002 |
| Billock et al. (2017)- United States | P: NRS. SN: 136 991 patients treated for firework injuries. SC: 0-20-year-olds with reported burn injuries to US ED's within 25 years (source: NEISS). | A cross-sectional study using injury data from population-based consumers' database. | To describe non-fatal paediatric firework injuries from 1990 to 2014 via a nationally representative sample. |
| Bishai et al. (2002)- United States | P: NRS. SN: 48 burns SC: 0-6 years with injuries from 1997-1999 in Medicaid MCO database from Baltimore | A cross-sectional study using a state-wide health insurance database. | To quantify the economic cost related to injury burden, service utilisation and rates in children insured by Medicaid |

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| Brehaut et al. (2003)- Canada | P: NRS. SN: 1346 burns SC: 0-19 years old with CBDs having injuries from 1990-1996 recorded in BCLHD. | A cross-sectional study using a state-wide health database. | To show the association between CBDs and injury |
| Brownscombe et al. (2004)- United Kingdom | P: NRS. SN: 91 thermal injuries from 2300 accidental injuries. SC: 0-4-year-olds with an injury in the BISS | A cross-sectional study using hospital surveillance data. | To illustrate the potential of injury surveillance data from ED's surveillance system. |
| Carlsson et al. (2006)- Sweden | P: 257,574 inhabitants in Malmo over the study period. SN: 148 children SC: 0-6-year-old reporting burn injuries to any 21 health study centres over the 5-year study. | A cross-sectional study using health study centre data | To describe paediatric burns at age 0-6 years old reporting to primary care and hospitals in Malmo, Sweden between 1998-2002 |
| Celko et al. (2009)- Czech Republic | P: NRS. SN: 1064 cases. SC: 0-16 years admitted to Prague Burn centre from 1993-2000 for the first time. | A cross-sectional study using burns unit data. | To assess the risk factors for paediatric burn injuries in the Czech Republic and to suggest prevention methods. |
| Cheng et al. (2016)- USA | P: NRS. SN: 17 845 families. SC: Parents of 0-7-year-olds are presenting to clinics for child care and filling the Child Health Improvement through Computer Automation (CHICA) questionnaire from August 2012 to November 2015. | A cross-sectional study using clinically collected population health self-reports. | To assess the association between parental health literacy and a range of paediatric health risks via a population-based sample of children visiting primary care clinics. |
| Choo et al. (2002)- Australia | P: NRS. SN: 33 cases SC: 0-17 years with injuries from 1999-2001 in SPPBC database. | A cross-sectional study using burn centre data. | To describe the risk factors and effects of campfire burns on children. |
| Colin et al. (2006)-UK | P: 4.5 million in and around Newcastle. SN: 125 cases. SC: 0-16 years reporting to Newcastle Burn Centre between 1997-2005 with a bath water scald injury | A cross-sectional study/ chart reviews of patients at the Newcastle Regional Burns Centre, the UK from 1997-2005 | To determine the frequency and severity of bath water scalds and estimate reduction costs if TMVs was used in future |
| Davey (1999)- Australia | P: NRS. SN: 4254 cases. SC: 0-17 years reporting/admitted for burns at Adelaide CHBU from 1960-1996. | A cross-sectional study using hospital burn unit data. | To describe changes in burn care over the 36 years checking for marked improvement in mortality and morbidity outcomes. |

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| Dempsey et al. (2006)-Ireland | P: 3,917,203-0.3% asylum seekers (2002). SN: 126 patients. SC:0-16 children reporting burns to A and E of Our Lady's Hospital for Sick Children, Dublin | A cross-sectional study- notes from A and E and the hospital's inpatient enquiry (HIPE) department. | To ascertain the burn injury profile of asylum seekers children compared to other/native children. |
| Dewar et al. (2004)-Australia | P: NRS. SN: 152 cases. SC: 0-17 years reporting SPPBC from July 1999 to June 2002 | A cross-sectional study using burn centre data | To see the mechanism and settings in which hot beverage burns occur. |
| D'Souza et al. (2009)-United States | P: NRS. SN: 2,054,563 estimated via sampling weights of 62,196 actual cases from 1990-2006. SC: 0-20 reporting burn injuries to US ED's within the study period (source: NEISS). | A cross-sectional study using burns unit data from 1990 to 2006 | To examine the patterns and trends of burn-related injuries in < 18 years treated in US ED's between 1990-2006 |
| Duke et al. (2011)-Australia | P: 2.2 million in Western Australia (WA). SN: SC: Under five years reporting burns to 6 significant hospitals across WA and morbidity data obtained via WADLS from 1983-2008. | A cross-sectional study using the WADLS database from 1983-2008. | To estimate incidence, temporal trends and cause of burn injury hospitalisations for under five children in Western Australia over 26 years and risk factors. |
| Eadie et al. (1995)-United Kingdom | P: NRS. SN: 146 admissions by 1991. SC: 0-16 years old with burns at the Welsh Centre for Burns from 1956 to 1991. | A cross-sectional study using burn centre data. | To assess the incidence and aetiology of scalds in their unit over 35 years |
| Eich et al. (2009)-Germany | P: NRS. SN: 83 cases. SC: 0-18 years reporting the thermal injury to University Hospital Schleswig-Holstein from September 2002-December 2005 | A cross-sectional study using burns centre data. | To assess the epidemiology and prevention of thermal injuries. |
| Elisdottir et al. (1999)- Iceland | P: NRS. SN: 290 cases SC: 0-15-year-old burn admissions to the University Hospital of Iceland from 1982-1995 | A cross-sectional study using hospital burn data. | To get the epidemiology and risk factors for paediatric burns injury in Iceland. |
| Foong et al. (2010)-UK | P: NRS. SN: 45 patients SC: 0-16 reporting hair straightener burns to BHCH, Manchester, UK | A cross-sectional study/ chart reviews of patients at BHCH, Manchester, the UK from Jan 2005-Dec 2006 | To assess the safety features of hair straighteners, the mechanism of their contact burns and resulting morbidity. |

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| Goltsman et al. (2016)-Australia | P: NRS. SN: 8223 patients SC: 0-15 reporting burns in New South Wales | A cross-sectional study using state-wide representative burn registry data. | To describe geographical patterns of severe burns in New South Wales and spatial patterns of burn risk. |
| Gulliver et al. (2005)-New Zealand | P: NRS. SN: 49 burn deaths and 3487 burn hospitalisations. SC: 0-4-year-olds with home injuries in the NZHIS from 1989-2000 | A cross-sectional study using nationally representative data. | To describe the epidemiology of injuries sustained by children < 5 years in the home. |
| Henderson et al. (2003)- Australia | P: NRS. SN: 59 children SC: 0-16 years with flammable liquid burns from 1997 to 2002 at SPPBC. | A cross-sectional study using burn centre data. | To identify the at-risk group in FLB and work on prevention strategies. |
| Hendricks et al. (1999)- United States | P: NRS. SN: NRS. SC: 14 to 17-year-olds with injuries from fast food industries in NEISS data from 1992 to 1994. | A cross-sectional l study using injury data from population-based consumers' database. | To describe the magnitude of adolescent injuries in the fast food industry and suggest prevention strategies. |
| Hjern et al. (2001)-Sweden | P: NRS. SN: NRS. SC: 0-3 years hospitalised for home injuries from 1987-1991 as seen from Swedish national registers. | A cross-sectional study using injury data from national registers. | To use Swedish national registers to study risk factors for hospitalisations for injury in 0-35 months of age. |
| Karr et al. (2005)-United States | P: NRS. SN: 113 burns from 2354 patients SC: Hospitalized burns (at least two days) or as death from 1995-1997 for < 19 years old retrieved from WSTR. | A cross-sectional study using state registry data. | To describe the injury incidence and severity among Hispanics and non-Hispanic whites with severe traumas in Washington State |
| Kramer et al. (2010)-United States | P: NRS. SN: 46, 582 cases. SC: 0-17 years with burn data in NBID from 1995-2007. | A cross-sectional study using burns unit data. | To examine the aetiology of paediatric burn injury considering age and race categories from the NBR. |
| Kubilius et al. (2014)-Lithuania | P: 3 million inhabitants (2011 census), 16.1% of population children. SN: 7146 children. SC: 0-14 years reporting burns as retrieved from the National Health Insurance database from 2001-2010. | A cross-sectional study using the National Health Insurance database. | To characterise the burn aetiology and epidemiology of children and adolescents in Lithuania |
| Laitakari et al. (2014)-Finland | P: 1.9 million for Southern Finland. SN: 106 patients. SC: <1-year-olds reporting to OPD with burns at HUH, Helsinki, Finland from Jan 2005-Dec 2009. | A cross-sectional study using outpatient departments' burns database | To find the distinctive features of outpatient burns and their epidemiology in < 1 year old from HUH District over five years |

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| Landolt et al. (2013)- Switzerland | P: NRS. SN: 1572 cases. SC: 0-17 years reporting skin conditions to the PED at University Children's Hospitals at Zurich every first ten days of each month from April 2009-March 2010 | A cross-sectional study using hospital data. | To evaluate the occurrence and spectrum of skin disorders in an urban PED in Zurich |
| Laursen and Nielson (2008)- Denmark | P: NRS. SN: 1482 burns. SC: 0-15-year-olds living in 32 Danish municipalities with injuries from 1998 to 2003 in Danish Injury Register. | A cross-sectional study using national injury registers. | To reveal how socio-demographic factors affect the incidence of unintentional home injuries in Danish children for specific injury mechanisms and involved products. |
| Lehna et al. (2016)- USA | P: NRS. SN: 1482 burns. SC: 0-5-year-olds are living in Jefferson County, Kentucky with injuries from 2008-2012 and with burn injury in 2013. | A cross-sectional study using census data and emergency department data. | To develop and validate fire and burns risk models among children under five years and their parents using GIS and cartographic modelling. |
| Lipovy et al. (2012)- Czech Republic | P: 1,258, 900 children between 0-14 years. In Brno, 266,748 children. SN: 383 children. SC: 0-14 years with burns admitted to ICU, Faculty Hospital Brno, the Czech Republic from 1997-2009 | A cross-sectional study using ICU data. | To describe essential epidemiological characteristics of severely burned children admitted to ICU, Faculty Hospital Brno, Czech Republic |
| Ljungberg et al. (2006)- Sweden | P: NRS. SN: NRS. SC: 0-14 years old hospitalised for hand injury in SHDR from 1987-2001. | A cross-sectional study using data from the national hospitals register. | To get incidences and risk groups in children with hand injuries using a national retrospective study. |
| Macgregor et al. (2003)- Scotland, UK | P: 500,000 North East Scotland, 6000 < 1 year. SN: 790 cases SC: 0-1 years having different injuries in 2000 and reporting to RACH, Aberdeen. | A cross-sectional study/ chart reviews of patients at the Royal Aberdeen's Children's Hospital, Aberdeen for 2000 | To examine A & E attendance of < 1year olds over 12 months to see the prevalence and severity of different accidents and suggest prevention. |
| Mah et al. (2013) - Australia. | P: NRS. SN: 81 cases SC: 0-17 years reporting sunburns to the WCH in South Australia from Oct 2006-March 2011 | A cross-sectional study using burn unit database. | To identify patterns and causative factors in the development of severe sunburns requiring hospitalisation |
| Mangus et al. (2004)- United States | P: NRS. SN: 35 burns from ADHD patients. SC: 5-18 years old with ADHD reporting burn injuries from 1995-2001 at Indiana University Department of Surgery | A cross-sectional study using regional paediatric burn data. | To assess the differences between ADHD children and non-ADHD children in burn injury and burn injury outcomes. |

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| Mardsen et al. (2016)-UK | P: 10 million. SN: 6441 patients-2094 aged 0-16 years. SC: all ages reporting to A and E with burn in Swansea between 2005-2014 | A cross-sectional study using hospital ED data. | To review burn epidemiology in a large Swansea teaching hospital over nine years; examine the association between deprivation and burns and discover if the data can identify at-risk groups in the region. |
| Martin et al. (2014) | P: NRS. SN: 613 patients. SC:0-16 children reporting to A and E with burn in Western Australia in 2 years 2011-2012 | A cross-sectional study using WA state paediatric burns unit data. | To examine the extent of hot ash burns in Western Australia, the seasonal variations and identify risks. |
| Morrow et al. (1996)-United States | P: 1,425, 407 children in North SN: 449 burns. Carolina (1990). SC: 0-16 years old admitted to JBC from 1988-1994. | A cross-sectional study using burn centre data. | To determine the effect of burn aetiology on outcome and mortality predictors for child burn victims. |
| Mumtaz et al. (2011)-UK | P: NRS. SN: 101 patients reporting burns SC: 0-16 reporting to burns unit of the UCH, Galway, Ireland between January 1995-December 2000 | A cross-sectional study/ paediatric burns unit case notes, UCH, Galway from 1995-2000. | To define the regional incidence of significant paediatric burn injuries requiring admission and associated risk factors. |
| Murphy et al. (1995)-United States | P: NRS. SN: 215 grease burns SC: 0-16 years reporting grease burns to Uni. Of Texas Hospital from 1973 to 1993 | A cross-sectional study using regional burn data. | To estimate the incidence and severity of grease and oil burns in children |
| Nayeb-Hashemi et al. (2009)- United States | P: NRS. SN: 14 cases. SC: 0-17 years reporting with full thickness calvarial burns between 1980-2006 | A cross-sectional study/burns unit data from the University of Texas Medical Branch between 1980 to 2006 | To ascertain the cognitive and affective difficulties of children with calvarial burns. |
| Nelson et al. (2005)-United States | P: NRS. SN: 23 children SC: 0-17 years with exhaust burns from 1993-2003 in the Paediatric Surgery Dept., University of Florida Hospital | A cross-sectional study using hospital burn data. | To document the incidence of exhaust burns in children from motorised vehicles. |
| Nguyen et al. (2008)-Wales, UK | P: 2.4 million over South and Mid Wales. SN: 104 patients SC: <1-year-olds reporting to WCBPS from Jan 2003 to Jan 2006 | A cross-sectional study/ chart reviews of patients at the WCBPS UK from Jan 2003-Jan 2006 | To find the burn epidemiology of <1 year old within the region over four years. |

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| Papp et al. (2008)-Finland | P: 5.2 million people (Helsinki and Kuopio). SN: 45 cases. SC: 0-16 years old admitted to ICU in 2 Finnish NBC with LOS over two days. | A cross-sectional study using burns unit data from ICU. | To examine the aetiology, incidence and prognosis of ICU paediatric burns in Finland and compare findings in the 2 NBC. |
| Patel et al. (2016)-USA | P: NRS. SN: 447 cases. SC: 0-5 years old admitted to Galveston's Shriners Hospital from Mexico over 13 years. | A cross-sectional study using burn centre data. | To examine burn aetiology in young children from Mexico receiving care at the burn centre |
| Phelan et al. (2005)-United States | P: NRS. SN: NRS. SC: 0-19 years old with injuries as retrieved from the NHAMCS database from 1993-1999. | A cross-sectional study using hospital data. | To estimate the rate and severity of trends in unintentional residential injuries in 0-19 years old from 1993-1999 |
| Pickett et al. (2003)-Canada | P: 120,000 SN: 57 burns SC: 0-1-year-old with injuries from 1994-2000 in Kingston via CHIRPP database. | A cross-sectional study using the national hospital injuries database. | To describe the risk factors and nature of injuries in geographically distinct population in Eastern Ontario |
| Poulos et al. (2007)-Australia | P: NRS. SN: 3689 burns SC: 0-15 years admitted for burn injuries in NSW from 1999-2005 | A cross-sectional study using burns unit data. | To examine the relationship between area related SES and different injury mechanisms for children |
| Poulos et al. (2009)-Australia | P: NSW= 6.7 million (2006). 75% in metropolitan areas, 10% in outer coastal regions. SN: 2981 cases. SC: 0-14 years reporting to hospitals in NSW from 2000 to 2005 | A cross-sectional study/burns hospitalisation data from New South Wales between 2000-2005 | To explore the geographic patterns of child fires and burns in NSW, Australia. |
| Pratt et al. (2016)-Canada | P: NRS SN: 835888 injuries SC: 10-17-year-olds with injuries from 1991-2012 in Canada via the CHIRPP database. | A cross-sectional study using the national hospital injuries database. | To describe features of work-related injuries in young Canadians and identify areas for prevention and intervention strategies. |
| Pym et al. (2013)-Australia | P: Queensland, 4.599 million (2010). SN: 10 fatalities. SC: 0-15 years admitted for motorcycle-based trauma across Queensland via STN and CCYPCG from Jan 2007 to Dec 2009. | A cross-sectional study using the state-wide database. | To describe paediatric motorcycle incidents in Queensland, identify data improvement opportunities and inform safety policy. |
| Quayle et al. (2000)-United States | P: NRS. SN: 8404 cases SC: 0-14 years old reporting burn injury in Missouri in 1994-1995 | A cross-sectional study using state-wide injury data. | To describe paediatric burn injuries from 1994-1995 using Missouri in- and outpatient data. |

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| Raj et al. (1999)- United States | P: NRS. SN: 185 cases SC: 0-18 years with electrical injuries to Shriners Hospital Texas from 1967-1997 | A cross-sectional study using hospital burn data. | To show the prevalence of electrical injuries admissions to the centre over 30 years |
| Rajan et al. (2011)- Australia | P: NSW and ACT were 1.37 million for 0-15-year-olds (2005). 15% is residing in rural areas. SN: 97 cases. SC:0-15 years with burns in Children's Hospital at Westmead between Jan 2003 to Jan 2008 | A cross-sectional study using a burns unit database. | To obtain the incidence and morbidity of exhaust injuries in the paediatric population in NSW and ACT. |
| Riedlinger et al. (2015)- Australia | P: NRS. SN: 730 patients SC: 0-14 years old with data in Burn Registry of Australia and New Zealand from Oct 1, 2009, to Sept 30th, 2011 | A cross-sectional study using burns unit data | To investigate the incidence, demographics, causes and treatments for hospitalised scalds in Australia and New Zealand |
| Roberts et al. (2002)- Australia | P: NRS. SN: 24 cases SC: 0-17 year with motorcycle burns to the SPPBC from 1996-2001. | A cross-sectional study using burn centre data. | To document motorbike exhaust burns on children. |
| Saeman et al. (2016)- USA | P: NRS. SN: 5959 cases SC: 0-18 year with burns admitted to the Parkland Burn Centre from 1974-2010. | A cross-sectional study using burn centre data. | To analyse the characteristics and outcomes of paediatric burns in this burn centre over 35 years. |
| Sarginson et al. (2014)-UK | P: NRS. SN: 161 patients reporting with hair care device burns. SC: 0-18 years reporting burns to SWPBC, Bristol | A cross-sectional study using departmental burn injury database from the SWPBC, Frenchay Hospital between 2007-2011 | To show the epidemiology of hair straightener burns in children reporting to Frenchay Hospital over five years |
| Schmertmann et al. (2012)- Australia | P: NRS. SN: 64,495 cases. SC: 0-4 years old hospitalised for an injury from 1999-2009 via population-based NSW Health Admitted Patient Data Collection | A cross-sectional study using state-wide databases | To identify the leading cause of injury in children aged 0-4 years using injury sub-mechanisms and provide an epidemiological profile of each cause. |
| Shah et al. (2011)- USA | P: NRS. SN: 2117 cases. SC: 0.1-19.7 years reporting with injuries to the Children's Hospital of Michigan from 1998-2006 | A cross-sectional study/burn units' database. | To determine demographics, patterns and circumstances leading to burns in the population |
| Shai and Lupinacci (2003)-United States | P: NRS. SN: 246 cases SC: 0-15-year-old involved in residential fire deaths as retrieved the Philadelphia Fire Department from 1989-2000 | A cross-sectional study using state department data. | To investigate high rates of residential fire deaths in Philadelphia from 1989 to 2000 in 0-15-year-old. |

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| Shenassa et al. (2004)- United States | P: NRS. SN: 11, 735 injuries. SC: 0-6 years with injuries in state hospital registers and US census from 1990-2000. | A cross-sectional study using state hospital registers and national data | To show the association of concentrated poverty, housing conditions, racial minority and paediatric injury. |
| Sheridan et al. (1997)- United States | P: NRS. SN: 34 cases. SC: 0-17-year-olds reporting camping burns from 1990-1995 at Shriners Hospital | A cross-sectional study using hospital burn data. | To describe trends in campfire burns over five years. |
| Shields et al. (2007)- United States | P: NRS. SN: 5,156 cases. SC: 0-17 years old reporting burn admissions as retrieved from KID in 2000 | A cross-sectional study using burns unit data | To assess the epidemiology and financial burdens of hospitalised paediatric burn injuries in the United States. |
| Soleimani et al. (2016)- United States | P: NRS. SN: 19,422 cases in KID and 13,828 in NBR. SC: 0-20 years old reporting burn admissions as retrieved from KID and NBR databases from 2000 to 2013 | A cross-sectional study using burns unit data- National Burn Repository (NBR) and Kids' Inpatient Database (KID) | To estimate the correlation between SES and burn injury in children and young people in both datasets. |
| Street et al. (2002)- Australia | P: NRS. SN: 11 cases SC: 0-17 years reporting woodstove burns to the SPPBC from 1997-2001 | A cross-sectional study using burn centre data. | To describe the effects of paediatric woodstove burns |
| Streeton and Nolan (1997)- Australia | P: NRS. SN: 4992 cases. SC: 0-14 years old admitted to the RCH burn unit from 1970-1994 and the VIMD. | A cross-sectional study using hospital burn unit data. | To describe trends in burn admission to a large paediatric burn centre from 1970-1994 in Australia |
| Suominen et al. (1998)- Finland | P: 262760 children in Uusimaa (1994). SN: 16 burn cases SC: 0-16 years old reporting injuries to HUCH from 1985-1994 | A cross-sectional study using hospital injury data. | To study the epidemiology of childhood severe trauma |
| Tan et al. (2012)-UK | P: NRS. SN: 766 patients SC: 0-15 years reporting burns to Burns Service, Alder Hey Children's NHS Foundation Trust, Liverpool, the UK from 2005-2010 | A cross-sectional study/ chart reviews of patients. | To analyse the differences in paediatric burn mechanisms and severity within different ethnic groups. |
| Thomas et al. (2004)- United States | P: NRS. SN: 39 burn cases with ADHD. SC: 4-17 years with burns and ADHD over the 20-year review period | A cross-sectional study using hospital data. | To investigate admissions to burn units over 20 years related to ADHD |

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| Thombs et al. (2006)- United States | P: NRS. SN: 12,902 SC: 0-17.9 years old with burn injury from 1992-2002 in ABA-NBR | A cross-sectional study using national burn database (ABA-NBR). | To describe what makes young age risk for mortality in acute burn injury using ABA-NBR databases |
| Tomkins and Holland (2008)- Australia | P: NRS. SN: 22 cases SC: 0-16 years admitted to the Children's Hospital Westmead from Nov 1995- Dec 2003 | A cross-sectional study using burns unit data. | To describe epidemiology, presentations, management and complications of paediatric electrical burns |
| Trop et al. (2015)- Austria | P: Austria- 8.43 million, 20.2% under 20, Styria- 1,209, 466 people and 19% under 20. It capital, Graz= 409,093 (2012). SN: 1586 inpatients. SC: 0-18 years reporting burns to Medical University of Graz from Jan 1988-Dec 2012. | A cross-sectional study/ chart reviews of patients | To characterise the burn epidemiology of children and adolescents admitted to the burn's unit at Graz. |
| Van Baar et al. (2011)-Netherlands | P: NRS. SN: 294 cases. SC: 5-15 years reporting burns to hospitals connected to the Dutch Injury Surveillance System (DISS) March 2001-Feb 2004. | A cross-sectional study using burn units' database. | To assess the prevalence and correlates related to the suboptimal quality of life (QOL) after burns in children aged 5-15 using BOQ. |
| Vassilia et al. (2004)- Greece | P: NRS. SN: 91 injuries. SC: 0-14 years reporting with firework injuries in the EDISS database from 1996-2000 | A cross-sectional study using hospital-based burn data. | To investigate the magnitude and characteristics of firework-related injuries using EDISS data. |
| Vermaak et al. (2012)-UK | P: NRS. SN: 9 patients. SC: 0-16 years reporting with disposable barbecue burns to the SWRPBC, Frenchay Hospital, Bristol from May-August 2010. | A cross-sectional study/ departmental burn injury database from the SWPBC, Frenchay Hospital between May-August 2010 | To document, describe and raise awareness of preventable injuries from disposable barbecues. |
| Viklund et al. (2013)- Sweden | P: NRS. SN: 181 deaths SC: data of fatalities of all ages from car fires/burns in Sweden from 1998-2008. | A cross-sectional study/Swedish Transport Administration database from 1998-2008. | To analyse the epidemiology of fire-related fatal car crashes on Swedish roads |
| Vloemans et al. (2011)- Netherlands | P: Mean population for 13 years- 15.98 million, 6.2% aged 0-4, 15.8% aged 5-17 years. SN: 2682 cases. SC: 0-17 years reporting to any of the 3 Dutch burn centres from 1995-2007 | A cross-sectional study using the burn unit's database | To describe the burn epidemiology of children admitted to Dutch burn centres from 1995-2007 |
| Vollman and Smith (2006)-United States | P: NRS. SN: 21,809 burns. SC: 0-20 years old with burn data in the NEISS database from 1990-2004 | A cross-sectional study using population-based NEISS databases. | To describe the epidemiology of lawn mower injuries among children in the USA. |

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| Wallis et al. (2008)- Australia | P: 760,000 (2003 mid-point data for 0-15 years in Queensland). SN: 27 cases. SC: 0-15 years reporting to SPPBC from 2001-2006. | A cross-sectional study using burns unit data. | To find numbers of paediatric scald injuries linked to vapour inhalation therapy for treatment of URTI's |
| Williams et al. (2003)- United States | P: 396,685 (St Louis) 193,224 (North St. Louis) (1999). SN: 311 patients in St Louis. SC: 0-14-year-olds with burn injuries to 2 St Louis Hospitals in 1995. | A cross-sectional study using hospital data. | To use GIS and spatial statistics to describe the geographic variation of burn injuries in 0-14-year-olds in St Louis in 1995. |
| Witsaman et al. (2006)- United States | P: NRS. SN: 51,703 burns. SC: 0-19 years old with firework burns in the US NEISS databases from 1990-2003 | A cross-sectional study using population-based NEISS databases. | To describe the epidemiology of US paediatric fireworks-related injuries |
| Woodbridge et al. (2010)-UK | P: NRS. SN: 158 patients reporting camping/caravan burns. SC: 0-16 years reporting to Frenchay Hospital from 2003-2005. | A cross-sectional study/ paediatric burns service case notes, Frenchay Hospital from 2003-2005. | To see if camping and caravanning burns are more severe and require extensive intervention than other burn types. |
| Yates et al. (2011)- Ireland | P: 150,000 children for 2008 with 42,830 reporting to the hospital according to ED records. SN: 282 cases SC: 0-16 years having burned in 2008 and reporting to ED of CUH, Dublin. | A cross-sectional study/ chart reviews of patients at the Children's University Hospital, Dublin for 2008 | To study the patterns of scald presentations and suggest countermeasures to reduce them. |
| Zoni et al. (2016)- Spain | P: NRS. SN: 6353388 injuries. SC: all ages reporting injuries to primary care in Madrid in 2012. | A cross-sectional study of injuries seen in Primary Care for the year 2012. | To analyses primary care injury data in the community of Madrid, Spain by SES, sex and age. |

AT 2.8: TABLE SHOWING INEQUALITIES OBSERVED IN PAPERS INCLUDED FOR SYSTEMATIC REVIEW

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| **SYSTEMATIC REVIEWS**<br>**Key: NRS= Not reported/stated, IR=incidence rate, ABP= Average burns presentations, ID= indigenous group, NID=non-indigenous groups** | | | |
| AUTHOR AND LOCATION OF STUDY [CASP rating] | BURN/SCALD TYPES | OUTCOME MEASURES | RESULTS |
| Burd and Yuen (2005)- Global<br>[Fair] | Burn injuries-not further specified | Number of childhood burn patients, catchment population, ABP/year, duration per study, city and region, IRs | North America: ABP/year= 172.67 children/year (IR=5.1 per 100,000 children/year). Europe, ABP/year= 467.33 children/year (IR= 8.4 per 100,000 children/year. Australia and New Zealand: ABP/year and IR could not be calculated. Global IR=7.9 per 100,000 children per year. |
| Moller *et al.* (2015)- Global [Good] | Mixed Injuries (burns included) | Rates and ratios of unintentional injury. | Thirty-nine papers met the inclusion criteria. 21 out of 39 (53.8%) from USA, 8 (20.5%) from Australia, 7 (17.9%) from Canada and 3 (7.7%) from New Zealand. 27 out of 39 (69.2%) were on age 0-19 years; others reported mixed ages. Burns data reported in 14 papers (the shared second place with drowning). All 14 papers report higher ratios of hospitalisation (1.3-4.4:1) and mortality (1.2-6.1:1) in ID: NID. 1 paper reported no difference in hospitalisation of scalds. Authors report Australian, and New Zealand studies had higher burn hospitalisation rate in younger than older children-data NRS. |
| PROSPECTIVE COHORT STUDIES<br>Key: IR=Incidence rate, IRR=Incidence rate ratio, PY= Person-years, MD=most deprived, LD= least deprived, FB= foreign-born, HR= hazard ratios | | | |
| AUTHOR AND LOCATION OF STUDY [CASP rating] | BURN/SCALD TYPES | OUTCOME MEASURES | RESULTS |

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| Emond *et al.* (2017) [Good] | Burns and Scalds | Burns reported in parental questionnaires when children were 6, 15 and 24 months, and 3.5, 4.5, 5.5, 6.5, 8.5 and one years old. Multivariable logistic regressions. | Medical attention sought for burns was 13.7% (189/1379) between birth and two years, 11.2% between 2 and 4.5 years, 7.7% (58/754) between 5 and 11 years. Children below age 2 had a significantly higher prevalence and incidence of burns than other age groups, especially for boys. Trends reversed in the 5-11-year olds with girls having higher prevalence and incidence than boys. Better maternal parenting score at six months was a protective factor for children aged 0-2 years old. Mothers with a degree were more likely to report their children aged 5-11 years for burns. Children with the most advanced gross developmental motor scores at six months were more likely to sustain burns in the 0-2-year olds group [AOR 95%C. I= 1.03 (1.02-1.03)]. Reported coordination problems at 4.5 years were much more likely have burns at ages 5 -11 years [AOR 95%C. I= 1.69 (1.21-2.35)]. Reported tantrums in children at 42 months predicted an increased risk of burns between ages 5 and 11 [AOR 95%C. I= 1.41 (1.04-1.92)]. Abnormal hyperactivity at age 47 months hinted increased burn risk in children at age 5-11 years old [AOR 95%C. I= 1.24 (1.01-1.54)]. IMD scores were not associated with burn injury at any age. |
| Karimi *et al.* (2015) [Good] | Mixed injuries (burns included) | Prevalence and HR (from Cox Regression Models) of fatal unintentional injuries across age, gender, SES, ethnicity. | 0.05% of all deaths were burn-related (134 Swede and 48 FB). Burns HR was 1.62:1 for FB: Swedes (95% CI: 1.15-2.27). 15-17-year-olds had the highest burns HR of 3.84 (1.92-7.63). All female FB: Swede burns HR = 2.17:1 (1.33-3.54). Females aged 15-17 years were five times more likely to die from burns than other females and ages, HR= 5.49 (2.26-13.30). |
| Orton *et al.* (2014) [Good] | Burns not further specified | IR and IRR of injuries across gender and different age groups (via Poisson regression models) | Fifteen thousand two hundred eighty-six children reported 15,880 burn cases (1.5% of the entire cohort and 2nd after fractures). From 1990-2009, burn incidence was 57.9/10,000 PY (95% C. I= 57-58.9/10,000). Adjusted IRR for boys > girls: 1.28 (1.24-1.33). Peak age= 1 years. Burns had the widest range in IR from MD to LD= 41.7/10,000 PY. Adjusted IRR for MD: LD = 1.94 (1.85-2.04). Inequality gap in IR of MD: LD cases fell by 56% over the study period. 30% of burns due to deprivation. Five thousand four hundred eighty-five burns were preventable provided injury rates be independent of social status. |
| Randall *et al.* (2017) [Good] | Scalds (most), Contact and flame burns c. | Crude and standardised incident admission rates of burn injuries generated for each region in Western Australia. Negative binomial regression analyses adjusting for age, sex and indigenous ethnic status. | Ten thousand seven hundred twelve burn hospitalisations in Western Australia from 2000 to 2012. Burns were more common in males, indigenous Australians, and those from a lower SES and the home environment. The admission rate for burns per population was lowest in Perth (4.7 burns per 1000 people) despite having the largest numbers. The highest crude burn rate was found in the Kimberley (19.2 burns per 1000 people), followed by the Goldfields, Pilbara, Midwest and the Wheatbelt, all with similar rates (12.1, 11.8, 11.2 and 11.1 per 1000 people, respectively). Outdoor controlled fire burns (e.g. campfires) were most common in the more remote regions while flammable material burns in agricultural areas and Perth (the capital). Overall, the incidence of burn admissions decreased for males in all regions |

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| | | | significantly in Goldfields, Great Southern and Kimberley regions. Significant annual reduction in incidence of burn admissions was seen in 0-4 years old group in 3 areas: Great Southern, AIRR 95% C. I=-15% (-23% to -6%); Kimberly AIRR 95% C. I=-16% (-23% to -4%) and Perth AIRR 95% C. I=-3% (-5% to -1%). Foer 5-14-year olds, the same was observed again in Kimberley AIRR 95% C. I=-26% (-35% to -15%) and South West AIRR 95% C. I=-7% (-11% to -2%). |
| RETROSPECTIVE COHORT STUDIES<br><br>Key: M:F= Male: Female ratio, %TBSA= total burn surface area percentage, MHBR= mean hourly burn rate, LOS= Length of stay, OPD= outpatient department, HR= hazard ratio, AR= absolute risk, MRR= Mortality Rate Ratios, ATR= Attributable Risk, ACM= All-cause mortality, RR= Rate Ratios | | | |
| AUTHOR AND LOCATION OF STUDY [CASP rating] | BURN/SCALD TYPES | OUTCOME MEASURES | RESULTS |
| Baker *et al.* (2016)-UK [Good] | Mixed injuries (including burns) | Incidence Rate Ratios (IRR) of injuries via Poisson Regression | Burns were the third most abundant group of injuries from fractures and poisonings. IRR for burns were 35.5 (95%CI 35.1-35.9). Age with the most substantial age incidence for burns was one year old (116.8/10 000 PY). Males aged 0–4 had a significantly higher burns incidence (71.0/10 000PY) than females (55.2/10 000PY). Three thousand one hundred twenty-five burn events were hospitalised while another ten led to death. 74.2% of the 1726 burns in 0-4-year olds were from heat and hot substances. By age, burns had a significant higher IRR in children from the most deprived backgrounds than those from the least deprived backgrounds; 0-4 years old (1.68), 5-9 years old (1.61) and 10-14 (1.57). NB: 95% CI not given. |
| Duke *et al.* (2015)-Australia [Good] | Mixed injuries (including burns) | Prevalence/MRR (HR), ACM, ATR of burn/scald injuries based on age, sex, time, ethnicity, affected sites, location and TBSA (from Cox Regression Models) | Median age = 2 years (IQR: 1-7). 65.1% aged 0-5 years. 19.7% Aborigines. 33% in the second most deprived quintile. 52.6% in major cities. 46.4% were minor burns of <20% TBSA. 45.6% were partial thickness. 43.5% affected upper limbs. 1% died in hospital, and 1.5% at follow up- 68% males. Case: control ACM was 8.5: 3.5 per 100,000 per person-years, adjusted MMR= 1.6 (95% CI: 1.3-2.0). Adjusted female burn MRR= 2.3 (95% CI= 1.5-3.5). Adjusted male burn MRR= 1.3 (1.0-1.7). Severely burned children had 4.3 times MR than minor burned children. |
| Hayes and Groner (2005)- | Mixed injuries (including burns) | Prevalence/ RR of injuries based on age, sex, ethnicity and location. (NB: 95%CI RR= NRS) | Most males. Burns were the leading injury of all minority groups, RR= 6.44. Burns were the 6th leading for minor child trauma (RR= 7.29). Age 1, 0 and two years had the highest RR. Burns were the 3rd leading cause of injury death. |

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| United States [Poor] | | | Some vacant housing unit, high population density, median income, education below 9th grade and unemployment were linked most to burn injuries. |
| Hutchings *et al.* (2010)-Wales, UK [Good] | Scalds (most), Contact, Chemical and Electrical burns | Prevalence of burn/scald injuries based on age, sex, time, TBSA and other socio-demographic factors. | All burned before age three years. 57.2% were males. Median age= 16 months (0-36 months). Median weight= 11.5kg (3.8-17.9kg). 67.6% scalds. The mean number of children in family= 1.83 (0-6). 86% had siblings at home during injury. 67% had two adults present. Median TBSA= 2% (0.25-50). 79% superficial burns. Median LOS= 3 days (0-33 days). Peak times= meal times. Limbs most affected. 88.3% were home injuries. 24% discharged from OPD because of non-attendance on 2 or more occasions. 89.7% were accidental. Youngest maternal age= 25.9 yrs. |
| Prasad *et al.* (2014), UK [Good] | Mixed injuries (including burns) | Prevalence, HR and AR of burn/scald injuries in "new" epileptic: non-epileptic patients based on age, sex, time, area/region. | 1-4 year olds burn injuries in epileptics: non-epileptics (range= 3.8%-4.5%: 3.4%-3.8%) but in 5-14 years, it reverses (range= 18.6%-19.1%:19.2%-21.6%). 51.8% of males burned in the epileptic group. North West region had the highest percentages of burns in people with epilepsy (13%): non-epileptics (12.8%). South West was 8th out of 13 regions (7.9%:9%). Most deprived individuals had more burns in epileptic (26%): non-epileptics (25%). This number was 1.6 times more than the least deprived. Thermal injuries were the 3rd highest in people with epilepsy compared to non-epileptics. (HR: 3.8, 95% CI, 3.3-4.3): HR 2.5, 95% CI, 2.3-2.8). After adjusting, the HR for burn injury in people with epilepsy was 1.49 (1.27-1.75), i.e. 50% more likely than in non-epileptics. AR of having a burn and being epileptic AR=19.2 (16.5-22.4) while that of burn and being non-epileptic, AR=12.3 (10.9-13.9). |
| Spady *et al.* (2004)- Canada [Good] | Mixed injuries (including burns) | Prevalence/ Odds Ratios (OR) of injuries based on age, sex, time, ethnicity, SES and location (via Logistic Regression Models) | First Nations were a most affected ethnic group, OR= 1.35 (95%CI: 1.25-1.46), children on welfare, OR= 1.57 (95%CI: 1.50-1.66) and those who moved residences more were more affected, OR=1.17 (95%CI: 1.13-1.22). Burns were a 4th leading injury. Burns had the most comprehensive gap in having injury and services provided in early age. The peak age of injury and services provided in both sexes= 1-2 years. More males were admitted. |
| Verey *et al.* (2014)-England [Good] | Scalds (most), Contact, Flame, Chemical, Friction, Flash, Electrical and Radiation burns | Prevalence of burn/scald injuries based on age, sex, time, location and TBSA. | M: F for burns = 1.28:1. Mean age= 3.9 years. 72% <5 years. 92.4% minor cases (TBSA<5%). 45.6% were from 8:00-15:59 especially in <5 years. Older children had burn injuries more at night. Highest MHBR= 0.19 burns/hour between16:00-18:59. Most cases on weekends. Weekday cases had an ascending trend in <5 years. Summer had more outdoor victims than other seasons. 11-15-year-olds had more injuries in August. 88% were indoors. 76.8% were at home. Larger burns (>10% TBSA) had M: F of 3.3:1 and 61.5% occurred outside of 9:00-17:00. South West region had more <5% TBSA cases, fewer outdoor burns and non-home environment burns than national estimates. |
| CASE CONTROLS | | | |
| Key: %TBSA= total burn surface area percentage, OR=odds ratio, BAI= burn avoidance index Ca=cases, Co=Control, CAS= child activity scores | | | |

| AUTHOR AND LOCATION OF STUDY [CASP rating] | BURN/SCALD TYPES | OUTCOME MEASURES | RESULTS |
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| Dedovic *et al.* (1996)- Czech Republic [Good] | Scalds (most), fire, electrical, contact and chemical burns. | Prevalence/Incidence of burn injuries based on age, sex, agents, severity %TBSA, and location. Comparison of cases and controls | 42.5% aged 0-14 years. Mortality in children= 1%. 1992 had highest incidence= 34.5 per 100,000 children. M: F = 1.8:1. Peak age group= 1-3 years. 76.5% scalds- with hot water being a leading agent (40%). 88% were home burns. Wednesdays had 1.5 times more than average daily incidence. Peak time= 4-6PM (36.3%). Spring, then Winter = peak season. 66% minor burns and < 10% TBSA. Mean LOS= 15.8 days (2-165 days). Unemployed parents, OR= 14.53 (95%CI: 3.56-127.37) and living in urban areas, OR= 1.97 (95%CI: 1.48-2.62) were strong risk factors. |
| Petridou *et al.* (1998)- Greece [Good] | Burn types not further specified. | Prevalence of burn/scald injuries based on age, sex, mechanism, first aid, treatment, severity %TBSA, BAI, CAS, socio-demographic factors and location. | 65.3% kitchen related. 60.7% burned via hot liquids. 38.5% had upper limbs affected. 61.5%=2nd degree burns. 29.3%=2-3% TBSA. 53.6% males, 39.8%-40.2% males <2 years. 92.9%-99.2% were other Greek. Cases had younger mums aged 25-29 years (30.1%). OR for cases having mothers working/schooling for < 6 years=2.6 (95% CI 0.7-9.4). 32.2% had a BAI score (where 0= low safety and 4= safety). 24.7% had a CAS score= 3 (where 1=low and 5=high). Higher OR in 1-bedroom houses 3.6 (95%CI: 1.1-12.2) and 3+ bedroom houses 2.7 (95%CI: 1.5-4.8). With BAI and child activity, for every unit and quintile increment respectively, OR reduced by 40% for BAI (0.6[0.5-0.8]) and 20% for child activity (0.8[0.7-1.0]) |
| Shah *et al.* (2013)-UK [Good] | Scalds | Prevalence of scald injuries based on age, sex, mechanism, first aid, treatment, severity %TBSA, socio-demographic factors, and location. | Males had OR of 1.34 (95% CI 1.17-1.54). Greatest age risk= 1-2 years (OR 2.40, 95% CI 2.05-2.81). $3^{rd}/4^{th}$ born cases had higher OR's than those born first (OR 2.17, 95% CI 1.60-2.94). Mums aged 40 years and above had the lowest odds of scald injury than teenage mothers (OR 0.32, 95% CI 0.16-0.64). Children in single adult homes (OR 1.26, 95% CI 1.08-1.46) and most deprived (OR 1.82, 95% CI 1.40-2.37) had more burn odds. Univariate analysis shows current/ex-smoker had OR=1.18 (95% CI: 1.08-1.38) and having perinatal depression had OR of 1.34 (95% CI: 1.06-1.70). |

CROSS-SECTIONAL STUDIES (PART 1)

Key: IRR= Incidence Rate Ratio, LOS= length of stay, BCA= burn centres admissions, NBCA= non-burn centres admissions, IR= incidence rates, SMR= standardized mortality ratio, M: F= male: female burn ratio, OR= odds ratio, CPD= common psychiatric disorders, FB= foreign born, %TBSA= total burn surface area percentage, spf= sun protective factor, M= mean, OP= outpatients, IP= inpatients, ODD= Oppositional Defiant Disorder, CRW= cool running water.

| AUTHOR AND LOCATION OF STUDY [CASP rating] | BURN/SCALD TYPES | OUTCOME MEASURES | RESULTS |
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| Brudvik (2000)- Norway [Fair] | Scalds (most), Contact and Flame burns. | Prevalence of burn/scald injuries based on age, sex and burn type. | Burns were 2.06% of injuries. 0.003% of Bergen's paediatric population medically reported burns. 50% were preventable. 30% were scalds and 31% contact burns. No other inequality results stated. |
| Brudvik *et al.* (2011)-Norway [Good] | Contact burns (most), Scalding Injuries, Friction, Sunburns and Flame | Incidence/prevalence of burn/scald injuries based on age, sex, mechanism, type, first aid, treatment and location (via Chi-Square test) | 50% were < 2 years. 78% < 6 years. 56% were males increasing to 70% for <2 years. Burn incidence for <5 years=6.6 per 1000, 5-9 years= 1.9 per 1000 and 10-14 years= 0.6 per 1000 children. Nine children admitted (8 under two years old). 14 /142 (9.6%) cases were FB. 4/9 hospitalised were FB (44.4%). 4/14 FB (28.6%) were hospitalised compared to 5/128 Norwegian children (3.9%). Odds for being FB and admitted = 9.84 (95% CI= 1.8-52.9). Peak time= 3-7PM (on weekdays). 45% were contact burns with mean TBSA of <2%. 47% affected hands. 85% were superficial 2nd-degree burns. One hundred six cases had parents/guides cooling the burn as first aid. 55% of parents of under 2's agree burns were preventable. |
| Cokkinides *et al.* (2009)-USA [Good] | Radiation burns | Prevalence/OR of radiation burns based on age, sex and legislation. | Indoor tanning increased by 1% from 1998-2004 (95% CI= -1.5%-3.5%). 204 adolescents used indoor tanners. 57.5% self-reported radiation burns. Females were 1.96 times more likely to burned (95% CI= 0.89-4.33). States with policies before/after 1997-2004 were 0.77/0.76 times likely to use indoor tanners. Teens >16 years were 1.46 times more likely to report burns than <16 (95% CI= 0.73-2.92). Using tanners > 6 times had 3.23 odds of getting burned (AOR 95% C. I= 1.63-6.39) |
| Cronin *et al.* (1996)- Ireland [Good] | Scald (most cases), Flame, Sunburn, Chemical burns and Electrical burns | Prevalence of burn/scald injuries based on sex, time, income, location and TBSA. | 60.5% were males. 16% admitted. 91.3% were home burns. 87% had a parent/guardian present. 64% scalds. 88% had <5% TBSA. 75% were from low-income families. 30% of parents felt they had good burn first aid knowledge. Winter= peak burn season. Mortality= 1.8% of cases. |
| Dokter *et al.* (2014)- | Flame and Scald (most cases), Contact burns, | IRR, median LOS over time and median %TBSA over time. | 43.1% <17 years. BCA: NBCA= 1.74: 1. IRR = 1.5 cases per 100,000. M: F IRR in BCA= 1.88:1. <5-year-olds mostly had scalds. (Their IRR's: other ages IRR= 8:1). IR of burns <10% TBSA = 2 per 100000 (annual increase of 5.1%). |

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| Netherlands [Good] | Chemical burns and Fat burns | | Median LOS < 15 days in 1995 to 5 days in 2011. 4% of admitted patients died. Mortality in < 5-year-old was due to flame and scald exposures. SMR's < with time. Most cases in summer and during festivities. |
| Fernandez-Morales *et al.* (1997)- Spain [Good] | Contact (most) especially from irons, motorcycle exhausts and cooking receptacles, scalds, flame and electric. | Prevalence of burn/scald injuries based on age, sex, mechanism, type and location(via Mann-Whitney, Chi-Square and t-tests) | Fifty-two cases were 0-15 yrs (10.3% of sample number and 0.004% of Malaga's population). M: F < 15 years= 29 cases: 23 cases. Sex ratios reversed with increasing age. Urban: Rural divide= 47:5 cases. Contact burns twice more than scalds for 0-15 years. 55.7% were home burns especially in the kitchen (4.2% at risk). |
| Hughes *et al.* (2014)-UK [Good] | Mixed injuries (including burns) | Prevalence/OR of burn/scald injuries based on age, sex, time trends, treatment options and deprivation rates (via Chi Square, ANOVA and backward conditional logistic regression) | 1.6% of complete cases had a burn. Age 1 had a peak burn OR (AOR=2.03, 95% CI: NRS). 62.4% aged 0-4 years. M: F= 1.14:1. Mean burn attendance peaked on weekends (72.73% Sunday, 65.73% Saturday) and July (67.71%). February peaked for 10-14 years while October for 5-9-year-olds. School holidays peaked reports at age 0-9 years. 34.4% discharged and 5.8% admitted. |
| Kemp *et al.* (2014)-UK [Good] | Scalds (most), Contact, Flame, Radiation, Chemical, Friction and Electrical burns. | Prevalence of burn/scald injuries based on age, sex, mechanism, type and location (via Mann-Whitney and Z-tests) | 1215 accidental cases. M: F = 3:2. Peak age= 1-year-olds. 58% scalds. 17.6% admitted- mostly flame burns (11.7%). 78% of scalds in <5-year-olds. 96% of scalds affected the front of the body. Scalds affected the face, arms, the upper trunk of under 5's while for over 5's; lower trunk, legs and hands. 7s1% of contact burns were in <5 years. 83% of indoor burns were in <5 years. 70% of outdoor cases were at older ages. 70% of flame burns were in older children. 1-year-olds: other ages ratio of burn injuries = 10:1. |
| Lam *et al.* (1999)-Australia [Fair] | Flame and Electric burns | Prevalence of fatal cases and associated risk factors. The incidence rate of injuries/mortality per year | 0.07% of mortality was burns related (2nd after drowning). 5/8 burn deaths were flame; others were electrical. Six males, two females. 6/8 cases wherein under 5's. 29.4% occurred at home. |

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| Mercier and Blond (1996)-France [Fair] | Scald (most cases), Flame, Chemical burns and Electrical burns | Prevalence of burn/scald injuries based on age, sex, time, location and TBSA (via t-test and ANOVA). | 0.0093% of burn victims in population. 61.6% were males. 50.8% occurred with mother around. 70.2% were in urban areas. 46.5% aged 1-3 years. 87.38% were home burns with 56.24% in the kitchen. 64.1% scalds. 56.24% of cases had <10% TBSA. Mortality = 1.18% of cases. |
| Natterer *et al.* (2009)-Switzerland [Good] | Contact (most), Scalds | Prevalence of burn/scald injuries based on age, sex, ethnicity and other socio-demographic factors. | 78% < 5 years old. 56% were males. 50% were Swiss. 47% were contact burns. 79% were at home. 57% occurred during meal time or preparation. 62% in autumn and winter. 69% had <5% TBSA. 93% were 2nd-degree burns. 56% affected upper limb with 77% on hands alone. 79% had parents present at injury and were married. 50.6% lived in 2-3.5 room apartments. 5.6% lived in crowded conditions. |
| Rowe *et al* (2004)-UK [Good] | Mixed injuries (including burns) | Prevalence/OR of burn/scald injuries based on age, sex, mechanism, type of CPD and location (via Logistic regression) | Burns were 3rd leading injury (2.3% of all injuries). Male OR for burns constant with age while female OR increased (OR=1.5, 95% CI=1.0-2.1). M: F OR= 1.4 (95% CI= 1.1-1.9). Unadjusted, ADHD (OR=2.3, 95% CI=1.2-4.6), ODD (OR=3.2, 99.9% CI=2.0-5.2), anxiety (OR=1.9, 95% CI=1.1-3.5), poor reading ability (OR=1.8, 99.9% CI=1.3-2.4) and stepfamily status (OR=1.5, 95% CI=1.0-2.3) had strong ORs for burns. However, on adjusting, only ODD (OR=2.7, 99.9% CI=1.6-4.5) and poor reading ability (OR=1.6, 99% CI=1.2-2.2) were linked to burns. |
| Saridi *et al.* (2015)- Greece [Good] | Sunburns | Prevalence/incidence of sunburns based on age, sex, skin sensitivity, time trends, SES, treatment options and location (via Logistic regression) | 72.6% were < 16 years old. 62.3% burned on their backs, then face. 22.4% had extensive burns with blisters. 39.5% used less sunscreen (2.5 times less than >16's). 72.9% were urban dwellers. 76.8% knew dangers of prolonged sun exposure (1.6 times more than >16's), especially from 10am-4pm. Urban: semi-urban divide of sunburn incidence= 34.4%:29.8%. 51% of pupils burned who used highly protective sunscreen (spf>30) (1.7 times >older group). Pupils with fair hair and skin tone had more burns than >16's (44.8%). More knowledge about sunburn risk lowered incidence (M=2.83, SD=0.87). |
| Stockton *et al.* (2015)-Australia [Good] | Scalds (most), Contact, Friction, Flame and others. | Prevalence of burn/scald injuries based on age, sex, mechanism, type, first aid, treatment and location (via Mann-Whitney test) | 60% were males. Male OP (60.3%): male IP (63.5%). 12.7% admitted. 62.4% aged 0-4 years old. 44.4% scalds. 95.4% of 0-2-year-old had scalds and contact burns. Flame burns were 15.4%, and 14.1% were friction burns in 11-16-year-olds. Peak agents for contact burns= hotplate injuries (6.6%), scalds= hot beverages (18.2%) and friction burns= treadmills especially in 2-3 years (1.7%). Contact burns agents for between OPs: IPs was hot plate/metal: coal/ash burns. 4% of all burns= flame burns with 37.9% being IPs. 25% electrical: 22.2% of chemical burns admitted. 34% of all burns affected hand. IPs had multiple burn sites than OPs. 54% of <1 yrs injured on hand and upper limb. In 11-16 years, lower limbs most affected. Full dermal thickness burns were 66.7% of IPs: 26.8% of OPs. <1% TBSA burns |

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| | | | were 21% of IPs: 62.2% of OPs. >10% TBSA were in 2.7% of burns and IPs. 70.3% were home burns with 53.5% in their kitchens or 36.3% in visitor kitchen. Carer witnessed 52.1% of burns. Peak times= 6-9PM (32.6%), weekends and in January (92 cases). 79.8% had CRW as first aid. Median healing time for IPs was ten days (7-17 days). |
| CROSS-SECTIONAL STUDIES (PART 2)<br><br>Key: IRR= Incidence Rate Ratio, LOS= length of stay, IR= incidence rates, M: F= male: female burn ratio, OR= odds ratio, CPD= common psychiatric disorders, FB= foreign born, %TBSA= total burn surface area percentage, OP= outpatients, IP= inpatients, HT= healing time, FU= follow up, LTFU= loss to follow up, HLUHS= Hospital of Lithuanian University of Health Sciences, LOE= length of exposure, QOL= quality of life, IB= indoor burns, OB= outdoor burns, DR= death rate, BR= burn rate, ABR= Annual burn rate, ADMR= admission rate, LGA= local government area, LV=low voltage, HV= high voltage. | | | |
| AUTHOR AND LOCATION OF STUDY [CASP rating] | BURN/SCALD TYPES | OUTCOME MEASURES | RESULTS |
| Abeyasundara *et al.* (2011)- Australia [Fair] | Scalds (most), Contact, Flame and others (Flash, Chemical, Electrical Friction and Radiation). | Prevalence of burns based on age, sex, mechanism, time trends; %TBSA, affected body part and treatment. | M: F= 1.5:1. Males more within contact (64%) and flame burns (84%). M: F increased with age, one year old=2.3:1 to 9:1 at age 12 for contact and flame burns. Scald and contact burn peak age= one year. Flame burns peaked in older children — — 55.9 % scalds. Scalds had a higher incidence than contact, AOR= 1.9 (95% CI: 1.74-2.07). Most contact agent= irons (n=146). 83% of burns were <5% TBSA (98.7% were contact burns). 61.4% of contact burns affected hands. Scalds mostly affected head, neck and trunk while flame burns had same (except trunk) plus hands and lower limb. |
| Addor and Santos-Eggimann (1996)- Switzerland [Fair] | Mixed Injuries (including burns) | Prevalence of burns based on mechanism, LOS and other socio-demographic factors. | Burns were the seco[nd] leading injury (n=68, 7.6%). The 5th leading injury mechanism was burns by a hot steam humidifier (n=9, 13% of burns). No inequality results reported. |
| Agran *et al.* (2003)- United States [Fair] | Mixed injuries (including burns) | Prevalence/IR of burns based on age and mechanism | Burns were a 5th leading injury. One thousand nine hundred fifty-one burn cases (8.42%). Annual IR for burns hospitalization and death= 31 per 100,000 0-4-year-olds. Biggest IR in 3-month age intervals= age 12-14 months (86 per 100,000). Scald and steam burns: fire/flame burns were 5:1 peaking in 1-1.2-year-olds and falling at 3.5-3.9 years. |

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| Alaghehbandan *et al.* (2012)-Canada [Good] | Scalds (most), Flames, Contact, Chemical and others. | Prevalence/ADMR of burns based on age, sex, agents, treatment, mechanism, ethnicity and location | Annual ADMR= 22.3 per 100,000 person years (PY). M: F = 27.7: 16.6 per 100,000 PY. Highest ADMR in < 1 years = 88 per 100,000 PY. Aboriginals are more in Labrador. ADMR for Newfoundland: Labrador= 20.3: 51.4 per 100,000 PY. Males admitted in Newfoundland: Labrador= 24.6: 71.9 and females= 15.6: 30.4 per 100,000. Median age for Newfoundland: Labrador = 2: 9 years. 52.2% scalds (M: F ADMR=12.5:10.8 per 100,000 PY), 32.5% flame (M: F ADMR= 11.4: 2.9 per 100,000PY). Common burn type in Newfoundland= scalds (56.4%) (Scald: flame ADMR = 11.4: 5.3 per 100,000). In Labrador, 66.7% flame burns (Scald: flame ADMR = 15.0: 34.3 per 100,000). Newfoundland: Labrador median LOS= 5 days: 3 days but for scalds= 7:2 days and for flame 3:5.5 days. Mortality rate for all cases= 0.9 per 100,000 PY. 14-16 years and 5-9 years have strong differences in Newfoundland: Labrador, 10.5:77.7 per 100,000 and 10.1: 28 per 100,000 respectively. |
| Alnababtah *et al.* (2011)-UK [Fair] | Scalds (most), Contact, Flames, Flash, Chemical, Electrical, Friction, Radiation and others | Prevalence of burns based on age, sex, mechanism, ethnicity, deprivation, time trends, %TBSA and location (via Chi-square and F tests) | Annual range= 225-281 cases/year. 0.3% was fatal. Mean admission age= four years. 59.6% were males. Mean age by sex= F (3.7 years): M (4.2 years). 66.9% scalds. 61.2% of mechanisms= "spill burns". Asians/Asian British and Africans/African British group had more burns than their general population while British/white and Mixed presented less. Asians/Asian British were younger (3.1 years) than white/white British cases (4.4 years) (F test= 23.9). White/white British more severe (mean TBSA= 5.7%) and hospitalised (5.1 days). 75% of White/white British burns from bathing. 32% of Asian/Asian British and 3% of Mixed origins from irons. Most bath and spills burns (8% each) in African/African British. All ethnic groups had a median IMD ranging from 40-50, higher than national IMD to 32.4 except in British group (30). For burn mechanisms, the IMD's are close to the national estimate except for spills (median IMD= 37.31). 11% burned in 6-9pm increasing hourly till 11 pm. Autumn had 26.4%. |
| Andronicus *et al.* (1998)-Australia [Fair] | Scalds (most), flash/flame, contact burns. | Prevalence/Incidence of burns based on age, sex, mechanism, LOS and other socio-demographic factors. | 86.4% in accidental group (some had previous burns). The average age in the accidental group= 3.7 years. Injury odds less in accidentals than in non-accidentals/neglect cases (2.4-4.8 times less). Scalds most common in accidentals than other groups (OR=1.7, 95%CI: 1.0-2.9). Average TBSA for the accidentals=9%, other groups twice that amount. Accidentals 9-36 times less likely to be admitted to ICU. Accidentals were 9-10 times less likely to be from single-parent homes. |
| Bachier *et al.* (2015)-United States [Fair] | Burn types not further specified. | The incidence of cooking and non-cooking related burns based on age, sex, mechanism, ethnicity, deprivation, time trends, %TBSA and location (via | 306 burns. Most patients were African American males (58% to 78% cohort versus 19.5% national), with public insurance, and aged 2 to 3 years old (not significant). Cooking-related scalds were more common on the head, neck, and upper body while non-cooking scalds were distributed over the lower body (P < 0.02). Cooking-related grease burns mostly occurred on the upper limb (76% grease vs 20% non-cooking; P < 0.0001), but are less likely to occur in the lower torso (22% grease vs 59% non-cooking; P < 0.01). Patients with 3$^{rd}$-degree cooking-related semisolid burns |

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| | | Chi-square and Mann-Whitney test; bivariate analyses) | were more likely to develop normal healing, NHIW (P<0.01) and wound contractures with limited mobility, WCLM (P< 0.01). Patients with 3rd-degree grease burns were more likely to develop NHIW (P< 0.03). |
| Barrow *et al.* (2005)- United States [Fair] | Scalds (most), Flames and Contact. | Prevalence of burns based on age, sex, mechanism, location and ethnicity. | 65% were males. M: F mortality= 10.5%:12.7%. Younger children (0-2.9 years) had higher MR than older children (3-17 years). The largest mean %TBSA= 57% in males aged 12-17 years. Older children had 46% of 3rd-degree burns. Longest mean LOS was in 40.8% of males aged 12-17 years. Mortality highest in females aged 0-2.9 years (18.1%). Black females had the most mortality (18.8%) and across all ages (except in age 12-17 years). The most affected were all aged 0-2.9 years and were: White Boys, Black Girls and Hispanic Girls. |
| Bernard *et al.* (2007)- United States [Fair] | Mixed injuries (including burns) | Prevalence/Incidence of burns based on age, sex, ethnicity, mechanism and location | Fire/burn-related injuries were the 3rd leading cause of death in 1-9 years old and the leading cause of death in Black children within this age group (RR=2.7; 95% CI=2.3-2.8.). The black children death rate for 1-9 years old was 3.0 per 100,000 population, then White, 0.9 per 100,000 and Hispanic, 0.7 per 100,000 populations. The trend was similar for 10-19-year-olds. |
| Billock *et al.* (2017)-United States [Good] | Firework-related injuries including burns | Prevalence/Incidence of injuries based on age, sex, mechanism and location | The annual incidence of firework-related injuries= 6.88 (95% CI: 5.7-8.05) per 100000 children. Most cases occurred in US Independence Day and New Year celebrations. Over 25 years, the annual injury rate decreased by 30.4%. 45.6% of injuries were home-based. 26% of all cases were via firecrackers, followed by aerial devices (16%) and sparklers (14.3%). Under 5's were likely injured via sparklers, RR=4.37 (3.45-5.55) while older ages were via aerial devices (RR=2.58) or firecrackers (RR=1.77). 30.6% of all cases were via explosions. 75.7% of all injuries were in males, and this was three times the rate of injury rate in females. Mean and median ages were 10.6 and 10.7 years respectively. 10-14-year-olds had the highest injury rate (9.02 per 100,000) while below 5-year-olds had the lowest injury rate (4.36 per 100,000). Bystanders were 2.05 times more likely to be injured than handlers on hands and neck (RR=2.05; 95% CI=1.61 to 2.61) 60% of all injuries were burns and led diagnoses in all age groups. 8.4% of all injuries were via illegal or homemade fireworks. Older ages (15-19 years) tend to use illegal fireworks, RR=2.73 (95% CI: 2.01-3.71). Amputation or fractures mostly occurred in users of illegal fireworks, RR=9.95 (95% CI: 6.17 to 16.05) or hospitalisation, RR=2.99 (95% CI: 2.06 to 4.34) than users of other types of fireworks. |
| Bishai *et al.* (2002)- United States [Fair] | Mixed injuries (including burns) | Prevalence/Incidence of burns based on sex, economic costs, treatment and mechanism | 48 burns/1732 injuries (2.77%). Burns were second leading injury (2202 per 100,000 PY). Total cost of burn= $66,458. Cost per child with burn injury= $1,385. Burns were third leading by utilisation of health services- 6% of total injury, 10% total care episodes, 4% of ED visits and 15% of OPD visits. Burns were 5th for some inpatient stays (7%) and 1st for an average duration of care (47 days). Hot objects were an 11th leading mechanism for injuries. |

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| Brehaut *et al.* (2003)-Canada [Good] | Mixed injuries (including burns) | Prevalence of burns based on age, sex, treatment and other socio-demographic factors. | 81.6% were males had CBDs. 49.1% of CBDs aged 9-13 years. 20.3% of CBDs were in seco$^{nd}$ most deprived quintiles, and most CBDs stayed in the Central region of British Colombia. One thousand three hundred forty-six burns (1.31 per 1000 injured people). 33 per 1000 burn injuries were in CBDs group while the prevalence of burns within the CBDs group= 2.68 per 1000 CBD patients. Burns were a 6$^{th}$ leading injury in CBD cases, OR=2.08 (95%CI: 1.41-3.08). After adjusting for age, sex, SES and Region, Burns had the 2$^{nd}$ highest injury OR= 1.99 (95%CI: 1.31-3.02) |
| Brownscombe *et al.* (2004)-United Kingdom [Fair] | Mixed injuries (including burns) | Prevalence of burns based on sex, ethnicity, location and other socio-demographic factors. | Burns/scalds were an 8$^{th}$ leading injury at ED's (4%). 56% were males. The kitchen was a leading place for burn, then living room and bathroom. 7.3% of burns admitted. Peak agent= hot water (33%). Peak mechanisms= pulling down or kicking over a hot object or liquid on themselves. |
| Carlsson *et al.* (2006)- Sweden [Fair] | Flame, Scald, Sunburn and Contact | Prevalence of burns based on age, sex, ethnicity, location and other socio-demographic factors. | Peak age= 1-2 years. 64% of were males. Most aged 0-2 years had more hand, foot and leg burns. 72% < 3 years old. Children with FB parents had more and larger burns than their Swedish counterparts. 81% scalds (71% via hot liquids). 95% were home burns with a family member present. Home burns were deepest. 51% reported to hospitals and 49% to Health Centres. Hospitals treated most non-scald burns affecting the face, leg/foot and other multiple sites. Health centre mostly treated hot food scalds with arms and hands more affected. |
| Celko *et al.* (2009)- Czech Republic [Fair] | Scalds (most), Contact, Flames, Chemical, Electrical, Radiation and others. | Prevalence/Incidence of burns based on age, sex, agents, treatment, mechanism and location | 64% males. Mean age for boys= 4.8 years while girls= 3.9 years. 54% < 3 years. 85% < 10 years. Peak age= 1-year olds- 31% aged 7-12 months. 79%= home injuries (70% in kitchen). Males= 60% of indoor and 80% of outdoor injuries. Outdoor injuries mostly in older children with 17% in gardens (37% having flammable liquid agent). Indoors, scalds= 70% (42% having hot water as agent). 65% of hot water scalds in kitchen. 46% of electrical burns were in living room/bedroom. Summer and winter= peak seasons. IB: OB in summer= 3:1 and in winter= >10:1. Peak day= Saturday. Peak time= 11am to 7pm. Mean LOS for < 10%: > 50% TBSA= 16 days: 91 days. 75%= 2$^{nd}$ degree burns. M: F for 3$^{rd}$ degree burn was 2.6:1. Males had severe burns requiring longer hospitalization, mean LOS for M: F= 22 days: 18 days. Smaller %TBSA (<15%) burns mostly at home (78%). Larger %TBSA (>40%) burns were outdoors (68%). |

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| Cheng *et al.* (2016)- USA [Good] | Mixed Injuries-including burns | Prevalence of injuries based on parental behaviours, attitudes, age, sex, mechanism and other socio-demographic factors | Parental self-reports on behaviour and potential risk of injuries of their children aged 0-7 years old were evaluated. These include second-hand smoke exposures, asthma treatment, parental depression, child rearing, injury prevention and first aid knowledge. Seventeen thousand eight hundred forty-five families assessed of which 36.5% had low health literacy with others being adequate. Mean child age=4.8 years. Males were 50.7%. 91.4% of families were in publicly insured, 55.6% preferred to speak English than Spanish while 50.5% were of Black ethnicity. Parents with low health literacy did not keep matches and lighters away from children or providing a safe space when cooking [AOR 2.58; 95% CI: 1.23-5.39]; not setting water heaters to a safe temperature [AOR 1.34; 95% CI: 1.19-1.52]; not having a working smoke detector [AOR 3.54; 95% CI: 2.74-4.58]; not checking smoke detector batteries [AOR 1.24; 95% CI: 1.05-1.46]; for not knowing what to do when a child had a burn injury [AOR 1.45; 95% CI: 1.29-1.63] and for not having a fire escape plan [AOR 1.25; 95% CI: 1.01-1.57]. These parents with low health literacy were commonly Spanish speaking Hispanics. |
| Choo *et al* (2002)- Australia [Fair] | Campfire burns. | Prevalence of burns based on age, sex, mechanism and other socio-demographic factors. | 55% males. Median age= 2.5 years (1.1-12.6 years). 58% < 4 years. Peak season= summer and school holiday. 61% outside Brisbane metro area. 82% were at campsite. 12.1% unsupervised. 49% stepped on ashes. Feet (61%) most affected. Median %TBSA= 2% (<1 to 18%). 36.4% admitted. Median LOS= 5.5 days (1-42 days). |
| Colin *et al.* (2006)-UK [Fair] | Bath water scalds | Prevalence of bath water scalds based on age, sex, treatment, costs, supervision levels, time trends, %TBSA and location | The incidence of 16 admissions/ year. 66% were males. Average age= 35.7 months (10-184 months). Average TBSA= 9.3% (0.5-45%). All home burns except a holiday cottage case. Two cases linked to autism and cerebral palsy. 83% of parents prepared baths. 2-3 cases left unsupervised. Average LOS= 7 days. Average cost of treatment= £2,072 (inpatient care only)-£5,955 (with additional skin grafting). |
| Davey (1999)- Australia [Fair] | Scalds (most), Flames, Electrical, Sunburn and others. | Prevalence/Incidence of burns based on age, sex, mechanism and other socio-demographic factors. | The highest incidence was in 0-3 years (69%). Scalds were 63%, then flame (21%). Males had more scalds and flame burns — no other inequality of importance. |

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| Dempsey *et al.* (2006)-Ireland [Good] | Scald (most), Flame, Contact, Firework, Chemical, Electrical and Friction | Prevalence of burn/scald injuries based on age, sex, time, location and TBSA. | 88% Irish. 11.4% of admissions from asylum children. M: F= 2.1:1. The median age in Irish= 5.5 years (2 months to 15 years): non-Irish= 18.6 months (10 months to 5.3 years). 11/14 non-Irish patients were <2 years with M: F= 0.75:1. All non-Irish burns were domestic compared to 71% in Irish. Mean TBSA for Irish: Non-Irish= 5.2% (1-28%): 5.7% (1-26%). Burn to the Primary area in Irish: Non-Irish group= 61%: 92.9%. LOS was the same for all=11.5 days (2-52 days) |
| Dewar *et al.* (2004)-Australia [Fair] | Scalds | RR of burns based on age, sex, affected body sites, location and other socio-demographic factors. | Beverage scalds= 18% of all burns. 68% < 2 years. Median age= 17.5 months (3 months to 11.5 years). 62% males. Peak time= 6-9AM. 71% home burns. 84% of home burns in kitchen. Peak beverage agent= tea (45%). 70% reached for container and poured on self. 80% had adult present. Median %TBSA= 4% (0.25-32%). 65% affected anterior torso. 52% admitted. Median LOS= 4 days (0.5-45 days). |
| D'Souza *et al.* (2009)- United States [Good] | Thermal, scalds, chemical, electrical and radiation burns | Prevalence/RR of burns based on age, sex, agents, treatment, mechanism and location | 58.6% were males. 57.7% < 6 years. 59.5% thermal burns. 91.7% home burns. Adolescents aged 11-20 were 3.2 times (95% CI 2.9-3.5) more likely to be injured at school, recreation, sports and other public places. Scalds affected upper trunk and body parts most, RR= 4.4 (95% CI, 4.0-4.8), electrical burns mostly affected fingers, RR=2.3 (95% C.I, 2.2-2.4) and chemical burns mostly affected head and face (73.2%), RR=5.6 (95% C.I=5.3-5.9). 52.5% of scalds from bath water. Household electrical appliances= peak agent for < 6 years burns. Bath water burns mostly affected upper arm/trunk (RR=2.6, 95% CI: 2.4-2.9), the lower trunk/leg (RR=2.7, 95% CI: 2.4-2.9) and foot/toe (RR=3.0, 95% CI: 2.7-3.3) than other body parts. 6.1% hospitalised. Scalds were 2.3 times more likely to lead to hospitalisation (95% CI: 2.1-3.0). Fuel/fuel burning equipment had 2.7 times likelihood than other consumer products to lead to hospitalisation (95% CI: 2.2-3.3). |
| Duke *et al.* (2011)-Australia [Good] | Scalds (most), Contact, Flame and others (Flash, Chemical, Electrical Friction and Radiation). | Prevalence/ IRR of index burns (first time admitted) based on age, sex, mechanism, time trends, %TBSA, affected body part, location, ethnicity and treatment. | 46.3% aged 1-2 years. 18% < 1 years. 59.1% were males. 17% Aboriginal. 30% were in remote/rural areas. 52.3% scalds. Aboriginals' admissions reduced by 42% over the study period, IRR: 0.58 (0.52-0.84). Males had higher hospitalisation rates, IRR: 1.37 (1.30-1.45). Aboriginals had three times hospitalisation rates of non-Aboriginals, IRR: 3.17 (2.95-3.39). Head and wrist most affected sites (38.5%). 60.6% had partial thickness. 90% had <10% TBSA. Big differences in median LOS for the 6 regional hospitals- 6 days (metropolitan, IQR=2-12 days), 2 days (rural, IQR= 1-7 days), 3 days (remote, IQR= 1-9 days). Children admitted to metropolitan hospitals had >10% TBSA, partial and full thickness burns than those in rural/remote areas. 50% of admissions = 1-2 years old. 80% of <1-year-olds admissions in 6-12 months old, 50% were scald related. Aboriginal: non-Aboriginal children had 44%:16.4% flame injuries, 46%: 74% scalds and contact burns. 78.2% home burns. Scald, flame and contact burn most in winter. |

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| Eadie *et al.* (1995)- United Kingdom [Fair] | Scalds (most), fire, contacts, fireworks. | Prevalence/Incidence of burns based on age, sex, TBSA, location and affected body site. | 12% increase in paediatric admissions to burn centre despite a decline in burn numbers overall. The number of under five years increased by 6% over the 35 years (85% to 91%). 60-67% of scalds occur in < 2 years and mostly in males. Most at evening time especially meal times. Most common agent for scalds declined from being the teapot (reduced by 7.7 times) and increased to being cups (increased by 4.8 times) over the study period. |
| Eich *et al.* (2009)- Germany [Fair] | Scalds, flame/fire, chemical, contact. | Prevalence of burns based on age, sex, agents, treatment, SES, mechanism and location | Most scalds in 1-3 years old. 6-18 years had more spirits and fire burns. Peak age= 1 years. 92% of home burns especially younger children. Older ones injured outside. Mean age of burn= 6.1 years. 67% were males. 60% scalds. Most scalding agents= water (23 cases). Eighteen cases of home burns in the kitchen. Peak time= 12pm-8pm. 76% had supervision. 45% of carer were present at the injury. Social indexing shows 48% had the lowest social status, then medium (38%) and highest (14%). |
| Elisdottir *et al.* (1999)- Iceland [Fair] | Scalds (most), fire, contacts, fireworks. | Prevalence/Incidence of burns based on age, sex, TBSA, location and affected body site. | M: F = 1.6:1 (in 10-15 years, its 4:1). 72.8% < 5 years. 50% < 2 years old. Average annual incidence of burn admission-30.4 per 100,000 children. 45.2% from geothermal and heated water. 81.2% home burns. Peak times= lunch and dinner hours. 72.4% had TBSA < 10%. 77% had partial thickness burns. Winter had an increase of firework injuries. |
| Foong *et al.* (2010)- UK [Good] | Hair straightener-contact burns | Prevalence of hair straightener (HS) contact burn based on age, sex, agent, mechanism, sources, treatment, time trends, %TBSA, affected body part and location | Median age= 1.6 years (6 months-15.9 years). Twenty-nine cases <2 years. 64.4% were females. M: F almost equal to < 2 years. Most affected body sites= volar hand surface (18 cases). Most mechanisms= grabbing or picking HS up (12 cases). 75.6% had superficial partial thickness burns. 44.4% had 0.5-1% TBSA. 4.4% admitted. Mean HT= 15.9 days (median 12 days, IQR: 8-19 days). |
| Goltsman *et al.* (2016)-Australia [Good] | Scalds (most), Contact, Flames, Chemical, Electrical, Radiation and others | Prevalence of burns based on age, sex, agents, treatment, SES, mechanism and location | 8223 patients-30.68% in high-risk areas (HRAs) and 5.56 in low-risk areas (LRAs). High SES results in low-risk areas and vice versa. Western and North Western areas had higher numbers of high-risk areas. Mean age in HRAs=3.91 years, in LRAs=4.31 years. 58% of all cases are males. However, more girls were injured in the 3-5 and 6-10-year-olds. No gender differences in HRAs compared to LRAs. HRAs had significantly higher scalds and friction than LRAs. LRAs, however, had more contact and flame incidence. In HRAs, TBSA >10% were seen in scalds, flames and radiant heat while TBSA < 10 years were seen in scalds, contacts and friction. This number was similar in LRAs, but >10% |

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| | | | TBSA prevalence was lower in scald and higher in flame injuries. Regarding CRW first aid, HRAs had a higher use (52.27%) than LRAs (64.77%). Burn risk was shown not to be associated with access to economic resources but with lower levels of education, occupation and socioeconomic disadvantage. |
| Gulliver *et al.* (2005)- New Zealand [Fair] | Mixed injuries including burns | Incidence of burns based on age, sex, location/body site affected. | Fire deaths were the third leading cause of death- same for males but were four$^{th}$ leading in females. Burns were the third leading cause for admission (101 per 100,000 0-4-year-olds). Males admitted more — the peak age for burns= 1-2 years old. Burns/scalds had 48% (2$^{nd}$ highest) reduction in incidence over the study period. Burn/scald incidence in males= 121 per 100,000 while females= 79 per 100,000 0-4-year olds. |
| Henderson *et al* (2003)- Australia [Fair] | Flammable liquid burns (FLB) | Prevalence of burns based on age, sex, ethnicity, mechanism and other socio-demographic factors. | 95% males. Median age= 10.5 (2-14 years). 86% aged 8-14 years. FLBs= 4% of burn centre admissions. Peak months= winter and summer start. Median %TBSA= 8% (0.5-70%). 55% affected right arms. 64% in child's home garden. 53% burned when they threw flammable liquid on open fire. 28% had carer throw the liquid. 66% unsupervised. For witnessing presents, 15% were dads and 8% mums. Peak agent= petrol (83%). Median LOS= 7 days (0-90 days). 1 fatal case. |
| Hendricks *et al.* (1999)- United States [Fair] | Mixed Injuries (including burns). | Prevalence of burns based on age, sex, mechanism, ethnicity and other socio-demographic factors. | 71% burns from eating and drinking establishments (EDEs). RR for EDEs: other industries= 6: 1. Burns M: F= 1.04:1. National estimates of Male burns= 2,942 and Female burns =2,282 for those attending physicians' appointments. 6.7% Whites, 3.5% other minorities. 55% of burns affected eyes (of which 66% were via cleaning agents and 34% splash of hot oil/grease). 49% of all burns were grease/oil associated. Burns (with lacerations) were leading male injuries. Burns were most in doughnut/bagel establishments (38%), hamburger (24%) and chicken/fish joints (24%). |

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| Hjern *et al.* (2001)- Sweden [Good] | Mixed injuries including burns. | Prevalence of burns based on age, sex, treatment and other socio-demographic factors. | More scalds in males (AOR=1.5, 95%CI: 1.3-1.7). Peak age= 1.08-1.25 years. Scalds had the longest mean LOS of 6.4 days. Children with low SES (7.0 days, 95%CI: 6.2-7.8) and mothers born outside western Europe (7.9 days, 95%CI: 6.4-9.4) had the highest mean LOS for burns. Maternal education at primary level (AOR=1.3: 95%CI: 1.03-1.5), mothers from outside Western Europe, AOR=1.7, (95%CI: 1.4-2.1) and >2 siblings had high odds for burns (AOR= 1.2, 95%CI: 1.02-1.0). Living in single-parent homes (AOR=1.2, 95%CI: 1.03-1.5) and in rural areas (AOR=1.4, 95%CI: 1.2-1.6) also increased odds of burn injury. Living in rural areas had the largest etiologic factors for scalds (EF 6.8%). |
| Karr *et al.* (2005)- United States [Fair] | Mixed injuries (including burns) | RR of burns based on age, sex, ethnicity, location and other sociodemographic factors. | Burns were 4.8% of injuries. Fire/hot objects were the fifth most common injury mechanism (18 cases) in Hispanics and 7th for non-Hispanics whites (95 cases). RR of Hispanics having contact burn injury compared to non-Hispanic whites= 2.3 (95%CI: 1.3-4.1). RR of Hispanics having fire injury compared to non-Hispanic whites was 0.7 (95%CI: 0.2-2.2). |
| Kramer *et al.* (2010)- United States [Fair] | Scalds (most), Contact, Flames, Chemical, Electrical, Radiation and others. | Prevalence/Incidence of scalds based on age, sex, agents, treatment, mechanism, ethnicity and location | Most males. 53.9% Caucasian, African Americans (21.4%), Hispanics (17.5%). 51.8% < 5 years old. 32% < 2 years. Minorities were younger than Caucasians. Asians had the youngest mean age, 4.4 years. Most 0-1 years= Asians, 2-4 years= Hispanics, 5-9 years= Native Americans and 10-17 years= Caucasian. 46.1% were minorities- 53.8% were <5 years old. Medicaid holder/uninsured status= lower SES. Native American (71.9%), Hispanic (68.4%) and African American (65.6%) had lower SES than Caucasians (35.9%). Medicaid group were younger than other groups.50.5% were scalds, and 30.8% were fire/flame- switched dominance in 5-14-year-olds. More scalds in Medicaid/uninsured group. Most fire/flame injuries (32.4%) and electrical (2.4% - shared with Hispanic) in Native American. African Americans and Caucasian had most chemical injuries. Biggest and deepest mean %TBSA found in Hispanics, Native American and Caucasian. African Americans had cases 4-6 times the US population census for each age category. |
| Kubilius *et al.* (2014)- Lithuania [Good] | Scalds (most), Contact, Flames, Flash, Chemical, Electrical, Friction, | Prevalence/IR of burns based on age, sex, agents, mechanism, affected sites, time trends, %TBSA and location | Seven thousand one hundred forty-six children admitted (44% of all burns). Burn incidence M: F= 149.8:99.9 per 100,000. 61% were males. Mean LOS= 10.5 days. Female burn IR increased annually by 1.7% (95% CI, 0.1-3.3) and for both genders by 1.1% (-0.5 to 2.6). Peak incidence= 0-3 years old. 1year olds had widest gender IR difference M: F= 1165.3:723.4 per 100,000. 70.4% were 0-3 years. IR in 0-1 years was ten times that of 2-14 years, 684.6: 54.6 cases per 100,000. The HLUHS Kauno Klinikos data show 1945 children admitted over ten years. 45%= 0-2 years |

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| | Radiation and others. | | while 6%= 2-14 years old. Most burns at HLUHS were 42% hot water scalds (0-1 years) and 48% hot water scalds (2-14 years). |
| Laitakari *et al.* (2014)- Finland [Fair] | Scalds (most) and Contact. | Prevalence of burns based on age, sex, agents, mechanism, affected sites, time trends, %TBSA and location | Annual paediatric burn cases aged 0-16 is 140. 106 (15%) < 1years old and treated as Ops. Most cases in 2006 (n=24). Mean cases over 5 years = 21.2/ year. 52% males. 57% aged 9-12 months. 80% were home burns. 66% had caregiver around. 56% single burn sites. 29% of single site cases on palm or finger. 67% had upper limbs affected. 61% scalds (mean TBSA= 1.7% (0.5-7%)). Mean age of scalds= 8.3 months (1.07-11.97). 34% of scalds had beverage spills. 53% of scalds in 9-12 months. 38% contact burns (mean TBSA= 0.9% (0.5-2%)) – mean age= 9.2 months (1.6-11.9). 14% of contacts burned via oven doors. |
| Landolt *et al.* (2013)- Switzerland [Fair] | Several Skin conditions including burn injuries | Prevalence of burns based on age, sex and hospitalisation. | Burns were the 5$^{th}$ leading skin problems (6%) and the seco$^{nd}$ leading cause for admission (13.6%). In < 1 years, burns were the third leading skin issue (6.6% of 347 children). In 1-6 years, burns were the four leading skin issue (7.6% of 786 cases). No other inequality reported. |
| Laursen and Nielsen (2008)- Denmark [Good] | Mixed injuries (including burns) | Prevalence, IR and IRR based on age, sex, mechanism, location and other socio-demographic factors. | Burns= 2.9% of all injuries i.e. IR= 2.0 per 1000 years at risk. 23% burned via cookers. Having mothers < 25 years had IR= 2.9 per 1000 and IRR=1.6(1.4-1.9). IR of M (2.2 per 1000): F (1.8 per 1000). Adjustment for sex, age and hospital distance shows that burn IRR of 2 children in a home= 0.8 (0.7-1.0); single parent homes= 1.3 (95% CI:1.1-1.5), maternal education level being primary, 1.6(1.4-1.9) or secondary, 1.2(95% CI:1.0-1.3), income of <100,000 DKK, 1.9(95% CI:1.6-2.3) and 100,000-199,999 DKK, 1.4(95% CI:1.2-1.7), crowded dwellings, 1.2 (95% CI:1.1-1.4) and flat dwellers= 1.7(95% CI:1.5-1.9). Burns on cookers were 4$^{th}$ leading cause of injuries. Adjusted for sex, age and hospital distance, cooker burns IRR for maternal age at birth <25 years= 1.9 (95% CI: 1.5-2.4); single parent homes= 2.0 (95% CI: 1.6-2.5), primary education= 1.8(95% CI: 1.4-2.3), lowest income= 2.4(95% CI: 1.7-3.5), 2$^{nd}$ lowest income= 1.8 (95% CI: 1.3-2.5) and flat dwellers= 2.1 (95% CI: 1.6-2.8). |
| Lehna *et al.* (2016)-USA [Good] | Burns not specified further. | The incidence rate of fire injuries based on location, race, age and SES | Children aged five years and below. Most members of Jefferson County are African American, teenage parents, non-high school graduate and live in older generation houses. Quartile scores generated from home value and year built where 1=low and 4=severe risk. Mapping revealed most of the high and severe risk cases were in the Western part of the county-most pronounced in the North West. These areas also had more substantial populations of deprived groups listed above compared to the East of the county with clusters of those with less risk. Multiple regression analyses |

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| | | | confirmed the deprived groups had a higher incidence rate of fire injuries especially for the less educated and those of Black ethnicity. However, the more recent a house was built, the fewer incidences of fire injuries. |
| Lipovy *et al.* (2012)- Czech Republic [Good] | Scalds (most), Flames, Contact, Electrical, Chemical and others. | Prevalence of burns based on age, sex, agents, treatment, mechanism, affected sites, time trends, %TBSA and location | 1245 ICU burns. 30.8% paediatric. 66.1% male. M: F admitted= 1.95:1. 85.6% indoors burns. 84.1% admitted < 6 years. 46.21% had TBSA of 10-19%. Most 20-25% TBSA was in 1998. 81.5% of burns= scalds. Trunk mostly affected (61%). Peak times= 4-8pm (22.45%). Meantime in ICU (10.71 days) while total LOS was 21.55 days. Duration in ICU per 1% TBSA= 0.65 days while for total LOS= 1.31 days. Mortality= 0.78% of cases and all septic. 27.2% of cases in autumn. Peak month= November (40 cases). Peak days= Friday and the weekends. |
| Ljungberg *et al.* (2006)- Sweden [Fair] | Mixed injuries (including burns- Mostly Contact, firearm discharge/explosion, contact with machinery) | Prevalence/Incidence of burns based on age, sex, time trends, burn degree, treatment and mechanism | 85.4% contact burns. Most males. Peak age= 1-year-old. Median age= 2 years (IQR: 1-5 years). Burns were a $2^{nd}$ leading injury in < 6 years (18.2%), $7^{th}$ for age 7-14 years (4.1%) and $four^{th}$ leading injury overall (10.5%). Contact with hot substance, fire or electric current was a $3^{rd}$ leading mechanism in < 6 years old (15.9%) and $11^{th}$ for 7-14 years old (2.9%). Highest burn IR for hospitalization= 5 per 100,000 children (1998). Incidence dropped by increasing age, 0.62 in < 6 years to 0.35 in > 6 years. 57.3% were $2^{nd}$ degree. Peak season= Winter (Jan and Dec) or Spring (April). |
| Macgregor *et al.* (2003)- Scotland, UK [Fair] | Mixed injuries including burns | Prevalence of accidental injuries based on age, sex, treatment, time trends and %TBSA. | Thirty-seven children had burns/scalds (4.7% of cases and 0.62% of <1-year-olds for NE Scotland in 2000). 59% were scalded, 22% contact. 10.8% had burns >5% TBSA. 18.9% admitted. No other inequality results. |
| Mah *et al.* (2013) – Australia [Fair]. | Sunburns | Prevalence of sunburns based on age, sex, ethnicity, treatment, time trends and %TBSA | 81. 54% male. 73% < 1 years= female but swapped to males from 5-17 years. No 2 or 3-year-olds. 98.8% Caucasian. Age 0-1 years had sunburns on the face (13.6%). Other ages (84.6%) burned on shoulder and backs. Warmer months had higher burns, no cases in March-September. 40% burned at the beach. 43% burned on the weekend. Sunday cases were twice Saturday's. 25% were on public holidays. 49% used no sunscreen. 4.9% used sunscreen > 1 time. More girls used sunscreen. 10-12 years old used at least sunscreen. Mean LOE= 4.1 hours. 27.2% admitted. Mean LOS= 2.32 days. |

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| Mangus *et al.* (2004)-United States [Fair] | Burns- not specified | Prevalence of burns based on age, sex, burn degree, treatment and mechanism | 35/278 burn patients had ADHD (13%). 15% males, 6% were females with ADHD. The median age of ADHD burn group= ten years and for non-ADHD= 11 years. ADHD children had more burns than non-ADHD (83%:58%). Median %TBSA in ADHD: non-ADHD= 10%: 5%. Median LOS in ADHD: non-ADHD= 11 days: 7 days. ADHD children had more burns from kitchen/bath and less from playing with matches or house fires. Flame burns in ADHD: non-ADHD= 17%: 42%. ADHD males suffer more thermal burns than non-ADHD males. |
| Mardsen *et al.* (2016)-UK [Fair] | Scalds (most), Flames, Contact, Electrical and Chemical. | Prevalence of burns based on age, sex, burn degree, treatment and mechanism | Six thousand four hundred forty-one patients of which 2094 are aged 0-16 years. Males=55%. Under 5's had the greatest admissions incidence rate= 1.29 per 1000 per year. Scalds were 67.1% of all cases. 0-5 years lead on all burn types (except electrical and sunburn). Mean deprivation score (MDS) = 20.7 (2-50). Those admitted had MDS of 21.2 compared to those discharged or outpatients (20.2). SES and burns were shown to be associated. Younger than 16 years and poorer individuals were 1.23 times at risk of burns than those older than 17 and in less deprived groups, OR=1.23 (95% CI:1.06-1.44). LOS increases with age. Males injured had a workplace influence especially for electrical and chemical burns. Females, however, had a domestic effect especially in having scalds. |
| Martin *et al.* (2014)-Australia [Good] | Hot ash burns, other burn types | Prevalence of hot ash burns based on age, sex, time, location and TBSA. | 50/613 (8.2%) had hot ash burns. 52% were males. Median age: 2 years 11mths. 74% in rural areas (16.1% admitted). 22%:14% for hot ash: another burn type in Aboriginals. 30% were on holiday trips. 70% were on Easter and school holidays. All burn median TBSA of 2%. Mean LOS= 9 days. |
| Morrow *et al.* (1996)- United States [Fair] | Flash/ flame (most), scalds, contact burns. | Prevalence of burns based on age, sex, TBSA, urban: rural divide. | 449 complete cases. Mean age= 4.3 years (6 weeks-15y.11 mths). M: F ratio= 1.9:1. Most < 2 years old. Higher mortality in < 4 years (6.1%). Overall mortality= 4.7%. Mean TBSA= 15.1% (0.5-98%). Larger burns (mean TBSA) in fatal: non-fatal burns= 55.3%: 13.1%. Burn size smaller in younger: older fatalities= 50.7%: 83% TBSA. 58% of younger children had scalds. 66% of older children had flame burns. Mean flame burn TBSA= 21.3%. Mean scald TBSA= 12.7%. 6 scalds fatalities mean fatal scald TBSA= 40.7%. Other fatalities were flame related. Mean fatal flame TBSA= 61.1%. 50.6% urban cases (209/413 with geographic info). Most contact burns in < 2 years old, electrical in 4-8 years old and chemical burns in 12-16 years old. |

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| Mumtaz *et al.* (2011)-UK [Fair] | Scalds (most), Flames, Contact, Electrical and Chemical. | Prevalence of campers burns based on age, sex, treatment, time trends, %TBSA and location | 54.4% were males. Mean age= 4.4 years. 72.2% scalds. Most were in the kitchen (46.5%). Most mechanism= tea/coffee spill (27.7%). Admissions "doubled" in the last three years: first three years, 64:37. 52.4% had no first aid before arrival to A and E. 50% of those with TBSA >10% (17% of the sample) got no first aid. Mean TBSA=7.8% (0.25%-55%). 55% of the burns were superficial. Mean LOS= 8.3 days (1-57 days). One fatal case. |
| Murphy *et al.* (1995)- United States [Fair] | Grease burns. | Prevalence of burns based on age, sex, TBSA, ethnicity, LOS and affected body site. | Two hundred fifteen cases (8% of paediatric inpatients and 2.5% of all admissions). Mean age= 3.2 years (1 month to 14 years). 59% were males. 49% whites. Mean TBSA= 12.1% (1 to 51%). 67patients had full thickness burns, mean TBSA of 7.6% (1-35%). 45.1% affected arms. Mean LOS= 13.1 days (1-90 days). 32% admitted to ICU. The wound infection rate was thrice that of general burn population. |
| Nayeb-Hashemi *et al.* (2009)- United States [Good] | Calvarial Burns | Prevalence/Incidence of calvarial burns based on age, sex, agents, treatment, ethnicity, mechanism and location | 14 cases. Most males. Most cases were <3.5 years or >11.5 years. 8/14 were <3.5 years (57.1%) – 6 had cognitive difficulties. 6/14 were >11.5 years-2 had cognitive difficulties. All young children had flame burns while older ones all had electrical burns. Mean age of young= 1.14yrs (0.02-3.4yrs) while old= 15.05yrs (11.9-16.5yrs). Mean TBSA larger in young= 44.75% than old=33%. 3$^{rd}$-degree burns were 37% of young and 28% of old. All were Hispanic. Flame cases more than electrical. |
| Nelson *et al.* (2005)- United States [Fair] | Exhaust burns | Prevalence of burns based on age, sex, burn degree, treatment and mechanism | 48% were < 6 years. Most males. Median age= 7 years (18 months to 17 years). Most mechanisms= contact with ATVs (30.4%), muffler/exhaust cars (26.1%). Mean %TBSA= 5% (1-17%). 66.6% were deep full thickness burns. 70% of the injuries affected lower extremities. Average LOS= 11 days (1-43 days). |
| Nguyen *et al.* (2008)-Wales, UK [Good] | Scalds (most), Contact, Chemical, Flame, Friction and Radiation. | Prevalence of burn/scalds based on age, sex, agent, mechanism, sources, treatment, time trends, %TBSA, affected body part and location | 104 patients were < 1 years (11.8% of 0-17-year-olds burns). 31% <2 years admitted. 56.7% were males. Mode= 9 months (1-11 months). 65% scalds. 63.5% admitted. 50% more boys had contact burns in <1 month old. Most agent= hot water (43%). Lead mechanism= pullover/push/kick (56%) increasing after the age of six months. 39% of scalds from cups. 30% of contacts from radiator/hot water pipe. 34.5% burned in the kitchen. Mean TBSA for IPS = 3.3% and 0.5% for OPS. TBSA of <5% was more in 1-4 months old and increased with age. Scalding had widest TBSA range and caused all burns >5% TBSA. 94% of contacts were small (0-1% TBSA). Scalds fairly distributed anatomically. 60% of the contact burns were in the upper limb. |

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| Papp *et al.* (2008)- Finland [Fair] | Scalds (most), Flames, Electrical and Contact. | Prevalence/Incidence of burns based on age, sex, agents, treatment, economic impact, mechanism and location | Annual incidence of ICU burns= 0.1 per 100,000 people/year. Median age= 5 years. Most males. 42.2% scalds. 0-2 years all scalds, 6-10 years mostly flame (83%), 11-16 years had equal flame and electrical injuries. Overall median %TBSA=26%. Median %TBSA in 0-2 years= 17%, 3-5 years old= 37.5%, 6-10 years= 27% and 11-16 years=35%. 6-16-year-old males had larger burns. Median TBSA in Kuopio= 27% while Helsinki= 24%. 87% affected upper extremities. Median LOS in hospital= 18 days (2-193 days). Median cost of care per patient in the Helsinki Burn unit= 1425 euros per hospital day while Kuopio= 1292 euros. |
| Patel et *al* (2016)- USA [Fair] | Flames (most), Scalds, Contact, Chemical and Electrical. | Prevalence of burns based on age, sex, mechanism and other socio-demographic factors. | Four hundred forty-seven burn cases in children aged 0-5 transferred from Mexico to the USA for treatment. 58% were males. Most injuries are flame (51%) and then scald (46%). Flame injuries mostly from house fires and fuel containers. Most patients stayed in urban than in rural areas. 74% of flame injuries were urban related; the rest were rural. 81% of scalds were urban, rest rural. Delay in seeking medical care was lack of transport, rural location, limited health literacy and distance from the hospital. 92-93% had information on delay in seeking treatment. All flame burns and 95% of scalds with this info mentioned receiving prior medical treatment before arrival in the USA. Supervision issues were highlighted and available for only 90% of flame and 98% of scald injuries. 60% of flame cases had supervision. Flame injuries involving explosions with one parent supervising occurred in 71% of these cases. Flame injuries involving house fires and having one parent present was 39% of these cases. Children with scalds injuries and one parent present accounted for 73% of these cases. For spills, one parent was present in 84% of cases. In all, 61% of scald cases had direct supervision from parents. Mortality occurred in 4% of flame and 2% of scald cases. |
| Phelan *et al.* (2005)- United States [Fair] | Mixed injuries (including burns) | RR of burns based on age, sex, ethnicity and other sociodemographic factors. | Burn/hot liquid/caustic was a 7$^{th}$ principal mechanism of injuries. Mean annual rate of burn mechanisms= 0.15 per 100 population. Peak age rate for burns= 0.43 per 100 population in age 0-1 years. Overall, burns had the fif$^{th}$ leading injury rate for ED visits, 0.18 (95%CI: 0.14-0.22). No other inequality results. |
| Pickett *et al.* (2003)- Canada [Fair] | Mixed injuries (including burns) | Prevalence of burns based on age, sex, mechanism and other socio-demographic factors. | Burns were a 5$^{th}$ leading injury in < 1 year. 57 burns/990 injuries (5.8%). Peak age= 9-11 months. 44.6% burned via hot liquids. Contact with hot objects/substance was a 3$^{rd}$ principal mechanism for all injuries (5.7%). |

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| Poulos *et al.* (2007)- Australia [Fair] | Mixed injuries (including burns) | Prevalence/IRR of injuries based on age and SES | 3689 burn/110,549 unintentional injuries (3.3%). The 2nd most deprived quintile had the strongest burn IRR, 2.00 (95% CI: 1.73-2.31), then most deprived quintile= 1.95 (95% CI: 1.69-2.26) and third most deprived quintile, 1.42 (95% CI: 1.21-1.66). Overall, burns had the 2nd highest IRR for hospitalisation. |
| Poulos *et al* (2009)- Australia [Fair] | Scalds, flame/fire, chemical, contact, electrical. | Prevalence/Incidence of burns based on age, sex, agents, treatment, mechanism and location | 2981 cases. 68.3% aged 0-4 years. Most males. 57% were drink and food scald injuries. 10-14 years mostly had flame burns. LGA's with RR> 1.2 were tagged high risk as that was a state-wide threshold. Higher risk for older children in rural areas than those from urban areas. Contact with heat/hot substances was compared with fire/flame burns under four categories: major cities (MC), inner regional (IR), outer regional (OR) and remote/very remote (R+V). All had higher contact with heat/hot fluids except in R+V areas where numbers were similar between both burn sources. From maps, Age 0-14 years mostly live within/close to the capital; 38/175 LGA's (21.7%) had RR higher than 1.2 for age 0-4 years, 55/175 LGA's (31.4%) for 10-14 years old and 25/175 LGA's (16%) had same for 5-9 years old. |
| Pratt *et al.* (2016)- Canada [Good] | Mixed Injuries including burns | Proportionate Injury Ratios (PIR) of injuries based on socio-demographical factors and comparisons between below and above 15-year-olds. The outcome was work-related compared to non-work-related injuries. | 835888 injuries identified in the 11 years. Final numbers included, 6046 work injuries compared to 829 668 non-work injuries. Males were more in the worker's group (63.9%). Some workers admitted for injuries less than that of non-worker injury (2.8%). 35.4% of all working related injuries attending ED were in the food and beverage industry. For burns specifically, food and beverage workers were 24 times more likely than non-working youths to be burned, PIR=24.36 (95% CI: 22.28 to 26.62). This rank was followed by those in the trade and manufacturing industry, PIR=3.24 (96% CI: 1.38-7.63). Overall, burns [PIR=9.77(96% CI: 8.94-10.67)] were more common in working youths- 15-17-year-old workers [PIR=10.53(96% CI: 9.62-11.53)] and 10-14-year-old workers [PIR=4.38 (96% CI: 2.98-6.43)] than non-working youths. |
| Pym *et al.* (2013)- Australia [Fair] | Motorcycle-based deaths and trauma including burns | Prevalence of motorcycle trauma and deaths based on age, sex, LOS, affected sites, time trends, %TBSA and location | Mean LOS was second longest for burn injuries= 5.8 days (1-28 days, 95% CI= 3.5-8.2). Burns were the 8th highest reason (32 cases) for injuries, 3% of all traumas and mostly full thickness injuries on lower limbs (81.3%). |
| Quayle *et al.* (2000)- United States [Fair] | Contact, (most), Scald, Flames, Electrical, Caustic, Explosion and other. | Prevalence/Incidence of burns based on age, sex, ethnicity, mechanism and other socio-demographic factors. | 63% were < 4 years. 71% White. 59% males. M: F BR = 392:283 per 100,000 children. ABR = 339 per 100,000 children. Annual IR for 0-4 years= 660 per 100,000 while 5-14 years= 184 per 100,000 children. Racial BR highest in Blacks= 592 per 100,000 children. 38% contacts. Flames/explosions more in older children. Peak season= summer (July). 69% in urban (metros) areas. 83% in low poverty counties. Metro: non metro ABR= 363:296 per 100,000 children. High poverty: low poverty rate= 490:247 per 100,000 children. Children most at risk= 0-4-year-old African |

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| | | | American girls in metro areas and high poverty (1357 per 100,000) or non-metro counties (1196 per 100,000) and African American boys living in metro areas and high poverty (1290 per 100, 000) or low poverty (1126 per 100,000). Regardless of SES, county, Black boys had high ABR ranging from 600 to 800 per 100,000 children. |
| Raj *et al* (1999)- United States [Fair] | Electrical burns. | Prevalence of burns based on age, sex, TBSA, ethnicity, location and affected body site. | 81% were males. 92% of cases were from the US and 8% from Mexico. 63% were HV injuries. For LV injuries, mean age in Americans=7 years and Mexicans= six years. Mean TBSA in Americans= 2% while Mexicans= 3.5%. Mean 3rd degree burns in Americans= 0.2% and in Mexicans= 0.3%. For HV injuries, mean age in Americans=10 years and Mexicans= 12 years. Mean TBSA in Americans= 26% while Mexicans= 32%. Mean 3rd degree burns in Americans= 14% and in Mexicans= 17%. Most causes of LV were house appliances with 120-240V. Last ten years of study show a decline in LV injuries with most aged 0-4 years (77%). 39% of oral LV injuries were in < 5 years old group. The main agent for HV= contact with high power lines. |
| Rajan *et al.* (2011)- Australia [Fair] | Exhaust burns | Prevalence/Incidence of exhaust burns based on age, sex, agents, treatment, mechanism, ethnicity and location | M: F=2.7:1. Mean age= 7.3 years. Most aged 0-5 years (38 cases). Most were metropolitan. Rural patients referred to the hospital later due to hospital distance. 79% caused by motorcycle/bike exhausts. Mechanism= 52.6% fall/slip while riding a motorcycle with exhaust touching exposed body part especially in >6 years old. 37.1% in December and January. Most burns= <1%TBSA (0.5-8%). Most affected lower limbs especially calves (70%). |
| Riedlinger *et al.* (2015)- Australia [Fair] | Scalds | Prevalence/Incidence of scalds based on age, sex, agents, treatment, mechanism, ethnicity and location | Scalds= 56% of all paediatric admissions. IR for scalds in 0-14 years= 7.1 per 100,000 children. Median age = 1-year-old (IQR 1-3). Males= 57.4%. 90.8% were home burns. 89.1% had an adult present. Most burns were <10% TBSA 20.5% had adequate first aid. 68.4% admitted within 24 hours. Shorter LOS for those with adequate first aid, two days (IQR 0.9-3.9). Lower odds for surgery to close a wound in those with adequate first aid AOR= 0.53, 95% CI, 0.27-1.04. 21% were Maoris, Aboriginals, Torres Strait Islander and Pacific peoples; their scald rates were about three times that of non-indigenous children (17.6: 4.9 per 100,000). The strong difference in mid-depth burns between indigenous (47.9%) and non-indigenous (32.9%) children. |
| Roberts *et al* (2002)- Australia [Fair] | Motorcycle exhaust burns | Prevalence of motorcycle burns based on age, sex, burn degree, treatment and mechanism | 24 cases. Median age= 8 years (1.2-14.5 years). Peak age for M= > 11 years, F= 6-8 years. 71% males. 33.3% in summer. 54.2% were drivers of motorcycle. 33.3% were passengers- 62.5% being female. Most in rural areas. 92% on leg (73% on right leg). Median %TBSA= 1% (0.5-8%). 50% had full thickness burns. 54.2% admitted. |

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| Sarginson *et al.* (2014)-UK [Good] | Hair straightener-contact burns | Prevalence of burns based on age, sex, mechanism, time trends, %TBSA and location | 96.3% of hair device burns were from hair straighteners (4.5% of all burns). Peak seasons= Christmas and summer. 33% were at 8-11am and evening time. 70% were <2 years old. Mean age of reporting in <5 years= 17 months (M): 21 months (F). Incidence higher for males <5 years and teenage girls. Most TBSA were <1%. Peak mechanism= "grab or touch" 49%. 60% were on hands. Deep burns on foot and ankle only. 15.5% reported two affected surfaces on limbs. |
| Saeman *et al (*2016)-USA [Fair] | Scalds (most), Flames, Contact, and Electrical. | Prevalence of burns based on age, sex, mechanism, time trends, %TBSA and location | 5959 cases. 96% due to thermal injury. Males were 66.2% of admissions. No significant differences in hospitalisation by burn type over the years though scalds were significantly admitted (78%) compared to lower percentages in flame (11%) and contact (7%) injuries. Little change in the racial profile of patients-42% White, 31% Hispanic, 24% African American and 3% Other. However, Hispanic admissions reduced by 0.5% since 1990. Linearly, this was an incidence decrease of 0.26 per 100,000 children per year. African American incidence had a reduced incidence of 0.16 injuries per 100,000 children per year. No change in gender ratio over 35 years with boys having about 3.5 times the rate of females for electrical and flame burns and 15 times for scalds. Older children were more likely to have flame burns: 9.5 years (IQR: 4-14 years). For younger children, this was scalds: 1.7 years (1-3 years old) and contacts: 1.6 (1-3 years old). Overall mortality, 2.5%. Children aged four years and below with 30-59.5% of TBSA had high mortality risk. |
| Schmertmann *et al. (*2012)-Australia [Fair] | Mixed injuries including burns | Prevalence of accidental injuries based on age, sex, treatment, time trends and %TBSA | Burns were $2^{nd}$ leading injury in < 1year olds. Over time, 1-year-olds had the highest annual hospitalisation rates for burns than other ages, 135.3 per 100,000 (128-142.9). M: F burn hospitalization rates were different in 1-year olds [159 (148-170.5): 110.3(101-120.3)] and < 1 years old [34.3 (29.3-40): 25.1(20.7-30.1)]. Children aged 1 yr.: <1 yr had higher RR, 4.51 (95% CI 3.86-5.27). Children aged 3 and 4 years were 60% (RR=0.4 (0.31-0.50)) and 72% less likely (RR= 0.28 (0.21-0.36)) to report burns respectively. Males: females RR for burn hospitalization was higher in age <1 year (1.37 (1.05-1.79)), 1 year (1.44 (1.23-1.70)) and 2 years (1.37 (1.03-1.82)). |

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| Shah *et al.* (2011)- USA [Fair] | Scalds (most), Flames, Contact, Motor Vehicle, Electrical, unknown and others. | Prevalence/Incidence of burns based on age, sex, agents, treatment, mechanism, affected sites, time trends, %TBSA and location | Mean age= 4.8 years, mode age= 1.2 years. 97.92% aged 0-15 years. Peak age= 1-5 years (about 1000 cases). <1 year= 16% of all Ips (mostly bathwater and bathtub burn). 86.9% had TBSA < 10%. 5-10 years had highest mean TBSA (7.63%). 247 cases had full thickness burn (19% had TBSA > 10%). 48.4% were scalds. 34% aged 1-5 years had scalds. 39.3% of home burns in kitchen (45% in < 5 years and 29% in > 5 years). Peak month= July. |
| Shai and Lupinacci (2003)-United States [Good] | Residential fire deaths. | Prevalence/DR of burns based on age, sex, ethnicity, time trends, mechanism and other socio-demographic factors. | Most males. DR per 100,000 population for M= 7.42 (6.22-8.64) and F= 5.33 (4.29-6.37). Higher DR in 0-4 years= 10.28 (8.60-11.97) and this decreased with ageing. Race-specific DR per 100,000 highest for Non-Hispanic Blacks (NHB) = 8.61 (7.33-9.89) and lowest for Non-Hispanics Whites (NHW) = 2.28 (1.39-3.18). RR of all races compared to NHW was highest for NHB= 3.78. Peak time= 12AM to 6AM. Most in winter. Peak agents= playing with matches, careless smoking. 1.22% unsupervised. Most lived in bad housing conditions. Most child deaths in Bedroom (32.1%) and living room (29.3%). Residential fires had a strong association with low-level income (OR=3.18, 95%CI: 1.55-6.53), dwelling in houses built before 1939 (OR=2.84, 95%CI: 1.50-5.37), single-parent households (OR=2.80, 95%CI: 1.38-5.69) and a high number of <15-year-old children (OR=1.001, 95%CI: 1.0009-1.0018). |
| Shenassa *et al.* (2004)- United States [Good] | Mixed injuries including burns | Prevalence/IR of burns based on age, sex, ethnicity, location and other socio-demographic factors. | Burns= 2$^{nd}$ leading injury (15.2%). IR of burns= 1.37 per 10,000 populations for <6 years old (95% CI: 1.31-1.44). Most affected age= 1-2 years old (RR= 8.28, 95% CI: 6.92-9.92). Most males (RR= 1.32, 95% CI: 1.18-1.48). Median burn LOS= 5 days. Every 10% increase in home ownership= 27% reduction in burn risk. A 10% increase in owning homes built before 1950= 34% increase of burn risk (RR=1.11, 95% CI: 1.04-1.18). Dwelling in very poor (RR=2.10, 95%CI: 1.56-2.83) or mid poor areas (RR=1.79, 95%CI: 1.36-2.36) = higher burn risk. Huge Black populated areas had high burn risk (RR=2.64, 95%CI: 1.84-3.79). |
| Sheridan *et al.* (1997)- United States [Fair] | Camping burns. | Prevalence of burns based on age, sex, TBSA, location and affected body site. | 34 cases. M: F= 1.62: 1. Average age= 5.2 years (4 months-17 years). Mean TBSA= 15% (1-98%). 88.2% admitted. 53% had hands affected. 3% mortality. 32.4% fell into fire pit or grill, 20.6% threw flammable liquid on open fire, 14.2% either touched/put a hand on open fire/objects or walked/fell on hot embers. |

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| Shields *et al.* (2007)- United States [Fair] | Burns not specified. | Prevalence/Incidence of burns based on age, sex, agents, treatment, SES, economic impact, mechanism and location | Burns= 0.2% of admissions. 16% of all injury-related hospitalisation in 0-17-year-olds. Median age= 3 years. 49.9%= < 2 years. 48.8% Whites. 63.7% of Males. Younger: Older child admissions= 5.3:1. Black: White admissions= 2:1. Older male children (3-17 years) admitted more, OR= 1.8 (95% C. I=1.5-2.1). 63% had annual income of $25,000-$44,999. Younger children were minorities, OR= 1.9 (95% CI: 1.6-2.4) and had Medicaid/Medicare, OR=1.5 (95% CI: 1.2-1.8). Black males aged < 2 years old (69 per 100,000) most at risk. 91.4% were home burns. 47% had private insurance. 95.8% had < 30% TBSA especially in < 3-year olds (OR=1.8, 95% CI, 1.2-2.6). 63.6% had 2$^{nd}$-degree burns. Younger children had more 2$^{nd}$ degree burns (OR=1.6, 95%CI= 1.3-2.0) while older children had more 3$^{rd}$ degree burns (OR=1.7, 95% CI=1.3-2.2). Younger children had more wrist/hand burns (OR=1.6, 95% CI: 1.3-2.0). Older children had more leg burns. (OR=1.8, 95% CI: 1.5-2.1). Younger children were admitted mostly to urban, teaching and children's hospitals than older children (OR=2.1, 95% CI, 1.5-3.0). Cases with > 30% TBSA were likely admitted to children's hospitals than those <30% TBSA (OR=1.4, 95% CI= 0.8-2.3). Younger children had more of scald, steam (OR=2.7, 95%C. I: 2.4-3.0) and contact (OR=2.2, 95% C.I: 1.8-2.7) mechanism while older children had fire/flame mechanisms (OR=3.4, 95% C.I: 2.8-4.2). 0.6% of fatal cases. Most fatalities were fire/flame burns and in older children. Mean LOS and total charges were highest in clothing fires and fire/flame burns. 10% had LOS > 14 days. > LOS was associated with >%TBSA. Older children had more LOS and were admitted to urban teaching hospitals or child unit in general hospitals (after adjustment). The total cost of 10,000 paediatric burn admissions for year 2000= 212 million dollars. Hand and wrist burn costs were lower compared to other body parts. >LOS= > Costs= >older age children in Western hospitals (after adjusting). Children in Southern Hospitals had the lowest costs. Most fatalities were male, had their head and face affected most, uninsured (covered by Medicaid), older, had average LOS of 9.1 days (4.6-13.5 days), had 3$^{rd}$-degree burns, had fire/flame injuries and were admitted to urban teaching hospitals. |
| Soleimani *et al.* (2016)- United States [Fair] | Scalds (most), Flames, Contact and others. | Prevalence/Incidence of burns based on age, sex, agents, treatment, SES, economic impact, mechanism and location | Data in KID was compared to that in NBR. Both datasets had a more substantial number of males. The racial profile was also similar to 47-48% of cases being the White majority, 22-23% Black, 20-21% Hispanic, etc. Significantly, both datasets had 35-51% of patients using Medicaid or Medicare. Scalds, flames and contact burns were leading types of injury. Both datasets showed burn size increased with age. Lower mortality observed in KID data. Mortality was associated with TBSA and aetiology but showed no differences when both datasets were compared. Medicaid users were predicted to have more prolonged LOS in hospital in KID data while in the two datasets, bigger TBSA and complications led to longer LOS. In all, logistic regression on complications seen in KID data showed greater admission odds in females, OR=1.2 (1.05-1.6); in contact injuries over scalds, OR= 1.2(1.05-1.5); in >10% TBSA, OR=1.6(1.5-1.9) and in insurance payers, private users compared to Medicaid users, OR=0.7 (0.68-0.9) |

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| Street *et al.* (2002)- Australia [Fair] | Woodstove burns | Prevalence of woodstove burns based on age, sex, burn degree, treatment and mechanism | Median age= 1 year (0.9-6.4 years). M: F= 64%:36%. 91% < 2.5 years. 81.8% had partial thickness burns. Median %TBSA= 1.5% (<1 to 4.5%). 63.6% touched stove surfaces. 36.3% supervised, but the injury was not witnessed. 81.8% had cold water first aid. 63.6% were outside the Brisbane metropolitan area. Peak months= May-Sept (especially in June and August). 45% admitted for 1-2 days. |
| Streeton and Nolan (1997)- Australia [Fair] | Scalds (most), Flames, Electrical, Sunburn and others. | Prevalence/Incidence of burns based on age, sex, mechanism, and LOS | 74-81% 0-4-year-olds admitted overtime. M: F= 2:1. 95% admitted had scalds and contact burns (65% were scalds). 80% fall in admissions for 5- 9-year-olds over 25 years. 60% fall in scald admissions. Hot bath/tap water scalds fell by 83%. Boiling water scalds fell by 64%. Scald admissions for <5-year-olds ranged from 89% to 91% in the 25 years. 59-60% of males scalded over the study period. Peak scald agent= hot water. Flame burn admissions fell by 74% in 0-4 years and 70% in 5-9 years but increased by 10% in 10-14 years for 25 years. Indoor heating-ignited flame burns admissions fell by 88%. The peak age for flame burns= 5-9 years. Contact burns fell by 70%. Peak contact agent= electric bar radiators or glass fronted heaters. 0-4 years old most at risk for contact burns. Severe %TBSA quadrupled. Head, face and neck burn increased. 93% of severe and fatal burns were flame burns. One hundred sixty-three children died over 25-year period especially from flame and contact burns. Burn mortality rate fell from 0.9 to 0.5 per 100,000 children. |
| Suominen *et al.* (1998)- Finland [Poor] | Mixed Injuries including burns. | Prevalence of burns based on age, sex, and LOS | Burns were four$^{th}$ leading fatal injuries (4.6% of all injuries). Three burn victims died (2.5% of all deaths). No other inequality info. |
| Tan *et al.* (2012)-UK [Good] | Scalds (most), Contact, Flame, Flash, Chemical, Electrical Friction and Radiation. | Prevalence of burns based on age, sex, mechanism, ethnicity, deprivation, time trends, %TBSA and location (via 1-way ANOVA, t-test) | Mean age = 4.5 years (7 days to 16 years). Median = 2 years. 60.4% were males. 90.3% Whites. Burned: unburned ethnic children population= 9.7%:5%. Chinese burns patients 2.1%: unburned population 0.3%. 61.3% scalds. 76.7% of home burns (35.5% in the kitchen). 56.2% affected upper limbs. Mean TBSA= 5.8% (0.1-85%). Mean LOS for IPs= 4.2 days (0-162; 0.72 days per %TBSA). Flame, flash and radiation burns (mean ages: 9.4, 11.6 and 8.5 years respectively) had older aged cases than scalds (mean age: 3.2 years). Those burned in their own homes (mean age: 3.5 years) were younger than those burned elsewhere (mean age: 7.5 years). In-home burns, Arabs, 100%, Black 62.5% and Chinese, 53.8% had more kitchen burns than White children (34.1%). Mean TBSA for all ethnic groups= 7.1%. Chinese, 10.2% and Asian 8.2% had higher TBSA than White children (mean TBSA: 5.6%). Ethnic minority children (IMD=48.7) were more deprived than Whites (IMD=40.9). The small negative correlation between deprivation |

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| | | | and TBSA (r=-0.11). Peak agents for Chinese burns (hot food scalds- food 60%): White burns (beverage 35.8%). 1/3 of Chinese patients' burn was from hot soup/fat. Highest mean TBSA= flame (13.4%). Mean LOS for flame burns (14.4 days), flash (4.9), scalds (3.8). |
| Thomas *et al.* (2004)-United States [Fair] | Flame, Scald, Sunburn and Contact | Prevalence of burns with ADHD based on age, sex, mechanism, location and ethnicity. | 39 cases with ADHD. 76.9% were males. Most were white, then Hispanic and black. Median age= 10 years (4-17 years). Median %TBSA= 23% (2-80%). 69.2% flame burns. 28% of burns with non-ADHD behaviour were related to burn time. Thirty-six patients had ADHD before admission with 35 of them with prescribed medication. Nine cases did not take their medication on the day of fire injury. |
| Thombs *et al* (2006)-United States [Fair] | Scalds (most), Flames | Prevalence/Incidence of burns based on age, sex, mechanism and location | 65.4% males. Older children (4-17.9 years) had bigger %TBSA and more 3rd degree burns. 60.5% scalds. Admission for a scald than flame injuries higher in children <4 years old, OR for 0-1.9 years= 22.61 (95% CI: 20.12-25.41) while 2-3.9 years= 5.77 (95% CI, 5.18-6.44). Scald mortality= 0.4%, flame mortality = 3.4%. Odds for flame mortality higher (OR= 8.94, 95% CI: 6.2-12.89). Scalds mortality odds higher in age 0-1.9 years (OR=4.96, 95% CI: 1.16-21.18) and 2-3.9 years (OR=6.93, 95% CI: 1.53-31.33). Flame burns in age 0-3.9 years had higher mortality odds than older children (OR=2.57, 95% CI: 1.73-3.82). Scalded children had smaller TBSA, mean= 9.7% and 3rd degree burns TBSA (mean=1.8%) than those with flame burns (mean=17%), 3rd degree burns TBSA (mean= 9.4%). Adjusted OR's show 0-1.9 years (2.70, 95%CI: 1.7-4.29) and 2-3.9 years old (2.00, 95% CI: 1.28-3.11) are more likely to die from their injuries. |
| Tomkins and Holland (2008)-Australia [Fair] | Electrical burns | Prevalence/Incidence of burns based on age, sex, agents, treatment, mechanism and location | 22/161 electrical injuries were true electrical burns (1% of all burns). 55% were males. Mean age= 7.6 years (8 months-14.3 years). 86% were LV, and 14% were HV. Mean %TBSA= 3.7% (0-35%). 68% had hands and upper limbs affected. 68% had superficial burns. Average LOS= 6 days (<1 day to 58 days). No fatalities but 14% had long-term morbidity. |
| Trop *et al.* (2015)- Austria [Fair] | Scalds (most), Contact, Flame and others (Flash, Chemical, Electrical Friction and Radiation). | Prevalence/RR of burns based on age, sex, agents, mechanism, affected sites, time trends, %TBSA and location | 64% were males. Mean number of IPs/years= 58. 60.6% aged 1-5 years. Burn admission risk higher in the male from 1989-2012, RR= 1.60 (1.43-1.79). 65.1% were scalded with 71.8% via beverages. 40% of contacts via a hot iron/iron machine. 22.6% of upper limbs affected. Deep burns were 84.6% of electrical cases, 58.8% of chemical and 55.1% of contact burns. 80.2% in the home (42.7% in the kitchen). 76.2% had TBSA < 10% (LOS, 3 days, IQR=1-8days). 4 males died in uncontrolled house fire with full thickness burns (75-95% TBSA). |

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| Van Baar *et al.* (2011)- Netherlands [Good] | Burns (type not specified) | Prevalence/OR of burns and suboptimal QOL based on age, sex, agents, mechanism, affected sites, time trends, %TBSA and location | 50% aged 5-8 years. 61% were males. 20% had comorbidity. 28% each had 0-3- and 4-13-days LOS. Most were two years after injury (46%). 67% had <10% TBSA. 33% affected hands. Children post 9 months of burn reported more mobility (OR= 5.9, 95% CI: 1.7-20.2), self-care (OR=11.8, 95% CI: 2.6-52.8) and depression (OR=3.7, 95% CI: 1.3-10.5) problems compared to 24 months post burn cases. 9-11 years old (3.3, 95% CI: 1.2-9.0) and 12+ (0.9, 95% CI: 0.3-2.4) had strong OR for suboptimal QOL compliance. Parents of girls had 3.6 times (OR=3.6, 1.5-8.4) parental concern than boys. Cases with >20% TBSA (OR=5.3, 1.5-17.9) had issues with upper extremity functions. 10-20% TBSA cases were 5.5 times more concerned about appearance (OR=5.5, 1.5-19.9) and 3.4 times not satisfied with the current state (OR=3.4, 1.3-9.0) while parents were 3.4 times more concerned (OR=3.4, 1.1-10.3). Cases with burns for more than a year were less likely to itch (OR=0.3, 0.1-0.7), to be incompliant (OR= 0.2, 0.1-0.7) and to have worried parents (OR=0.2, 0.0-0.7) compared to <1 year after burns. |
| Vassilia *et al.* (2004)- Greece [Fair] | Firework-related injuries. | Prevalence of firework injuries based on age, sex, mechanism, location and time trends. | 93.4% were males. 70.3% aged 10-14 years. 50.5% on weekdays. 78% in spring-Greek Orthodox Easter holidays. 70.6% injured in streets. 92% had an adult present. Burns= 48.8% of firework injury. Most affected site= upper limb (34.1%). |
| Vermaak *et al.* (2012)-UK [Good] | Disposable barbecue contact burns. | Prevalence of disposable barbecue burns based on age, sex, mechanism, time trends; %TBSA, affected body part and treatment. | Nine cases (52.9% of barbecue burns and 3% of all burns reported) were from the hot sand where disposable barbecues were placed. 66.6% females mean age= 4.6 years (1.4-13.4 years). 80% affected both hands and feet. Mean TBSA= 1.23% (0.1-2.5%). 53.3% had superficial partial thickness. One was LTFU. Mean LOS= 2.3 days. Mean FU= 40.5 days (5-180 days). |
| Viklund *et al.* (2013)- Sweden [Good] | Car/ vehicle-related fire burn and death | Prevalence of vehicle-related fire deaths based on age, sex, agents, mechanism, affected sites, time trends, %TBSA and location | One hundred eighty-one persons died in 133 car fire road crashes (5% of all 3767 vehicles victims). The annual rate of 4 per million cars= 0.3 deaths in burning cars per 1 billion km driven. 0-9-year-olds had the fourth most substantial numbers (7.2%, 13 cases- 7 males and six females.). 30% of deaths were from fire burns/smoke inhalation (71% from fire and smoke while 29% from fire and combined trauma). 69% male. When combined, age 0-15-year-olds burn deaths were 16/55 (29%). Of the 55 deaths from 32 car fires, seven vehicles caught fire from the fuel tank. |

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| Vloemans *et al.* (2011)- Netherlands [Good] | Scalds (most), Fat, Flames, Contact, Electrical, Chemical and others. | Prevalence/Incidence of burns based on age, sex, agents, treatment, mechanism, affected sites, time trends, %TBSA and location | 1995-1999 (Period 1) and 2000-2007 (Period 2). 2 age groups, 0-4 years (young group) and 5-17 years (older group). Mean admissions number increased over the study period- in young by 44% (113 to 163 per year) and in older children by 44.3% (50 to 71 per year). Children admitted to burn centres rather than hospitals increased from 30% in 1995 to 50% in 2007. 50% of 0-4 years admitted to a specialised burn centre (RR= 5 x older children and adults). Referrals from other hospitals increased from 62.9% in Period 1 to 68.8% in period 2 for 0-4 years (OR=1.3, 1.1-1.6). More males in both periods (Period 1, 61.7%: Period 2, 64.2%). In the younger group, TBSA and full thickness burns reduced overtime (Median TBSA from 7% to 5% and mean burn size from 8.7% to 6.4%). In the older group, those with >10% TBSA reduced while mean burn size was 9.5%. For the younger group, mean LOS reduced from 7 days or more (OR=0.6, 0.4-0.8). Odds of home injury was 60% less in the older group (OR= 0.4) while the initial injury was flame burn (OR= 4.9) and not scalds (OR=0.2). OR for having surgery was 40% less in 0-4 years (OR=0.6, 0.5-0.7) and 20% less in 5-14 years (OR= 0.8, 0.6-1.1). |
| Vollman and Smith (2006)- United States [Fair] | Mixed injuries (including burns). | Prevalence/Incidence of lawn mower burns based on age, sex, mechanism and location | 21,809 burns/140, 700 lawn mower injuries (15.5%). Most males. Peak age= 1-2 years and 15 years mean age= 10.6 years. Burns were third leading lawn mower injury and also third most common injury treated at ED (16.9%). Burns were 41.8% of injuries in <5 years old and 6.5% above five years (RR: 6.40, 95% CI: 6.23-6.57). 34.5% affected hands and fingers (RR: 6.30, 95% CI: 6.12-6.49). The most common mechanism was in contact with the hot surface of a lawnmower. |
| Wallis *et al.* (2008)- Australia [Fair] | Scalds | Prevalence/Incidence of scalds based on age, sex, agents, treatment, mechanism and location | Mean age= 5 years (7 months-14 years). Modal age= 1 year. 44% were < 3 years. 59% females (F: M= 1.4:1). Peak season= Winter. The mechanism was a spillage on lower regions in 5-14 years and reaching for and touching hot contents/ part of the vaporiser in 0-4 years. 63% of spills from boiled water. 41% of scalds were >4% TBSA (4-15%). Spills caused multiple injuries. 73% affected on thighs, abdomen, genitals and upper thighs. For a touching, most cases were 7-28 months, M: F= 1.5:1. Most injured in the bedroom with the device on the floor had a mean TBSA= 1.22% (1-3%), and 75% were under supervision. |
| Williams *et al.* (2003)- United States [Fair] | Burns- not specified | Prevalence/RR of burns based on age, sex, ethnicity, location and other socio-demographic factors. | 54.7% males in St Louis. 85.2% African American. 65% 0-4 years. North St Louis burn incidence more than rest of St Louis. 98% of North St Louis = African American. For < 14 years old, 51% Whites in St Louis, 83.4% Blacks in North St Louis. Low SES, below poverty levels, children in poverty, unemployment and single parents more in North St Louis than St Louis itself. Burns from study hospitals as % of all Missouri burns ranged from 44.4% to 114.3% (St Louis) and 42.9% to 97.4% (North St Louis). One hundred ninety-six burns were in 58 North St Louis census tracts. Mean burn |

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| | | | rate= 3.4 per 1,000 0-14-year olds (0-11.5 per 1,000). Burns in St Louis census tracts (1995) had children in poverty (35.4%), unemployment (12%), the median age of housing (55.6 years) and single parents (48.6%). |
| Witsaman *et al.* (2006)- United States [Fair] | Mixed firework injuries | Prevalence/Incidence of burns based on age, sex, mechanism and location | Mean age= 10.8 years. 62% > 10 years old. 77.9% were males. 60.3% were burns. 29.6% from fireworks, 10.7% from illegal fireworks. Children < 10 years more affected by sparklers/novelty devices than older children. (13.1%, RR: 2.04, 95% CI: 1.68-2.47). Children > 10 years had higher RR (RR: 1.91, 95% CI: 1.27-2.89). 10-14 years had the highest numbers of cases over the period. Mostly hands and face affected. All agents caused burns over 50% in each case except in illegal fireworks. Roman candles= leading firework burn agent (77%). 5.3% admitted. 49.5% were using fireworks, and 22.2% were bystanders. |
| Woodbridge *et al.* (2010)-UK [Fair] | Burns from caravans and camping. | Prevalence of campers burns based on age, sex, treatment, time trends, %TBSA and location | 20% of eligible 151 cases were campers. The median age in campers: non-campers were 35 months: 24 months. 29% were from Bristol. Somerset and Devon (46% each) had the highest camper burns. TBSA of only partial thickness burns were larger for campers: non-campers, i.e. 6%:3% TBSA. Campers: non-campers had longer LOS, 5.3:3.8 days. |
| Yates *et al.* (2011)-Ireland [Fair] | Burns and Scalds- not further specified. | Prevalence of burns based on age, sex, treatment, time trends, %TBSA and location | One hundred twenty-one burns and 161 scalds. 127/161 scalds were < 5 years. M: F ratio= 1:1, mean age= 42 months (3 years 3 month), 11% were > 10 years. Peak month= June (14%). First six months: last six months = higher: lower attendances. 60% reported to A & E within 1 hour, 75% within 4 hours and 8% in 1 week after with infection. Minor peak time= 12-1pm while major peak= 8-9pm. 65% of scalds via hot beverage (28% tea only). Scalds affected upper limbs (35%) most. Upper: lower body part affected were 2:1. 25% had first aid (92% was via cold water). 6% were admitted. |
| Zoni *et al.* (2016)- Spain [Good] | Mixed injuries including burns | Crude Incidence rates via Poisson regression of injuries based on age, sex, SES status. | The incidence of all injuries more in females than males (across all quintiles), 1028:941 per 10000 per year. Burns were a 5th most common injury. Females below 15 years old and in the 5th quintile had the most significant risk for injuries compared to those from the 1st quintile, IRR= 1.5 (1.46-1.54). This ratio was similar to that of males below 15 years, although it was lower. For burns specifically, the most substantial IRR for all burn injuries were seen in girls aged 0-14 years old, IRR=1.89 (95% CI: 1.65-2.18). Boys aged 0-14 had a burn IRR of 1.73 (1.56-1.92) - this was the thi rd largest burn injury IRR overall. |

# APPENDIX FOR CHAPTER 3

## AS 3.1 Research Outputs from this Thesis

The following are research outputs that have been produced during this thesis, with more to occur in the nearest future. These have been split into two parts as shown below:

3.1.1 Published abstracts

These items have also been presented at conferences highlighted below:

1. Ikpeme M, Emond A, Mytton J, *et al.* G143(P) Ethnic inequalities in paediatric burns: Findings from a systematic review and analyses of hospital episodes statistics data from 2009 to 2015, Archives of Disease in Childhood 2017;102: A59.

2. Ikpeme M, Emond A, Mytton J and Hollen, L G433 (P), Associations between pre-injury impairment and thermal burn injury in children: analyses of the Burns and Scalds Assessment Template (BaSAT) data, Archives of Disease in Childhood 2018; 103: A177.

3. Ikpeme, M., 2018. 6.4-O5 Ethnic inequalities in burn types in children in England and Wales: analyses of the Burns and Scalds Assessment tool (BaSAT) data. The European Journal of Public Health, 28(suppl_1), pp. cky047-220.

3.1.2 Oral and Poster Presentations

1. Poster Presentation titled “Associations between Pre-Injury Impairment and Thermal Burn Injury in Children: Analyses of the Burns and Scalds Assessment Template (BaSAT) data” at the 2018 Royal College of Paediatrics and Child Health (RCPCH) Conference, SEC, Glasgow 13 – 15 March 2018.

2. Poster Presentation titled “Ethnic Inequalities in Paediatric Burns: Findings from a Systematic Review and Analyses of Hospital Episodes Statistics data from 2009 to 2015” at the 2017 Royal College of Paediatrics and Child Health (RCPCH) Conference, ICC Birmingham, 24th to 26th May 2017.

3. Oral Presentation titled “Investigating Inequalities in Paediatric Burn Injuries in England- Findings from Analyses of Hospital Episodes Statistics (HES) data from 2009-2015”. Presented at the 50th Annual Scientific Meeting, “New Burn Technologies

for Better Burn Care" of the British Burns Association (BBA), Royal College of Surgeons of England, London, May 3rd to 5th 2017.

4. Oral Presentation titled "Investigating Inequalities in Paediatric Burn Injuries in England" at the South West Public Health Conference 2017, Bristol Mercure Hotel, Bristol; March 2017.

5. Poster Presentation titled "Socioeconomic Inequalities in Paediatric Burns" at the Association of Schools of Public Health in the European Region (ASPHER) Young Researchers' Forum Pre-Conference at the European Public Health Conference, Vienna. November 2016.

6. Oral Bell Session and Poster Presentation titled "Socioeconomic Inequalities in Paediatric Burns" at the 'Children's Burns Research Network Showcase', At-Bristol, Bristol, 1st July 2016

7. Oral Presentation on Research in Progress for the PhD titled "Epidemiology of burns and scalds of children and young people in the UK" Postgraduate Symposium, 11 December 2015, SSCM, Canynge Hall; University of Bristol

8. Poster Presentation on Research in Progress for the PhD titled "Epidemiology of burns and scalds of children and young people in the UK" at the 2nd Annual Faculty of Medicine and Dentistry, Postgraduate Away Day, 27th August 2015, Richmond Building, University of Bristol.

9. An oral presentation titled "Ethnic inequalities in burn types in children in England and Wales: analyses of the Burns and Scalds Assessment tool (BaSAT) data" at the 1st World Congress on Migration, Ethnicity, Race and Health, EICC, 17-19 May 2018, Edinburgh.

# APPENDIX FOR CHAPTER 4

# AS 4.1 FORMS USED IN OBTAINING ACCESS TO HES DATA

CONDITIONS OF ACCESS FOR THE HES DATASET

School of Social and Community Medicine and CLAHRC West, University of Bristol

The HES Dataset

The Hospital Episode Statistics (HES) is the data collected during a patient's outpatient and A&E consultations or admission at NHS hospitals. It covers all NHS Trusts in England, including primary care and mental health, and is maintained by the Health and Social Care Information Centre (HSCIC). The primary purpose is to facilitate an audit of hospital activity and allow hospitals to be paid for the care they deliver. It is also used for secondary non-clinical purposes such as research.

The School of Social and Community Medicine (SSCM), University of Bristol, has a Data Re-Use Agreement (DRA) with the HSCIC for HES Admitted Patient Care (inpatient) data. The DRA currently covers data from the years 1989-90 to 2011-12, but an application for extracts for 2012-14 and other datasets (A&E and Outpatients) is currently ongoing.

The dataset held by the School only includes non-identifiable and non-sensitive data fields and contains pseudonymised HES IDs. It is physically kept in a dedicated encrypted SSCM server and access to the full dataset is limited to designated intermediaries. All researchers wishing to use the HES data for approved research will be provided with data extracts.

This document outlines the conditions of access to the HES data, by the provisions of the DRA.

The purpose for which the data is to be used

The purpose of the HES data access is to conduct studies looking to improve the Health and Social Care system or promote health. It has been used by researchers from the SSCM in studies evaluating the equality of access to NHS care and its effectiveness, safety and cost-effectiveness.

The use of the HES database under the DRA is restricted to the staff of the SSCM. This includes the staff of the NIHR Collaboration for Leadership in Applied Health Research and Care (CLAHRC) West. Researchers within the School wishing to use the data should contact Prof. William Hollingworth in the first instance, to discuss the project. The project proposal will be submitted and reviewed by two academics who will decide whether it fits with the SSCM data reuse agreement.

Conditions of access

Provisions

Data extracts provided to the researchers must only be used for the explicit purpose set out in the proposal. These extracts will follow the data specifications outlined in the approved proposal.

Access to the HES data and data sharing

Only investigators who were approved to use HES data, as well as research staff associated with data analysis for the corresponding project, will be granted access to the data extract. They will be granted access after confirming they have read the HES analysis guide. No individual other than those named in the agreement can access the dataset. In the case of staff changes, the investigators will inform the SSCM HES data managers of the changes. Access to staff who have left the project or SSCM will be removed.

No part of the dataset may be shared with any third party.

Data security

For purposes of data security, all data extracts will be kept in a folder in the SSCM G Drive (Groups → HES). A dedicated folder will be assigned to the Principal Investigator of the project. In the case of multiple projects for the investigator, subfolders will be created within the folder. The HES folder and subfolders can be accessed using UOB user ID and password, only by people who are named in the application.

New desktop computers assigned to investigators and research staff working on the HES data will be encrypted. Researchers using existing desktop computers that are not encrypted must request encryption from IT services before access to HES data will be approved. No parts of the dataset can be kept in other physical locations, including, but not limited to, the hard drive of SSCM computers, personal or work laptops, memory sticks and DVDs.

The SSCM HES database managers reserve the right to access the folders for purposes of data management and to ensure compliance with the DRA.

Confidentiality

While the HES dataset kept by SSCM is pseudonymised, there remains a risk of unintentional breach of confidentiality. Recognition of an individual while carrying out analysis or from existing analyses should be reported to the SSCM HES data manager, who will inform the HSCIC.

Data should always be released at high levels of aggregation to preserve patient confidentiality. Low cell counts (1-5) for specific measures such as numbers of patients, episodes, admissions and deaths are considered disclosive and should be suppressed. Other measures that may not appear to be disclosive, such as bed days and average wait times or length of stay, may imply small numbers of cases and would require similar suppression. Judgement needs to be taken as to whether averages imply more information about individual cases. Suppression of specific conditions about small numbers are outlined below:

Small numbers in any individual cell are acceptable at the levels of national, regional, area team, commissioning region and strategic clinical networks unless prohibited by specific guidelines

Small numbers in an individual cell are not acceptable and should be suppressed at the level of postcode district, local area, electoral ward, LSOA, MSOA, CCG, GP practice, Trust and provider

Small numbers in an individual cell are not acceptable at any level of neurosurgery for mental disorders, electroconvulsive therapy (ECT) and IVF.

Small numbers of deaths at the levels of: national, regional, area team, commissioning region and strategic clinical networks, are acceptable but footnotes should be given with the outputs.

There are restrictions on the use and release of abortion statistics, and these have to be discussed with the HSCIC before analysis.

Where the release of small numbers is necessary, authority and advice must be sought from the Information Governance team of the HSCIC.

Reporting

Before undertaking publication activity, the users of the dataset or any derived information will undertake an organisational Risk Assessment Exercise to ensure compliance with the guidelines.

All analyses using the data must state the data source: Hospital Episode Statistics, Health and Social Care and Information Centre.

HSCIS retains copyright of any information and must be cited as:

"Copyright © 2013, Re-used with the permission of The Health and Social Care Information Centre. All rights reserved."

Any publication resulting from the use of the HES data should be reported to the HES data management team and copies should be deposited in the Publications subfolder inside the HES folder.

Project Information

**Project Title:** **An Investigation of Inequalities in Paediatric Burns in England and Wales.**

Principal Investigator (within SSCM):

| | |
|---|---|
| Name: | Prof Alan Emond |
| Position: | Director, Healing Foundation Children's Burns Research Centre |
| Address: | Centre for Child and Adolescent Health (CCAH) |
| | School of Social and Community Medicine, Oakfield House BS8 2BN |
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| | |
|---|---|
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Principal Investigator on Project (if different from above):


| | |
|---|---|
| Name: | Moses Ikpeme |
| Position: | PhD student |
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| Telephone: | [redacted] |


| | |
|---|---|
| Funder (if any): | The Healing Foundation |

| | |
|---|---|
| Start date: | May 2016 |

| | |
|---|---|
| End date: | Dec 2018 |

Brief project description (max 500 words)

This study aims to examine any observable inequalities in accidental burns of children and young people (0-16 years) in England and Wales. This will be achieved via secondary data analysis of admissions data from Hospital Episodes Statistics (HES) databases in England. A data set of burns admissions in 0-16-year-olds for the years 2009/10- 2014-15 has been provided and used for analysis.

The associations between hospital admission of burns and socio-economic status (IMD quintile), geographical factors (urban/rural residency) and family ethnicity (categorised using census criteria) have been explored in each gender group using STATA. The initial univariate analyses have shown that paediatric burns admissions are actively social patterned, with clear associations with household deprivation, family ethnicity and urban/rural residence.

As these factors are inter-correlated, multivariate logistic regression models are now needed to understand the associations between these covariates and to assess any independent effects. A series of sensitivity analyses will assess the bias introduced by missing data, and multiple imputation techniques will be employed if appropriate. To construct the regression models, we now need a sample of unselected paediatric admissions to act as the comparator group.

We are therefore requesting a dataset of admissions from all causes for 0-16-year-olds for the years 2009/10- 2014/5.

After cleaning, the burns admissions will be removed from this set and then a random sample will be created which will act as the comparator group in logistic regression.

**Please list all individuals who need access to individual-level HES data for this project. All must be SSCM staff at the University of Bristol (UoB). UoB students can be named, but the Principal Investigator should be their supervisor and will be responsible for their work with the HES data. Please use additional pages if necessary.**

**All desktop computers used to access and analyse data <u>must be encrypted</u>, please contact IT services.**

**By signing below, you are confirming that you understand and agree to the conditions set out in this document. Any breach of conditions may result in termination of access to the data.**

Researcher 1:

Name: Moses Ikpeme

Position: PhD student

UoB Email: mi14551@bristol.ac.uk

Signature & date:

Researcher 2: :

Name: Dr Linda Hollén

Position: Senior Research Associate in Medical Statistics

UoB Email: linda.hollen@bristol.ac.uk

Signature & date:

Researcher 3:

Name: Prof Alan Emond

Principal Investigator and Senior PhD supervisor, SSCM

Position: Professor of Child Health University of Bristol

UoB Email: Alan.Emond@bristol.ac.uk

Signature & date:

[redacted] 26.10.16

Researcher 4:

Name: Dr Julie Mytton

Second PhD supervisor

Senior Research Associate, SSCM

Position: Associate Professor of Child Health, the University of the West of England, Bristol

UoB Email: Julie.Mytton@uwe.ac.uk

Signature & date:

# AS 4.2 TABLES OF SELECTED CODES USED FOR HES ANALYSES

Tables made up with selected codes from the HES Admitted Patient Care (APC) Dictionary (AT4.1, AT4.3, AT4.4 and AT4.5) and HES Outpatient Data Dictionary (Table AT4.2) were submitted to the HES team, the University of Bristol for data query and extraction:

| **AT4.1: LIST OF VARIABLES NEEDED FOR HES ANALYSIS OF ADMITTED PATIENTS CARE DATA BASED ON CODEBOOK INFORMATION** | | | | |
|---|---|---|---|---|
| **S/NO** | VARIABLE CODES | FIELD NAME | VARIABLE TYPE | CLEANED? |
| **1.** | ACTIVAGE | patient's age, in years, at the time of activity, such as admission | Numerical, continuous. | N |
| **2.** | ADMIAGE | A patient's age, in years, at the date of admission | Numerical, continuous. | N |
| **3.** | ADMIDATE | Date of admission | String | - |
| **4.** | ADMIMETH | identifies how the patient was admitted to the hospital | String | - |
| **5.** | ADMINCAT | Administrative category on admission, e.g. NHS or private patient. | Numerical, discrete | - |
| **6.** | ADMISORC | identifies where the patient was immediately before admission | Numerical, discrete | - |
| **7.** | ADMISTAT | Identifies previous psychiatric care for psychiatric patients. | Numerical, discrete | - |
| **8.** | BEDYEAR | Duration of an episode of days within the HES data year. It is derived from epistart (episode start date) and epiend (episode end date) | Numerical, continuous. | - |
| **9.** | BIRORDER_N | Birth order | String | - |
| **10.** | BIRWEIT_N | Birth weight | Numerical, continuous | - |
| **11.** | CARERSI | states whether carer support is available to the patient at home or another usual residence | Discrete, categorical | - |
| **12.** | CAUSE_4 | initial four characters of the first diagnosis code that represents an external cause, e.g. accidents | String | - |
| **13.** | CLASSPAT | Patient classification by time of day and frequency of attendance in hospital | Numerical, discrete | |

| | | | | |
|---|---|---|---|---|
| **14.** | CSNUM | Commissioning serial number (used in HES to identify OATs - Out of Area Treatments) | String | - |
| **15.** | DIAG_NN | Diagnoses on admission, where DIAG_01 stands for primary diagnoses and DIAG_02 to DIAG_20 represent secondary diagnoses coded following ICD10 code formats | String | |
| **16.** | DISDEST | Destination on discharge | String | - |
| **17.** | DISMETH | defines the circumstances under which a patient left the hospital | Numerical, discrete | - |
| **18.** | ELECDUR | The difference in days between the date on which it was decided to admit the patient (elecdate) and the actual admission date (admidate). | Numerical, continuous | - |
| **19.** | ENCRYPTED_HESID | Encrypted Patient identifier - HES generated | String | - |
| **20.** | ENDAGE | patient's age in whole years at the end of a finished episode | Numerical, continuous | - |
| **21.** | EPIDUR | the difference in days between the episode start date (epistart) and the episode end date (epiend) | Numerical, continuous | - |
| **22.** | EPIORDER | number of the episode within the current spell | Numerical, discrete | - |
| **23.** | ETHNOS | specifies some ethnic groups and some nationalities | String | - |
| **24.** | FIRST REG | Is this the first admission or subsequent episode within the sequence | Numerical, categorical | - |
| **25.** | GORTREAT | Derived from the hospital provider code (procode). It indicates the government office region (GOR) area within which the treatment took place | String | - |
| **26.** | GPPRAC | The practice of the patient's registered GP. Registered GP may not be the same as the referring GP | String | - |
| **27.** | GPPRACHA | Health authority area in which the patient's GP is registered | String | - |
| **28.** | GPPRACRO | Regional Office area in which the patient's GP is registered | String | - |
| **29.** | GPPRPCT | Primary Care Trust area where patient's GP was registered | String | - |
| **30.** | GPPRSTHA | Strategic Health Authority area where patient's GP was registered | String | - |
| **31.** | HATREAT | Health Authority of treatment | String | - |
| **32.** | IMD04 | IMD Index of Multiple Deprivation | Numerical, continuous | - |
| **33.** | IMD04_DECILE | IMD Decile Group | String | - |

| | | | | |
|---|---|---|---|---|
| **34.** | IMD04C | IMD Crime Domain | Numerical, continuous | - |
| **35.** | IMD04ED | IMD Education Training and Skills Domain | Numerical, continuous | - |
| **36.** | IMD04EM | IMD Employment Deprivation Domain | Numerical, continuous | - |
| **37.** | IMD04HD | IMD Health and Disability Domain | Numerical, continuous | - |
| **38.** | IMD04HS | IMD Barriers to Housing and Service Domain | Numerical, continuous | - |
| **39.** | IMD04I | IMD Income Domain | Numerical, continuous | - |
| **40.** | IMD04IC | IMD Income affecting Children Domain | Numerical, continuous | - |
| **41.** | IMD04LE | IMD Living Environment Domain | Numerical, continuous | - |
| **42.** | IMD04RK | IMD overall ranking is made by combining the seven IMD Domain scores | Numerical, continuous | - |
| **43.** | LSOA01 | Lower Super Output Area | String | - |
| **44.** | MAINSPEF | Main speciality | String | - |
| **45.** | MENTCAT | Defines the mental categories of a patient by the designations in the Mental Health Act 1983 | Numerical, discrete | - |
| **46.** | MSOA01 | Middle Super Output Area, 2001 | String | - |
| **47.** | OPERSTAT | Operation status code | Numerical, discrete | - |
| **48.** | POSOPDUR | Contains the difference in days between the date of the principal operation (opdte_01) and the date the episode ended (epiend). | Numerical, discrete | - |
| **49.** | POSTDIST | outward portion of the patient's postcode | String | |
| **50.** | PREOPDUR | Pre-operative duration contains the difference in days between the date the episode started (epistart) and the date of the principal operation | Numerical, discrete | - |
| **51.** | PROVSPNO | A number to provide a unique identifier for each Hospital Provider Spell for a Health Care Provider | String | - |
| **52.** | RESCTY | County of residence | String | - |
| **53.** | RESGOR | defines the Government Office Region of residence of the patient | String | - |
| **54.** | RESHA | Health Authority of residence | String | - |

| | | | | |
|---|---|---|---|---|
| **55.** | RESPCT06 | primary care trust (PCT) in which the patient lived immediately before admission | String | - |
| **56.** | RESRO | code for the Regional Office in which the patient lived immediately before admission | String | - |
| **57.** | RESSTHA06 | code for the strategic health authority (SHA) in which the patient lived immediately before admission | String | - |
| **58.** | ROTREAT | defines the Regional Office (RO) where the treatment took place | String | - |
| **59.** | RURURB_IND | Rural/Urban Indicator, describes the nature of an Output Area regarding its morphology (hamlet, town, urban, ) and context (sparse or less sparse) | Numerical, Discrete | N |
| **60.** | SEX | Sex of patient | Categorical, numerical | - |
| **61.** | SITETRET | Site code of treatment defines the site on which the patient was treated within an organisation | String | - |
| **62.** | SPELDUR | Duration of the spell, the difference in days between the admission date (admidate) and the discharge date (epiend) | Continuous, Numerical | - |
| **63.** | STARTAGE | contains the patient's age in whole years from the start of the episode | Numerical, continuous | |
| **64.** | STHATRET | indicates the strategic health authority (SHA) area within which the treatment took place | String | - |
| **65.** | TRETSPEF | Treatment speciality defines the speciality in which the consultant was working during the period of care | String | - |

| AT4.2: LIST OF VARIABLES NEEDED FOR HES ANALYSIS OF OUTPATIENTS PATIENTS DATA BASED ON CODEBOOK INFORMATION (IN ADDITION TO SHARED GENERAL VARIABLES ABOVE) | | | | |
|---|---|---|---|---|
| S/NO | **VARIABLE CODES** | **FIELD NAME** | **VARIABLE TYPE** | **CLEANED** |
| 1. | **APPTAGE** | **calculated from appointment date (appt date) and date of birth (dob), contains the patient's age in whole years** | **Numerical, continuous** | **-** |
| 2. | **ATENTYPE** | **Attendance type: used to identify if the attendance occurred and whether it was the first or subsequent** | **Categorical, numerical** | **-** |
| 3. | **ATTENDED** | **whether or not a patient attended an appointment** | **Categorical, numerical** | **-** |
| 4. | **DIAG_NN** | **Diagnosis code** | **String** | **-** |
| 5. | **DIAG_4_NN** | **first four characters of diagnosis** | **String** | **-** |
| 6. | **FIRSTATT** | **the patient is making a first attendance or follow-up attendance, and whether the consultation was face-to-face or via telephone/telemedicine consultation** | **Numerical, categorical** | **-** |
| 7. | **OUTCOME** | **the outcome of an outpatient attendance** | **String** | **-** |
| 8. | **WAITING** | **the period of days between the date of the appointment date and either the referral request received date (reqdate) or the DNA (did not attend) date** | **Numerical, continuous** | **-** |

| AT4.3: LIST OF 1CD 10 CODES FOR BURNS OUTCOMES IN HES APC DATASET | | |
|---|---|---|
| S/NO | **VARIABLE CODES** | **FIELD NAME** |
| | **M61.3** | **Classification and ossification of muscles associated with burns** |
| | **T21** | **Burns and corrosion of the trunk** |
| | **T20** | **Burns and corrosion of the head and neck** |
| | **T22** | **Burns and corrosion of the shoulder, upper limb except for wrist and hand** |
| | **T24** | **Burns and corrosion of the hip, lower limb except for ankle and foot.** |
| | **T30** | **Burns and corrosion of the body region unspecified** |
| | **T23** | **Burns of unspecified degree of wrist and hand** |
| | **T25** | **Burns of unspecified degree of ankle and foot** |
| | **T29** | **Burns and corrosion of the multiple body regions.** |
| | **T31** | **Burns classified according to the extent of body surface involved** |
| | **L55** | **Sunburns** |
| | **T95** | **Sequelae of burn, corrosion and frostbite** |

The above table (AT4.3) was to set up a query that the interest of the project was in anyone below 18 years with burn admissions as diagnoses recorded from the year 2009/2010 to 2014/2015.

With the hopes of being able to secure possible causes for the occurrence of burn injuries from the HES APC dataset, two separate tables filled with codes to determine A) accidental and undetermined intent (Table AT4.4) B) intentional burns (Table AT4.5) were equally submitted to the HES team, University of Bristol. This action was done to "flag up" cases that had recorded any causes from Table AT4.4 and Table AT4.5 during data query and extraction.

Below are Tables AT4.4 and AT4.5:

| AT4.4: LIST OF 1CD 10 CODES FOR "ACCIDENTAL OR UNDETERMINED BURN INTENT EXPOSURES" AND OTHER VARIABLES OF INTEREST IN HES APC DATASET FROM 2009/10 TO 2014/15 | | |
|---|---|---|
| S/NO | **VARIABLE CODES** | **FIELD NAME** |
| | **X00-X06, X08-X09, X33,** | **exposures to smoke, fire and flames** |
| | **X10-X14** | **exposures to hot foods, liquid, gases, air, steam, water** |
| | **X15-X19** | **Exposure/contact with hot surfaces** |
| | **F90 to F98** | **ADHD, conduct disorders and other behavioural or developmental disorders.** |
| | **Y25-Y27** | **The undetermined intent with explosive material, smoke, fire, flames, hot vapours** |
| | **X32** | **Exposure to Sunburns** |
| | **X33** | **Exposure/victim to lightning** |

| AT4.5: LIST OF 1CD 10 CODES FOR "EXPOSURES TO INTENTIONAL BURNS" IN HES APC DATASET FROM 2009/10 TO 2014/15 | | |
|---|---|---|
| S/NO | **VARIABLE CODES** | **FIELD NAME** |
| | **X75-77** | **Intentional self-harm with explosive material, smoke, fire, flames, hot vapours** |
| | **X96-98** | **assault by explosive materials, smoke, fire, hot vapours** |
| | **Y36.3** | **war operations involving fires (burns listed in the description)** |
| | **F63.1** | **Pathological fire-setting [pyromania]** |
| | **Y36.1** | **War operations involving the destruction of aircraft: burned, exploded, shot down** |
| | **F90 to F98** | **ADHD, conduct disorders and other behavioural or developmental disorders.** |

At the end of the data query and extraction process, the HES team at the University of Bristol were able to deliver a sub-dataset with requested codes from Appendix Table (AT) 4.1, 4.3, 4.4 and 4.5 for inpatient data analysis. A second dataset with requested codes from Appendix Table (AT) 4.1,4.2, 4.4 and 4.5 for outpatient data analysis. Both datasets had data from the financial years 2009/2010 to 2014/2015. However, as envisaged by the data extraction, research and supervisory team concerning secondary interests for this thesis, the outpatient numbers were not enough nor had complete information for a proper analysis of the inpatient data.

Regarding plans to compare accidental and undetermined intent to intentional burns, this idea was also dropped because the numbers of the latter were minute compared to the former. Also, there is the ongoing debate of classing intentionality of burn injuries when a patient (in this case, a child) presents to the hospital for examination. Thus, it was agreed with a supervisory team that no such comparison would be made. Thus, the focus of analysis shifted to the extracted HES inpatient dataset only with information from 2009/2010 to 2014/2015.

To make comparisons of extracted HES data with the general population, the 2011 Census data for England was examined. The data regarding age, sex, ethnicity, rural/urban divide and regions in England was extracted from the 2011 Census datasets. These data are available from the Office of National Statistics (ONS) website http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/guide-method/census/2011/census-data/2011-census-data-catalogue/population-and-household-estimates/index.html and the NOMIS website, an official labour market statistics online database ran by the University of Durham in conjunction with the ONS. https://www.nomisweb.co.uk/query/construct/submit.asp?forward=yes&menuopt=201&subcomp

# AS 4.3 DATA CLEANING

On inspection of the extracted HES inpatient dataset of interest, the total number of individuals was given as 98, 557. However, this number shows individuals that had **any** of the codes listed in Table 3, 4 and five above. The data was however flagged during extraction to ascertain how many of these individuals had any of the codes from the previously listed tables. If they had any codes/variables from table 3 (i.e. the burn diagnosis table), they were listed under a flagged variable titled “table3_flag”. If any case had any of the codes from table 4.4, they were listed under a flagged variable titled “table4_flag”. This format was also applied if they had any of the codes/variables from Table 5. However, as the main interest of this thesis was how many people had burn injury as diagnosis or as a reason for admission, the focus was on any case that was recorded as having a yes (or 1) within the variable “table3_flag”. A simple tabulate command to reveal this was applied to the HES inpatient dataset extract opened in STATA 14 as shown below in Table A4.6:

Tab table3_flag

| table3_flag | Frequency | Per cent | Cumulative Freq |
|---|---|---|---|
| **0** | **58,385** | **59.24** | **59.24** |
| **1** | **40,172** | **40.76** | **100.00** |
| **Total** | **98,557** | **100** | |

This simple table shows us those children within our dataset with any burn diagnoses codes are 40,172 in number. With this information, a new subset data was created titled “BURN OUTCOMES ONLY TAB 3 CODES” in which cases where dropped if they had table3_flag=0. i.e. they did not have a burn diagnosis.

The next step involved understanding the distribution of the burn diagnoses within the data set via the diagnoses codes variable (DIAG_NN). As stated above, there are primary and secondary codes for diagnoses in the HES dataset; as such, it became necessary to know the numbers of primary burn admissions from secondary burn admissions. This action was achieved by carrying working with the variable “DIAG_01” that contains all the diagnoses codes for primary admissions. The codes within the DIAG_01 had some errors with the codes; either an extra character or a character was in the wrong place as defined by the ICD-10 coding system. This was shown by using the STATA command below:

icd10 check diag_01, generate(prob)
(cause contains x missing values)

Where “prob” stands for problems and list the number of issues that are wrong with the ICD 10 codes in the below manner:

cause contains undefined codes:

1. Invalid placement of period x

2. Too many periods x

3. Code too short x

4. Code too long x

5. Invalid first char (not A-Z) x

6. Invalid 2nd char (not 0-9) x

7. Invalid 3rd char (not 0-9) x

8. Invalid 4th char (not 0-9) x

99. Code not defined x

Total x

Presenting issues were resolved by creating a new variable **“primarydiag”**. Below is a list of commands used to do so via STATA 14:

gen str3 primarydiag = substr(diag_01,1,3)
tab primarydiag

This command helps create clean ICD-10 diagnosis codes using the first three characters, e.g. T21. This command makes the codes easy to use and analyse the diagnoses in the dataset.

The next step involved creating a variable called **“primaryburnoutcome”** in which one could separate primary from secondary burn diagnoses. Below is a list of commands used to do so via STATA 14:

icd10 generate primaryburnoutcome=primarydiag, range(L55 M61.3 T20/T26 T29/T31)

tab primaryburnoutcome

| COUNTS OF PRIMARYDIAG WITH BURN OUTCOME CODES OF INTEREST | Frequency | Per cent | Cumulative Freq |
|---|---|---|---|
| **0** | **3,501** | **8.72** | **8.72** |
| **1** | **36,671** | **91.28** | **100.00** |
| **Total** | **40,172** | **100** | |

Table A7: Table showing the number of primary and secondary burn diagnoses from a variable: “primaryburnoutcome.”

This command shows us there are 36,671 children with a primary burn admission (labelled as one above in the table above while 0 is the label for secondary burn admissions). The **“primarydiag”** codes in parentheses in the above command are a range of the burn diagnoses of interest as highlighted in Table 3, i.e. **“table3_flag”** above. With the number of primary burn admissions established, it was decided that another data subset is created called “PRIMARY BURN OUTCOMES ONLY” that had only cases where **“primaryburnoutcome=1,”** i.e. with counts of primary burn admissions. The choice to focus on only primary burn admissions as our outcome of interest is because they are the valid and primary reason for which a child was admitted for burns.

Below are the variables that were “cleaned” using processes described above:

Categorised financial years of admission:

There was no variable originally coded within the HES inpatient dataset to address this issue. Thus, one had to create this from the variable **“admdate”** which is labelled “date of admission” within the HES dataset. The date of admission was retrieved from hospital records as the day a child was admitted to the ward. However, **“admdate”** or **“iadmdate”** as it was in our dataset was a complex string variable that presented the dates of admission in the DD/MM/YYYY format. Thus, the first step was to extract the month and year, i.e. MM/YYYY and form a new variable “admfinancialyr” using the STATA14 substr command as shown below:

```
gen str7 admfinancialyr = substr(ïadmidate,1,7)
```

The next step was to change the new format from a string variable to a numerical variable. However, the “destring” command in STATA did not work the hyphen character was still present. Thus, the best option was the “encode” command which does the same thing but with complex strings. This is shown below using the STATA command:

```
encode admfinancialyr, gen(numadmfinyr)
```

This will involve generating a numerical admission financial year “numadmfinyr” and automatically assigned a numerical value ranging from 1 to 72 representing each month of the six financial years collected with 1 representing “April 2009” to 72 representing “March 2015”. As there are too many months, it was decided to categorise this into six broad categories that will cover each financial year. The STATA commands below generate a new variable “catfinadmyr”:

```
generate catfinadmyr=12 if numadmfinyr>=1 & numadmfinyr<=12
replace catfinadmyr=24 if numadmfinyr>=13 & numadmfinyr<=24
replace catfinadmyr=36 if numadmfinyr>=25 & numadmfinyr<=36
replace catfinadmyr=48 if numadmfinyr>=37 & numadmfinyr<=48
replace catfinadmyr=60 if numadmfinyr>=49 & numadmfinyr<=60
replace catfinadmyr=72 if numadmfinyr>=61 & numadmfinyr<=72
tab catfinadmyr
```

Next step was to label our variable and define what each category meant. This action is shown below using the following STATA commands:

```
label variable catfinadmyr "CATEGORISED FINANCIAL ADMISSION YEAR."
label define catfinadmyr 12 "APRIL 2009/MARCH 2010", modify
label define catfinadmyr 24 "APRIL 2010/MARCH 2011", modify
label define catfinadmyr 36 "APRIL 2011/MARCH 2012", modify
label define catfinadmyr 48 "APRIL 2012/MARCH 2013", modify
label define catfinadmyr 60 "APRIL 2013/MARCH 2014", modify
label define catfinadmyr 72 "APRIL 2014/MARCH 2015", modify
```

To make the label names reflect on every STATA output for categorised financial years of admission, the following STATA commands where carried out:

```
label define catfinadmyr1 12 "APRIL 2009/MARCH 2010" 24 "APRIL 2010/MARCH 2011"
label define catfinadmyr1 36 "APRIL 2011/MARCH 2012" 48 "APRIL 2012/MARCH 2013"
label define catfinadmyr1 60 "APRIL 2013/MARCH 2014" 72 "APRIL 2014/MARCH 2015"
label values catfinadmyr catfinadmyr1
tab catfinadmyr
```

Thus, from this point onwards, any questions that may involve associations with the financial year of admissions will utilise the variable **"catfinadmyr".**

Government Office's region of Residence:

This variable can assist in giving insights on geographic patterns based on the region a child's official address at the time of injury is located. This data is recorded in HES via the variable **"resgor"**. This variable in HES was extracted from the primary address of the child admitted and by using UK Region of Residence classification, which region their town/city is based.

As **"resgor"** is a string recorded variable, i.e. in alphabets or words, STATA cannot read or carry out basic summary analyses until it has been made numerical. The following STATA commands below solve this problem associated with this variable:

The first step undertaken here was to label the variable "resgor" with a clear definition as shown below:

```
label variable resgor "GOVERNMENT OFFICE REGION OF RESIDENCE."
```

Like with financial admission years, the STATA "destring" command does not work. Thus, we use the "encode" command to transform into a digital version for analyses as shown below:

```
encode resgor, gen(numresgor)
```

The digital version of government office region of residence “numresgor” is then assigned value labels in STATA as shown below:

```
label define numresgor 1 "North East", modify
label define numresgor 2 "North West", modify
label define numresgor 3 "Yorkshire and Humber", modify
label define numresgor 4 "East Midlands", modify
label define numresgor 5 "West Midlands", modify
label define numresgor 6 "East of England", modify
label define numresgor 7 "London", modify
label define numresgor 8 "South East", modify
label define numresgor 9 "South West", modify
label define numresgor 10 "Scotland", modify
label define numresgor 11 "No fixed abode", modify
label define numresgor 12 "Wales", modify
label define numresgor 13 "Foreign (including Isle of Man and the Channel Islands)", modify
label define numresgor 14 "Unknown", modify
label define numresgor 15 "Northern Ireland", modify
```

STATA can then be used to reflect the label names, so these are shown henceforth for every output related to this variable:

```
label define numresgor1 1 "North East" 2 "North West" 3 "Yorkshire and Humber."
label define numresgor1 4 "East Midlands" 5 "West Midlands" 6 "East of England."
label define numresgor1 7 "London" 8 "South East" 9 "South West", add
label define numresgor1 10 "Scotland" 11 "No fixed abode" 12 "Wales", add
label define numresgor1 13 "Foreign (including Isle of Man and the Channel Islands)"
label define numresgor1 14 "Unknown" 15 "Northern Ireland", add
label values numresgor numresgor1
tab numresgor
```

Although we have numbers for those classed as unknown and no fixed abode, these have to be re-coded to missing as we cannot do much with this information. The below STATA 14 commands help fix this:

```
replace numresgor =. if numresgor==14
replace numresgor =. if numresgor==11
```

Henceforth, analyses involving a region of residence will rely on the created variable "numresgor."

Age

Age is complete in all cases. However, as the date of birth is sensitive data, this was not retrieved for the HES inpatient extract in this thesis. Age was however coded as **"endage"** which is "age of the child at the end of admission". Age was raised by a new variable called "endagecat" which was derived from the HES variable "endage". Age at start and end of admission was extracted from hospital records documenting this information when the child was admitted to the ward. However, this variable is scalar, i.e. recorded as a continuous variable and ages of children lesser than one year was recorded using complex numerical codes in STATA that messed with any analyses involving age. Thus, the following STATA syntaxes where employed in resolving the issues with this variable.

The first step is to recode children below age 1 years into meaningful values (i.e. converting age format to years by dividing by 365 days) that will help analyses. This was carried out via the STATA command below:

7001= under 1 day= 0.003
7002 = 1 to 6 days= 0.02
7003 = 7 to 28 days= 0.08
7004 = 29 to 90 days (under 3 months)= 0.25
7005 = 91 to 181 days (approximately 3 months to under 6 months)= 0.49
7006 = 182 to 272 days (approximately 6 months to under 9 months)= 0.57
7007 = 273 to 365 days (approximately 9 months to under 1 year)= 0.90

```
recode endage 7001=0.003 7002=0.02 7003=0.08 7004=0.25 7005=0.49 7006=0.57
```

```
7007=0.90, gen(new_endage)
tab new_endage
```

A new variable (new_endage) was generated which reflected the changes. However, categorization was needed to reduce the age ranges:

```
generate byte endagecat=4 if new_endage<=4
replace endagecat=9 if new_endage>4 & new_endage<=9
replace endagecat=16 if new_endage>9 & new_endage<=17
```

The new categorized age variable “endagecat” had label variables and values defined using the STATA syntax below:

```
label variable endagecat "CATEGORISED AGE AT END OF ADMISSION"
label define endagecat 4 "0 TO 4 YEARS", modify
label define endagecat 9 "5 TO 9 YEARS", modify
label define endagecat 15 "10 YEARS TO 15 YEARS", modify
```

STATA was used to modify the variable so that label names are reflected during analyses involving categorized age as shown below:

```
label define endagecat1 4 "0 TO 4 YEARS"
label define endagecat1 9 "5 TO 9 YEARS"
label define endagecat1 15 "10 YEARS to 15 YEARS"
label values endagecat endagecat1
tabulate endagecat
```

Hence, the newly generated “endagecat” is the preferred variable to use when carrying out analyses with age in this HES data extract.

Ethnicity:

This factor was coded as the variable **“ethnos”** within the HES inpatient dataset. However, like “resgor” above, it was coded as a string variable needing to be encoded into a numerical variable amidst other issues. Below is a description of the STATA syntaxes used to tidy up this variable:

The first step involved encoding that changed the variable from string to numerical. This involved the generation of a new variable named “ethnosnum” as shown below:

```
encode ethnos, gen(ethnosnum)
summ ethnosnum
tab ethnosnum
```

The **"summ"** command helps confirm if the change to numerical has occurred as it does not work for string variables. Thus, if we get an output summarising the information from a particular variable, it is successful.

The next step will involve defining the variable and value labels as shown with the STATA syntax below:

```
label variable ethnosum "NUMERICAL VALUES FOR ETHNICITY."
label define ethnosnum 1 "Not known also", modify
label define ethnosnum 2 "White British", modify
label define ethnosnum 3 "White Irish", modify
label define ethnosnum 4 "Any Other White background", modify
label define ethnosnum 5 "White and Black Caribbean (Mixed)", modify
label define ethnosnum 6 "White and Black African (Mixed)", modify
label define ethnosnum 7 "White and Asian (Mixed)", modify
label define ethnosnum 8 "Any other Mixed background", modify
label define ethnosnum 9 "Indian (Asian or Asian British)", modify
label define ethnosnum 10 "Pakistani (Asian or Asian British)", modify
label define ethnosnum 11 "Bangladeshi (Asian or Asian British)", modify
label define ethnosnum 12 "Any other Asian background", modify
label define ethnosnum 13 "Caribbean (Black or Black British)", modify
label define ethnosnum 14 "African (Black or Black British)", modify
label define ethnosnum 15 "Any other Black background", modify
label define ethnosnum 16 "Chinese (another ethnic group)", modify
label define ethnosnum 17 "Any other ethnic group", modify
label define ethnosnum 18 "Not known", modify
label define ethnosnum 19 "Not stated", modify
tab ethnosnum
```

As there are too many ethnic groups, two separate variables were created to describe ethnicity in two broad categories (**ethnic2grp**) and into five categories to reflect the UK Census classification (**ethnic5grp**) respectively. This is presented below as:

ETHNIC2GRP= WHITE MAJORITY AND NON-WHITE ETHNIC MINORITY GROUPS
generate ethnic2grp=4 if ethnosnum>1 & ethnosnum<=4
replace ethnic2grp=17 if ethnosnum>4 & ethnosnum<=17

Those with no stated or not known recorded were re-coded as missing as one can't use the numbers for such groups to obtain important information:

replace ethnic2grp=. if ethnosnum>18 & ethnosnum<=.

The variable "**ethnic2grp"** was then given a label with defined values as shown below:

label variable ethnic2grp "WHITE AND NON-WHITE GROUP."
label define ethnic2grp 4 "WHITES", modify
label define ethnic2grp 17 "NON-WHITES", modify

STATA can be used to configure this variable, so we see the value labels whenever outputs related to this variable is produced:

label define ethnic2grp1 4 "WHITE" 17 "NON-WHITE."
label values ethnic2grp ethnic2grp1
tab ethnic2grp

The same set of commands are repeated but slightly tweaked when creating the "**ethnic5grp"** variable which will present five separate ethnic categories based on the UK census classification system. See STATA syntax below:

ETHNIC5GRP FOR WHITE, BLACK, ASIAN, MIXED, OTHERS
generate ethnic5grp=4 if ethnosnum>1 & ethnosnum<=4
replace ethnic5grp=8 if ethnosnum>4 & ethnosnum<=8
replace ethnic5grp=12 if ethnosnum>8 & ethnosnum<=12
replace ethnic5grp=15 if ethnosnum>12 & ethnosnum<=15
replace ethnic5grp=12 if ethnosnum==16
replace ethnic5grp=17 if ethnosnum==17

The next step for the "**ethnic5grp"** variable is labelling the variable and defining value labels:

```
label variable ethnic5grp "CENSUS CATEGORIES: WHITE, BLACK, ASIAN, MIXED, OTHERS."
label define ethnic5grp 4 "WHITE", modify
label define ethnic5grp 8 "MIXED", modify
label define ethnic5grp 12 "ASIAN OR ASIAN BRITISH", modify
label define ethnic5grp 15 "BLACK OR BLACK BRITISH", modify
label define ethnic5grp 17 "OTHER ETHNIC", modify
```

As with previous variables, STATA can be used to modify it, so label names are shown during analyses:

```
label define ethnic5grp1 4 "WHITE" 8 "MIXED" 12 "ASIAN OR ASIAN BRITISH"
///
15 "BLACK OR BLACK BRITISH" 17 "OTHER ETHNIC"
label values ethnic5grp ethnic5grp1
tab ethnic5grp
```

Henceforth, based on our interest in investigating ethnicity, once can use either "**ethnic2grp"** or "**ethnic5grp."**

Sex

This factor had an eponymous variable titled **"sex"** within HES inpatient data. Fortunately, it did not require much attention as variables above except dealing with the "not specified" category and label defining. See the following STATA syntax:

First, the value labels for sex are defined as follows:

```
label define sex 0 "not known" 1 "male" 2 "female" 9 "not specified"
```

STATA can modify the variable, so its value labels are reflected in analyses as shown below:

```
label define sex1 0 "not known" 1 "male" 2 "female" 9 "not specified"
label values sex sex1
label list sex
```

The “not specified” category within the variable is re-coded to missing:

```
replace sex=. if sex==0
tab sex
```

Index of Multiple Deprivation:

This factor was recorded in HES inpatient data as several variables, but the one which gives the complete information required is called **“imd10_decile”.** Below are the STATA syntaxes used to resolve the issues with this variable.

The first step is to encode the variable, so we develop a digital version from its original version here which is a string variable:

```
encode imd04_decile, gen(imd04decilenums)
summ imd04decilenums
tab imd04decilenums
```

The next step is to create two separate variables which will recode the deciles into halves (**imdhalves**) and quintiles (**imdquintiles**) respectively. The commands are as follows:

FOR IMDHALVES

```
generate imdhalves=1 if imd04decilenums>=1 & imd04decilenums<=5
replace imdhalves=2 if imd04decilenums>5 & imd04decilenums<=10
```

For a definition of the **imdhalves** variable and value labels, one uses:

```
label variable imdhalves "LEAST AND MOST DEPRIVED IMD HALVES."
label define imdhalves 1 "LEAST DEPRIVED HALF", modify
label define imdhalves 2 "MOST DEPRIVED HALF", modify
```

Next, STATA modifies the variable, so label names are shown during tabulation/analyses:

```
label define imdhalves1 1 "LEAST DEPRIVED HALF" 2 "MOST DEPRIVED HALF."
label values imdhalves imdhalves1
tab imdhalves
```

FOR QUINTILES

```
generate imdquintiles=1 if imd04decilenums>=1 & imd04decilenums<=2
replace imdquintiles=2 if imd04decilenums>=3 & imd04decilenums<=4
replace imdquintiles=3 if imd04decilenums>=5 & imd04decilenums<=6
replace imdquintiles=4 if imd04decilenums>=7 & imd04decilenums<=8
replace imdquintiles=5 if imd04decilenums>=9 & imd04decilenums<=10
```

For a definition of the **imdquintiles** variable and value labels, one uses:

```
label variable imdquintiles "LEAST AND MOST DEPRIVED IMD QUINTILES."
label define imdquintile 1 "1ST QUINTILE-LESS DEPRIVED", modify
label define imdquintile 2 "2ND QUINTILE-LESS DEPRIVED", modify
label define imdquintile 3 "3RD QUINTILE-MORE DEPRIVED", modify
label define imdquintile 4 "4TH QUINTILE-MOST DEPRIVED", modify
label define imdquintile 5 "5TH QUINTILE-MOST DEPRIVED", modify
```

Next, STATA modifies the variable, so label names are shown during tabulation/analyses:

```
label define imdquintiles1 1 "1ST QUINTILE-LESS DEPRIVED" 2 "2ND QUINTILE-LESS DEPRIVED" 3 "3RD QUINTILE-MORE DEPRIVED" 4 "4TH QUINTILE-MOST DEPRIVED" 5 "5TH QUINTILE-MOST DEPRIVED"
label values imdquintiles imdquintiles1
tab imdquintiles
```

Rural/Urban Divide

This factor is described in this HES inpatients dataset via the variable **“rururb_ind”.** This variable has about eight different outcomes describing urban and rural locations as well as a brief idea of the population density for each. However, as these seem to be a lot for classifying this divide, it was decided that a new dichotomous variable reflecting rural and urban divide be created. This new variable is called **“urbrural”.** Below is a description of the STATA syntax used to correct the original version and create this new variable:

The new variable was a division of urban (all urban categories) and rural (a merger of town, fringe, village, hamlet and isolated dwelling categories)

```
generate urbrural=1 if rururb_ind==1
replace urbrural=1 if rururb_ind==5
replace urbrural=2 if rururb_ind>=2 & rururb_ind<=4
replace urbrural=2 if rururb_ind>=6 & rururb_ind<=8
```

The new variable was defined as well as its value labels:

```
label variable urbrural "STAYING IN URBAN AND RURAL AREA."
label define urbrural 1 "URBAN DWELLER", modify
label define urbrural 2 "RURAL DWELLER", modify
```

STATA was used to modify it, so label names are shown during tabulation/analyses:

```
label define urbrural1 1 "URBAN DWELLER" 2 "RURAL DWELLER."
label values urbrural urbrural1
tab urbrural
```

Thus, for any analyses involving the rural/urban divide, the new variable **"urbrural"** will be used.

Below is a table showing a list of variables that were derived from the HES variables for analysis of the dataset for this thesis

| TABLE AT8: LIST OF VARIABLES DERIVED FROM ORIGINAL HES VARIABLES FOR THE PURPOSE OF ANALYSIS | | | | |
|---|---|---|---|---|
| **S/NO** | VARIABLE CODES | FIELD NAME | VARIABLE TYPE | CLEANED |
| **1.** | PRIMARYDIAG | A corrected version of the HES variable diag_01 (represents the primary diagnosis of the patient) | String | Y |
| **2.** | PRIMARYBURNOUTCOME | Derived from “PRIMARYDIAG”-counts of primarydiag with burn outcome codes of interest as the primary diagnosis | Binary, numerical | Y |
| **3.** | ETHNOSNUM | Derived from “ETHNOS”-numerical values for ethnicity | Numerical, discrete | Y |
| **4.** | ETHNIC2GRP | Derived from “ETHNOSNUM”-white and non-white group (splits participants into white majority and other ethnic groups combined) | Binary, numerical | Y |
| **5.** | ETHNIC5GRP | Derived from “ETHNOSNUM- Census Categories: White, Black, Asian, Mixed, Others (Based on 2011 Census categories) | Binary, discrete | Y |
| **6.** | FIRESMOKEFLAME | Derived from HES variable “CAUSE3”- Counts of accidental burns with exposures related to fire, smoke and flame | Binary, numerical | Y |
| **7.** | SCALDS | Derived from HES variable “CAUSE3”-Counts of accidental burns with exposures related to scalding | Binary, numerical | Y |
| **8.** | GASAIR | Derived from HES variable “CAUSE3”-Counts of accidental burns with exposures related to hot gases and or air | Binary, numerical | Y |
| **9.** | CONTACTS | Derived from HES variable “CAUSE3”-Counts of accidental burns with exposures related to hot objects, surfaces | Binary, numerical | Y |
| **10.** | UNDETEREXP | Derived from HES variable “CAUSE3”- Counts of accidental burns with exposures with undetermined intent | Binary, numerical | Y |
| **11.** | SUNBURN | Derived from HES variable “CAUSE3”- Counts of accidental burns with exposures to sunlight | Binary, numerical | Y |
| **12.** | LIGHTENING | Derived from HES variable “CAUSE3”- Counts of accidental burns with exposures to lightning | Binary, numerical | Y |
| **13.** | INTBURN | Derived from HES variable “CAUSE3”- Counts of burns with exposures to the intentional intent | Binary, numerical | Y |
| **14.** | ASSAULT | Derived from HES variable “CAUSE3”- Counts of burns with exposures to assault | Binary, numerical | Y |

| | | | | |
|---|---|---|---|---|
| **15.** | WARFIREBURN | Derived from HES variable “CAUSE3”- Counts burns with exposures to war fires, ammunition. | Binary, numerical | Y |
| **16.** | WARAEROBURN | Derived from HES variable “CAUSE3”- Counts burns with exposures to warplanes. | Binary, numerical | Y |
| **17.** | IMD04DECILENUMS | Derived from “IMD04DECILE”-numerical values for IMD deciles | Numerical, discrete | Y |
| **18.** | IMDHALVES | Derived from“IMD04DECILENUMS”- least and most deprived IMD halves | Binary, numerical | Y |
| **19.** | IMDQUINTILES | Derived from“IMD04DECILENUMS”- least and most deprived IMD quintiles | Categorical, numerical | Y |
| **20.** | URBRURAL | Derived from “RURURB_IND”- staying in the urban and rural area | Binary, numerical | Y |
| **21.** | ADMFINANCIALYR | Derived from “ADMIDATE”- admission date within a financial month and year format | String | Y |
| **22.** | NUMADMFINYR | Derived from “ADMFINANCIALYR”-Numerical version of admission date by financial month and year | Numerical, discrete | Y |
| **23.** | CATFINADMYR | Derived from “NUMADMFINYR”- categorised financial admission year | Numerical, categorical | Y |
| **24.** | NEW_ENDAGE | Derived from “ENDAGE”- re-coded version of age groups especially those below one year old | Numerical, continuous | Y |
| **25.** | ENDAGECAT | Derived from “NEW_ENDAGE”- the categorised age at the end of the admission | Numerical, categorical | Y |
| **26.** | NUMRESGOR | Derived from “RESGOR”- Numerical version of Government Office Region Of Residence | Numerical, discrete | Y |

# AS 4.4 FURTHER DETAILS OF DESCRIPTIVE ANALYSES AND CLEANING OF VARIABLES OF INTEREST

Ethnicity

The variable **"ethnos"** in HES was derived from patient records denoting the ethnicity of the patient's family most identify with based on the 2001 UK Census classification. The variable **"ethnos"** was then re-coded from its string format into as a numerical variable **"ethnosnum".** Below is a table (Table AT9) showing the distribution of the 30,956 cases (with complete ethnic information) primarily admitted for burns:

| ETHNICITY | HES SAMPLE | HES PROP. | 95% C.I |
|---|---|---|---|
| White British | **19,786** | **0.55** | **0.55-0.56** |
| Pakistani (Asian or Asian British) | **2,123** | **0.06** | **0.06-0.06** |
| Any Other White background | **1,572** | **0.04** | **0.04-0.05** |
| African (Black or Black British) | **1,344** | **0.04** | **0.04-0.04** |
| Any other ethnic group | **1,242** | **0.03** | **0.03-0.04** |
| Any other Asian background | **1052** | **0.03** | **0.03-0.03** |
| Indian (Asian or Asian British) | **853** | **0.02** | **0.02-0.03** |
| Any other Mixed background | **602** | **0.02** | **0.02-0.02** |
| Any other Black background | **487** | **0.01** | **0.01-0.02** |
| White and Black Caribbean (Mixed) | **352** | **0.01** | **0.01-0.01** |
| Caribbean (Black or Black British) | **340** | **0.01** | **0.01-0.01** |
| Bangladeshi (Asian or Asian British) | **292** | **0.01** | **0.01-0.01** |
| White and Black African (Mixed) | **273** | **0.01** | **0.01-0.01** |
| Chinese (other ethnic group) | **270** | **0.01** | **0.01-0.01** |
| White and Asian (Mixed) | **252** | **0.01** | **0.01-0.01** |
| White Irish | **116** | **0.003** | **0.003-0.004** |
| TOTAL | **30,956** | | |
| KEY: PROP. = proportions, C.I= confidence interval, O.R= odds ratio, C.O.P= comparison of two proportions. | | | |

The categories are representing the **"Not known"** and **"Not stated"** were re-coded as missing leaving only complete information for 30,956 out of the 36,080 (85.8%). Thus, the number of children with missing ethnicity data was 5124 (14.2%).

However, since there are too many categories for ethnicity, two extra variables were created to reflect a merger of the ethnicities. The variable **"ethnic2grp"** was created to compare the white ethnic majority to all other ethnic minorities while the variable **"ethnic5grp"** was created to classify the ethnicities into the U.K Census broad categories namely: White, Mixed, Asian or Asian British, Black or Black British and Other Ethnic Groups.

Rural/Urban Divide

The 142 children with no information available were re-coded as missing, leaving the exact number of individuals with complete rural/urban divide information as 35,728 out of 36,080 **(99%).** Thus, the total number of those with missing information was 352 (1%)

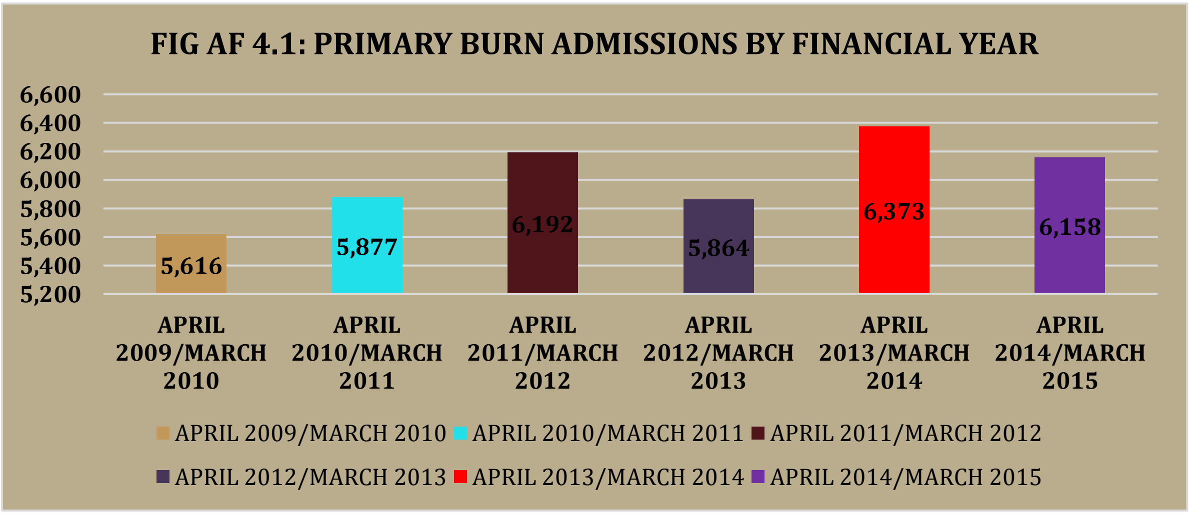
Below is the table (Table AT10) showing proportions for the variable **"rururb_ind"** as presented in STATA:

| RURAL/URBAN CATEGORIES IN HES DATA | HES SAMPLE | PROPORTION | 95% C.I |
|---|---|---|---|
| Urban =>10K - sparse | **63** | **0.002** | **0.002-0.002** |
| Town and Fringe (sparse) | **117** | **0.003** | **0.003-0.004** |
| Village (sparse) | **132** | **0.004** | **0.003-0.004** |
| Hamlet and Isolated dwelling (sparse) | **94** | **0.003** | **0.002-0.003** |
| Urban =>10K - less sparse | **31,331** | **0.87** | **0.87-0.88** |
| Town and Fringe - less sparse | **1,978** | **0.06** | **0.05-0.06** |
| Village - less sparse. | **1,389** | **0.04** | **0.04-0.04** |
| Hamlet and Isolated Dwelling - less sparse | **624** | **0.02** | **0.02 -0.02** |
| Postcode outside England= No info available | **142** | **0.004** | **0.003-0.005** |
| TOTAL | **35,870** | | |

Admissions by Financial Year

This information was available for all 36,080 individuals primarily admitted for burns in the HES dataset. However, there is no variable directly defining this information. Thus, a new variable **“catfinadmyr”** with the label “categorised financial year of admissions” was derived from the original HES variable **“admidate”** which shows the date of admission of the patient in the dd/mm/yyyy format.

Below is a bar chart (Fig. AF 4.1) showing the number of primary burn admissions by financial years from 2009 to 2015:




Proportions for primary burn admissions by financial admission years as presented in STATA is shown in the table (AT11) below:

| ADMISSIONS BY FINANCIAL YEAR | HES PROPORTION | 95% C.I |
|---|---|---|
| April 2009/March 2010 | **0.16** | **0.15-0.16** |
| April 2010/March 2011 | **0.16** | **0.16-0.17** |
| April 2011/March 2012 | **0.17** | **0.17-0.18** |
| April 2012/March 2013 | **0.16** | **0 .16-0.17** |
| April 2013/March 2014 | **0.18** | **0.17-0.18** |
| April 2014/March 2015 | **0.17** | **0.17-0.17** |

Region of Residence

This variable in HES was designed to show the region of residence everyone resides in across the United Kingdom. The variable is titled **“resgor”** in HES and with the label “government office region of residence”. It was retrieved from the UK census classification of the government office region of residence a patient’s town or city of residence. However, as this variable has coded a string, it was re-coded into a new variable titled **“numresgor”** so one could obtain the data for each region in a numerical fashion. Of the 36,080 individuals, 35,977 children had complete information as regards the region of residence **(99.7%).** Thus, 103 (0.3%) children had missing data for the region of residence. There were 590 children permanently based outside England in Scotland, Wales, and Northern Ireland. It is likely these children were injured while visiting or on holiday in England. These numbers have been merged into a category called **“Outside England*”**. It is also worth mentioning that the proportions of children staying outside England will not be calculated from the general population of the 2011 Census as the data for admissions in HES is complete for only those in residing in England alone. Thus, they are not represented in the table of proportions.

# APPENDIX FOR CHAPTER 5

# AF 5.1 BASAT DATA QUESTIONNAIRE

# Children's Burns Research Centre: Burns & Scalds Assessment Tool

For **ALL** children **0-16th birthday**, presenting with a burn or scald injury, the **WHOLE** form **MUST** be completed ticking **ALL** answers which apply in **EACH** section.

| **Centre** | **ID no.** *(allocated by research team)* |
|---|---|
| Cardiff & Vale | |
| North Bristol Trust | |
| University Hospital Bristol | |

**Person completing this form:** ☐ Research Nurse ☐ Nurse ☐ SHO ☐ REG ☐ ENP ☐ CONS ☐ ANP

**Who is accompanying the child?** ☐ Mum ☐ Dad ☐ Grandparent ☐ Unaccompanied ☐ Other: ..........

**Assessment undertaken:** Date: ..../..../........ *(dd/mm/yyyy)* Time: ....:.... *(24 hrs)*

**Injury occurred:** Date: ..../..../........ *(dd/mm/yyyy)* Time: ....:.... *(24 hrs)*

**Details of child:** Gender: .......... *Age: .......... *(please record age in months if child ≤ 2 years)*

## Section 1: History of injury

### 1.1. Type of Injury

☐ Scald ☐ Sunburn
☐ Contact burn ☐ Flame
☐ Electrical
☐ Other: ..........

### 1.2. Location

☐ Home ☐ Café/restaurant
☐ School
☐ Other: ..........

### 1.3. Details of Incident

**Was anyone in the room/vicinity at the time?** ☐ Yes ☐ No

***If yes, who?***
☐ Parent ☐ Sibling
☐ Grandparent ☐ Peer
☐ Other: ..........

***If yes, did they see what happened?*** ☐ Yes ☐ No

***What is the explanation for the injury?***

..........

### 1.4. In which position was the child just before the incident?

☐ Running/walking ☐ Lying down
☐ Standing ☐ Being carried/held
☐ Sitting
☐ Other: ..........

### 1.5. Agent/Mechanism *(please complete all applicable)*

***Agent**
☐ Hot drink: .......... ☐ Oven hob ☐ Iron
☐ Hot food: .......... ☐ Oven door ☐ Radiator
☐ Hot water ☐ Hair tongs/straightener ☐ BBQ grill
☐ Fat/oil ☐ Sun
☐ Other: .......... ☐ N/K

**Source if scald**
☐ Mug/cup ☐ Bowl ☐ Tap
☐ Kettle ☐ Pan ☐ Bath
☐ Other: .......... ☐ N/K

**Location of hot item** ☐ Floor
☐ Kitchen surface ☐ Low table ☐ Oven
☐ On cooker hob ☐ Dining table ☐ Garden/outdoor
☐ Other: .......... ☐ N/K

**Mechanism** ☐ Immersion
☐ Touch ☐ Spill ☐ Child fell/ran into
☐ Pull down ☐ Splash ☐ Exposure to sun
☐ Other: .......... ☐ N/K

### 1.6. First aid *(including inappropriate first aid)*

**Was first aid given by parent/carer?** ☐ Yes ☐ No

***If yes, was it:***
☐ Cold water
☐ Other: ..........

***If cold water:***
***a) How was the water applied?***
☐ Tap/shower *(running water)* ☐ Put into water *(immersion)*
***b) How long was water applied for?*** .......... *(min)*

***Was the burn covered?*** ☐ Yes ☐ No
***If yes, what with:*** ..........

### Section 2: Details of child

**2.1. Is there any developmental impairment?**
*(please tick as many as apply)* ☐ N/A

| | | |
|---|---|---|
| ☐ Motor | ☐ Neurological | ☐ Hearing |
| ☐ Behavioural | ☐ Learning | ☐ Vision |
| ☐ Other: ........................ | | |

**2.2. Current 'best' stage of motor development**
*(please complete for **children <3 years**)* ☐ N/A

| | |
|---|---|
| ☐ Non-mobile baby | ☐ Crawling |
| ☐ Baby able to roll over | ☐ Cruising |
| ☐ Sitting | ☐ Walking |

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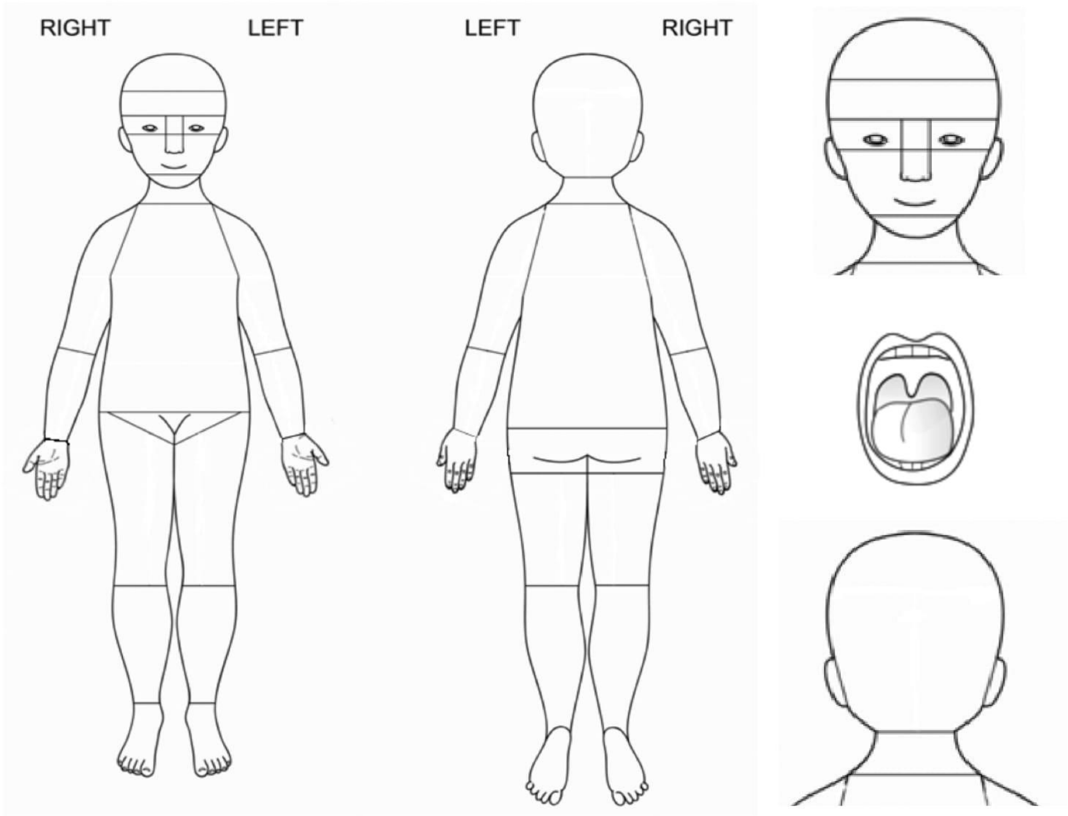
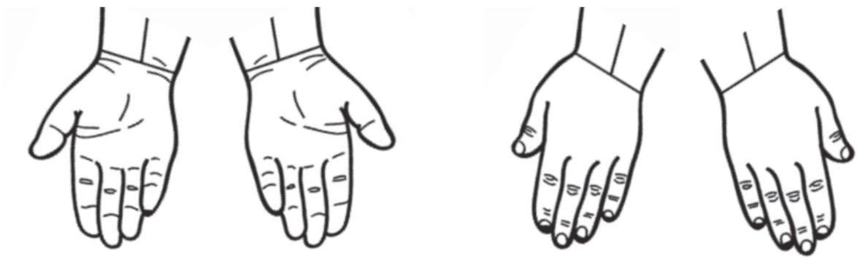
### Section 3: Characteristics of injury on examination

***3.1. Body map**

**Please shade the distribution of the burn:** ☐ N/A - no visible injury



***3.2. Pattern of injury** ☐ N/A

*(please tick as many as apply)*

- ☐ Symmetrical *(both sides of body)*
- ☐ Glove/stocking distribution *(circumferential)*
- ☐ Clearly defined margins
- ☐ Skin fold sparing
- ☐ Margin in the shape of an implement
- ☐ Multiple contact burns *(more than one)*

***3.3. Depth of injury** ☐ N/A

*(please tick as many as apply)*

- ☐ Erythema/redness
- ☐ Blisters, not burst
- ☐ Broken skin, wet, pink
- ☐ Broken skin, dry, white or charred

**3.4. TBSA** ☐ N/A

*(if TBSA>1% consider referral to Specialist Burns Unit, School Nurse, Health Visitor)*

***Percentage of body injured:***

☐ ≤1% ☐ 2-9% ☐ 10-14% ☐ ≥15%

**3.5. Any other injuries?**

☐ Yes ☐ No

***Details if yes:*** ......................................

**3.6. Was there any previous ED attendance for a burn injury?**

☐ Yes ☐ No

***Details if yes:*** ......................................

## Section 4: Screening, Referrals & Outcomes

*** 4.1. Social Services (SS) involvement**

**Does the child/family have a social worker (SW) now?**

☐ Yes ☐ No

**Did the child/family have a SW or any SS involvement in the past?**

☐ Yes ☐ No

**Is there any domestic violence in the home?**

☐ Yes ☐ No *(A proposed way to ask this question is **"Do you feel safe at home?"** – Only ask this question if you can talk to one of the parents independently.)*

***4.2. Do you have any concerns about…**

**Appropriate adult supervision?**

☐ Yes ☐ No

**Late presentation?**

☐ Yes ☐ No

***If yes, is there a valid reason for delay?***

*(previous GP/ED attendance, etc.)*

......................................

......................................

***4.3. If an explanation was given…**

**Was it consistent with the stage of development?**

☐ Yes ☐ No

**Did it fit with the burn pattern seen?**

☐ Yes ☐ No

**4.4. Referrals and outcomes** *(please tick as many as apply)*

***Was a Child Protection referral made?**

- ☐ None
- ☐ Social Services
- ☐ Hospital safeguarding team

**Were any other referrals made?**

- ☐ None
- ☐ School Nurse
- ☐ Health Visitor
- ☐ Other: ......................................

**Outcome**

- ☐ Discharged home
- ☐ GP/ Practice Nurse
- ☐ ED review
- ☐ Specialist burns unit
- ☐ Transfer to acute ward
- ☐ Other: ......................................

**Overall additional comments:**

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AT 5.1: TABLE SHOWING VARIABLES EXTRACTED AND USED FOR BASAT ANALYSES

| S/No | Variable of Interest | Name in Version 6 and (level of completeness, %) N=1,469 cases | Options for variable | Name in Version 5, similar coding to V6 and level of completeness (%) N=657 cases | Name in Version 3-4, similar coding to V5-6 and level of completeness (%) N=847 cases | Needs recoding before appending after a change of name? T=2973 |
|---|---|---|---|---|---|---|
| | IMD | Basat6_imd (80.64%) | 1-5 (1=LD, 5=MD) | Det_imd, not similar (free text) and 10.5% complete | N/A | Y |
| | Ethnicity | Basat6_ethnicity (81.01%) | 1-18 (1=White British, 18- Any Other) | Det_ethnicity, similar and 15.98% complete | N/A | N |
| | Ethnicity (Other) | Basat6_other ethnicity (0.61%) | Free text (if category not above) | N/A | N/A | N |
| | Date injury occurred | basat6_inj_date (98.3%) | text (date_dmy) | Basat5_inj_date, similar coding, 96.19% complete | basat_inj_date, similar coding, 99.88% complete | N |
| | Time injury occurred | basat6_inj_time (83.05%) | text (time) | Basat5_inj_time, similar coding, 73.7% complete | basat_inj_time, similar coding, 90.8% complete | N |
| | Gender | basat6_gender (98.84%) | 1= Male, 2= Female | Basat5_gender, similar coding, 99.39% complete | N/A | N |
| | Age at time of injury (years) | basat6_age_years (99.52%) | Text, Min=0, Max=15 years | Basat5_age_years, similar coding, 99.09% complete | basat_age_years, similar coding, 99.88% complete | N |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Age at time of injury (months) | basat6_age_months (98.9%) | Text, Min=0, Max=11 months | Basat5_age_months, similar coding but seems there's an error as it does this for all ages rather than under 1-year-olds? 99.09% complete | basat_age_months, similar coding but seems there's an error as it does this for all ages rather than under 1-year-olds? 99.8% complete | Y- Query, do we drop this variable? YES |
| | Type of Injury | basat6_inj_type (98.9%) | 1 Scald, 2 Sunburn, 3 Contact burn<br>4 Flame<br>5 Electrical<br>6 Other | Basat5_inj_type, similar coding but 0 is coded as missing in V5, 99.85% complete Need to recode 0 here as proper missing. DONE | basat_inj_type, different coding- 1: Scald 2: Flame 3: Electrical 4: Contact burn 5: Friction 6: Chemical 7: Radiation/Sunburn, 8: Other, 0: Missing. DONE 99.8% complete | Y- V3-4, DONE |
| | Type of Injury Details if other | basat6_inj_type_details (89.7%) | Free Text | basat5_inj_type_details, similar coding, 99.9% complete | basat_inj_type_details, similar coding, all complete | N |
| | Presence of another at time of injury | basat6_others_present (92.85%) | 1 Yes<br>2 No | Basat5_others_present, similar coding except 0 was tagged as missing here, 75.8% real complete Need to recode 0 or N/K as proper missing. DONE | basat_others_present, coding same as v5, 97.9% real complete Need to recode 0 or N/K as proper missing. DONE | Y, V3-4, DONE |
| | Who was present at injury? | basat6_others_who (all complete except for parents with 7.15% missing) | 1 Parent 2 Sibling, 3 Grandparent, 4 Peer<br>5 Other | Basat5_others_who, similar coding, (all complete except eight missing cases coded as 0). Need to recode 0 as proper missing. DONE | basat_others_who2, *different coding-need to match V5-6, 1, Parent 5-Grandparent, 4 Sibling 6-Other relation 3-Other adult, 2-Peer 0-Missing* all complete (save 2.1% missing)Need to recode 0 here as proper missing and merge other relation/adult. DONE | Y, V3-4, DONE |
| | Details of others present? | basat6_others_otheradult (complete, mostly made of relatives | Free text | Basat5_others_otheradult, same coding, all complete | basat_others_otheradult, same coding, all complete | N |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Others who were present did they witness it? | basat6_others_seen (73.66%) | 1 Yes<br>2 No | Basat5_others_seen, similar coding with 0 as missing, 58.3% complete. Need to recode 0 here as proper missing DONE. | basat_others_seen, same coding as V5, 76.4% true, complete Need to recode 0 here as proper missing. DONE | Y, V3-4, DONE |
| | Agent of injury | basat6_agent (97.35%) | 1 Hot drink<br>2 Hot food<br>3 Water<br>4 Fat/oil<br>5 Oven hob<br>6 Oven door<br>7 Hair tongs/straightener<br>8 Iron<br>9 Radiator<br>10 BBQ<br>11 Sun<br>12 Other<br>13 N/K<br>Need to recode N/K as proper missing. DONE | Basat5_agent, similar coding with 0 as missing, 98% complete. Need to recode 0 and N/Ks here as proper missing. DONE | basat_agent, different coding need to fuse some?<br>1: Tea, 2: Coffee, 3: Soup, 4: Hot food, 5: Water, 6: Steam, 7: Fat/oil, 8: Oven door, 9: Oven hob, 10: Iron, 11: Radiator, 12: Cigarette, 13: Hair straightener, 14: Hair tongs, 15: Sunburn, 16: Sunbed, 17: Fireworks, 19: Barbecue/grill, 20: Cooking utensil, 18: Other, 0: Missing. 99.4% complete. Need to recode all to match V5-6 and 0 here as proper missing. DONE | Y, V3-4, DONE |
| | Agent if other | basat6_agent_other (3 missing from some others) | Free text | Basat5_agent_other, same coding, all complete | basat_agent_other, same coding, all complete | N |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Source of the agent if scald | basat6_source (47.86%) | 1 Mug/cup<br>2 Bowl<br>3 Tap<br>4 Kettle<br>5 Pan<br>6 Bath<br>7 Other<br>8 N/K<br>9 Shower<br>Need to recode N/K as proper missing. DONE | Basat5_source, not precisely the same, 9=shower in V6, absent in V5, 46.42% complete. Need to recode 0 and N/Ks here as proper missing. DONE | basat_source, different coding, 1: Kettle, 2: Mug/cup, 3: Pan, 4: Bath, 5: Shower, 6: Tap, 8: Flask/bottle/container, 7: Other, 0: Missing. 47.9% correct complete- others may be non-scald burns? Need to recode all to match V5-6 and 0 here as proper missing. DONE | Y, V3-4, DONE |
| | Other Source of the agent if scald | basat6_source_other (98.5%) | Free text | Basat5_source_other, same coding, all complete | basat_source_other, same coding, 92.7% complete | N |
| | Mechanism of injury | basat6_mechanism (95.58%) | 1 Immersion<br>2 Touch<br>3 Spill<br>4 Fell/ran into<br>5 Pull down<br>6 Splash | basat5_mechanism, coding with 0 as missing, 95.9% "true" complete. Need to recode 0 and N/Ks here as proper missing. DONE | basat_mechanism2, *different coding need to fuse some?* 1, Pull down \| 2, Spill \| 3, Climbed into \| 4, Fell/run into \| 5, Touch \| 6, Splash \| 7, Explosion \| 8, Not known \| 9, Immersion \| 10, Caught fire \| 11, Inflicted \| 12, Stepped on \| 13, Other \| 0, Missing Need to recode all to match V5-6 and 0 here as proper missing. DONE | Y, V3-4, DONE |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 7 Exposure to sun<br>8 Other<br>9 N/K<br>Need to recode N/K as proper missing. DONE | | | |
| | Another mechanism of injury | basat6_mechanism_other (98%) | Free text | basat5_mechanism_other, same coding, all complete | basat_mechanism_other, same coding, all complete | N |
| | Did parent/carer give first aid? | basat6_firstaid_given (93.46%) | 1-Yes, 2-No | basat5_firstaid_given, coding with 0 as missing, 87.1% "true" complete. Need to recode 0 here as proper missing. DONE | basat_firstaid_given, coding with 0 as missing, 99% "true" complete. Need to recode 0 here as proper missing. DONE | Y, V3-4. DONE |
| | If FA was water, how was it applied? | basat6_firstaid_cold_water (N used cold water, 1042, 92.8% complete) | 1 Tap/shower (running water)<br>2 Put into water (immersion) | basat5_firstaid_cold_water, coding with 0 as missing, 53.1% "true" complete<br>Need to recode 0 here as proper missing. DONE | basat_firstaid_cold_water, *different coding need to fuse or drop "Others"?* 1: Immersion, 2: Under running tap, 3: Other, 0: Missing, 71.1% "true" complete. Need to recode 0 here as proper missing. DONE | Y, V3-4.<br>DONE |
| | Was burn covered? | basat6_inj_covered (78.45%) | 1 Yes<br>2 No | basat5_inj_covered, same but 0 coded as missing, 67% true complete. Need to recode 0 here as proper missing. DONE | basat_inj_covered, same but 0 coded as missing, 88.5% true complete. Need to recode 0 here as proper missing. DONE | Y, V3-4. DONE |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Covered with what? | basat6_inj_covered_with (mostly cling film and wet cloth, 96.1%) | Free text | basat5_ inj_covered_with, same coding, 98.1% complete (202 of 206 entries) | basat_inj_covered_with, same coding, 36% complete | N |
| | Is there any developmental impairment? | basat6_impaired (100% complete, 84.8% tick n/a?) | Tick if n/a | basat5_impaired___0, same coding, all complete | basat_impaired, same coding but 0 coded as missing, 98.3% complete, Need to recode 0 here as proper missing. DONE | Y, V3-4, DONE |
| | What kind of developmental impairment if yes? | basat6_impairment (100% complete) | 1 Motor<br>2 Neurological<br>3 Hearing<br>4 Behavioural<br>5 Learning<br>6 Vision<br>7 Other | basat5_impairment___x, same coding, 100% complete for each impairment but seems only 33/147 disclosed info (22.4% complete) | basat_impairment, *different coding need to recode* 1, Motor \| 2, Behavioural \| 3, Neurological \| 4, Learning \| 5, Hearing \| 6, Vision<br>100% complete, DONE | Y, V3-4, DONE |
| | Other impairment not above? | basat6_impairment_details (mostly speech, then behaviour, have several combined. 2 missing) | Free text | basat5_impairment_details, same coding, 100% complete, mostly behavioural issues | basat_impairment_details, same coding, 100% complete, mostly behavioural issues | N |
| | Current 'best' stage of motor development<br>(children aged < 3 only)<br>If no developmental | basat6_motor_stage (47.65% complete- likely others are older ages) | 1 Non-mobile baby<br>2 Rolling over<br>3 Sitting<br>4 Crawling<br>5 Cruising<br>6 Walking | basat5_motor_stage, same but 0 coded as missing, 29.5% complete- others likely older ages. Need to recode 0 here as proper missing. DONE | basat_motor_stage, same but 0 coded as missing, 92.8% complete-seems all ages were recorded? Need to recode 0 here as proper missing. DONE | Y, V3-4. DONE |

| | | | | | | |
|---|---|---|---|---|---|---|
| | impairment and aged >18m, assume walking unless otherwise stated | | | | | |
| | Depth of injury | basat6_injury_depth (100% complete) | 0 N/A<br>1Erythema/redness<br>2 Blisters, not burst<br>3 Wet, pink<br>4 Dry, white or Charred<br>Need to recode N/A as proper missing. DONE | Basat5_injury_depth, same coding but 9 is coded missing, 100% complete Need to recode nine here as proper missing. DONE | basat_injury_depth, *different coding* 1 Erythema (no blisters) 2 Partial thickness (Epidermis/Dermis, Blisters) 3 Full thickness (Epidermis/Dermis, Blisters)<br>100% complete. DONE | Y, V3-4 DONE |
| | TBSA (%) | basat6_injury_tbsa (86.6% complete) | One ≤1%<br>2 2 to 9%<br>3 10 to 14%<br>Four ≥15%<br>9 N/A<br>Need to recode N/A as proper missing. DONE | basat5_injury_tbsa, same but 0 coded as missing, 64.4% true complete Need to recode 0 here as proper missing. DONE | basat_injury_percent (different name), *different coding need to fuse* 1: <1%, 2: 1%, 3: 2-4% 4: 5-9% 5: 10-14%, 6: 15-20%, 7: >20% 0: Missing, 81.3% true complete, Need to recode 0 here as proper missing. DONE | Y, V3-4. DONE |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| | Does the child/family have a social worker (SW) now? | basat6_social_worker (86.4% complete) | 1 Yes<br>2 No | basat5_social_worker, same but 0 coded as missing, 54.5% true complete. Need to recode 0 here as proper missing. DONE | basat_social_worker, same but 0 coded as missing? 1: Yes, 2: No, 3: Don't know, 0: Missing. 96% true, complete Need to recode 0 and D/K here as proper missing. DONE | Y, V3-4<br>DONE |
| | Did the child/family have an SW or any SS involvement in the past? | basat6_social_worker<br>_past (84% complete) | 1 Yes<br>2 No | basat5_social_worker_past, same but 0 coded as missing, 50.5% true complete. Need to recode 0 here as proper missing. DONE | valq_ss_referral (different name- CHANGED to social_worker_past), same but 0 coded as missing and three as don't know, 15.8% true complete. Need to recode 0 and D/K here as proper missing. DONE | Y, V3-4. DONE |
| | Is there any domestic violence in the home? | basat6_domest_abuse (61.7% complete) | 1 Yes<br>2 No | basat5_domest_abuse, same but 0 coded as missing, 28.2% true complete. Need to recode 0 here as proper missing. DONE | basat_domest_abuse, same but 0 coded as missing and three as don't know, 73.3% true complete. Need to recode 0 and D/K here as proper missing. DONE | Y, V3-4. DONE |
| | Appropriate adult supervision? | basat6_adult_supervis<br>ion (85.16% complete) | 1 Yes<br>2 No | basat5_ adult_supervision, same but 0 coded as missing, 63.8% true complete. Need to recode 0 here as proper missing. DONE | basat_adult_supervision, same but 0 coded as missing, 97.5% true complete. Need to recode 0 here as proper missing. DONE | Y, V3-4. DONE |
| | The outcome of attendance? | basat6_outcome (all complete) | 1 Discharged home<br>2 GP/practice Nurse<br>3 ED review | basat5_outcome___x, same but there's NO 7-REF TO BURNS/PLASTIC, ALL complete. | basat_outcome, different coding need to recode, 1, Discharged home \| 2, Transfer to acute ward \| 3, HDU \| 4, ED review \| 5, Specialist burns unit \| 6, PICU \| 7, Another specialist \| 8, Another hospital. All complete. DONE | Y, V3-5, DONE |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 4 Specialist burns unit<br>5 Transfer to acute ward<br>6 Other<br>7 Referral to burns/plastics | | | |
| | Outcome details if other | basat6_outcome_details (98.2% complete) | Free text | basat5_outcome_details, same coding, all complete. Most community, burns/plastic clinic. Need to recode free text here to No 7 (as applicable)? | basat_outcome_details, same coding, all complete | N |

*NB: Those coded in yellow- not used

Is there any developmental impairment? (choice=N/A)

# AS 5.1 Descriptive analyses

IMD quintiles

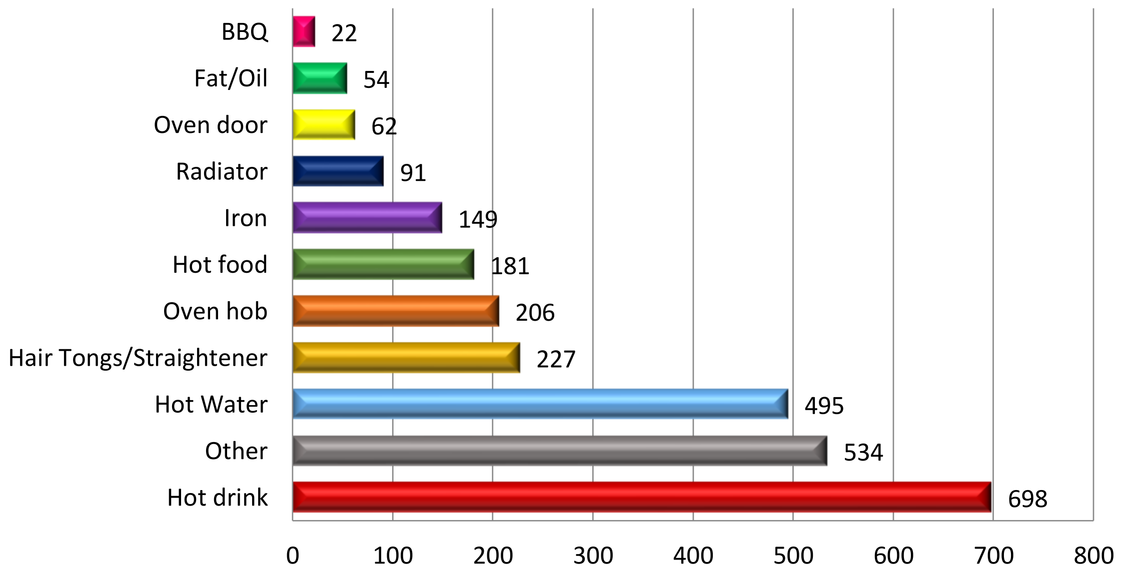
The scoring is based on the guidelines from the 2004 English Indices of Deprivation http://webarchive.nationalarchives.gov.uk/20120919132719/http://www.communities.gov.uk/documents/communities/pdf/131206.pdf

Other Burn-related variables

1. Agent of Injury

This information was obtained by ED staff when the child reported to the ED for treatment. Parents/ witnesses were asked what happened when the injury occurred and what was the responsible agent. The information for this variable was 97.8% complete (i.e. 2719 out of 2779 cases). Missing data accounted for just 2.2%. Most of the cases, 698 (25.7%) out of 2719) had hot drinks as the agent of injury, (see Fig.7). There is also a general reflection of the leading agents matching the burn types described earlier.

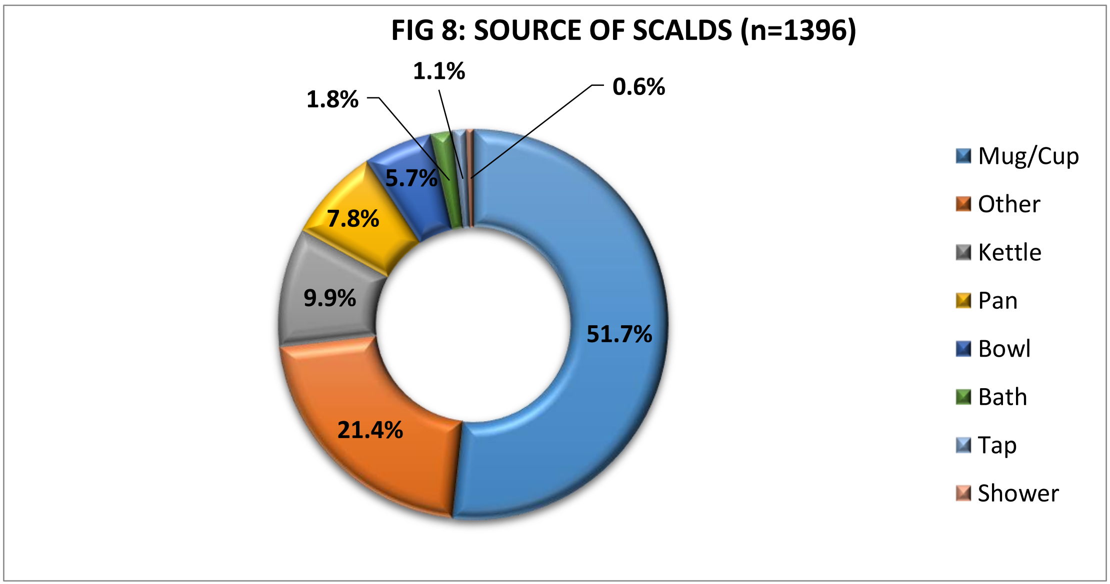
FIG 7: AGENT OF BURN INJURY (n=2719)




The ‘Other’ category includes a random list of other burn sources that were too few to leave on their own, e.g. candle wax etc. Hot water was the 2nd leading scald agent (18.2%)- these include scalds resulting from hot water accidentally pouring on the victim or from a few bath incidents. Hair straighteners were the 3rd leading defined agent of all burns, 227 of 2,719 (8.4%) and leading agents for contact burns.

2. Source of scald injuries

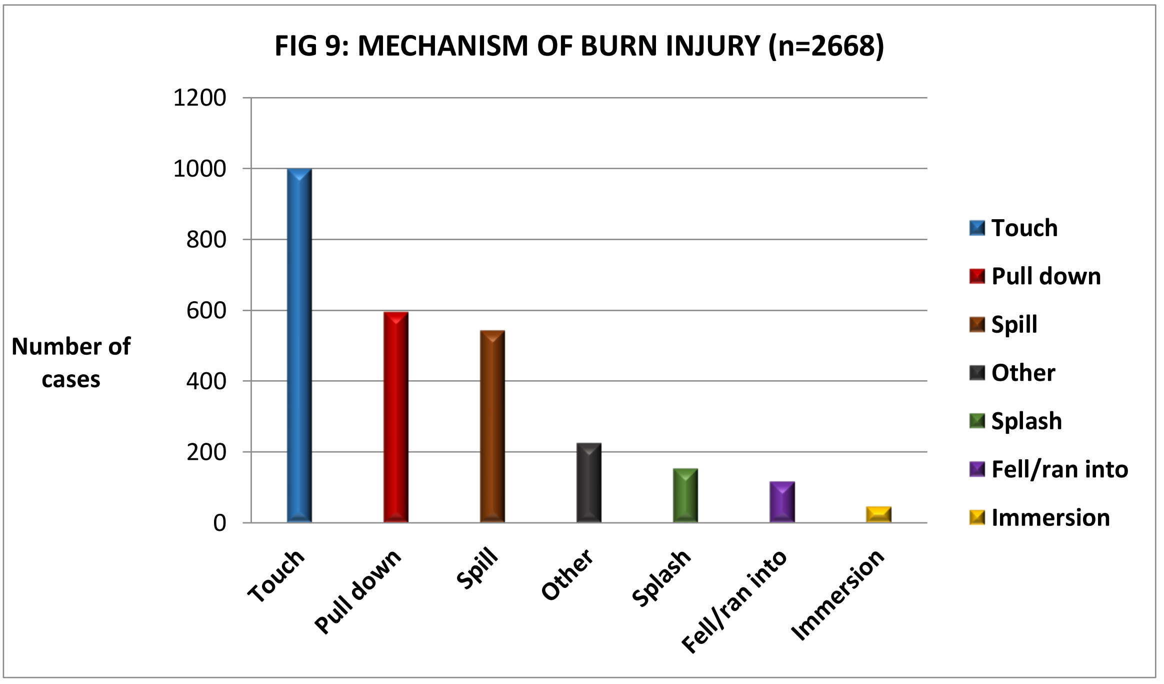
This information was collected by ED staff from parents/witnesses specifically for scalds injuries given the fact that they tend to be the most common form of burns in young children. The BASAT dataset so far follows this pattern. This variable had 95.8%% of all scald cases (1397 out of 1457 scald cases) reporting some form of the source of scalds. Thus, missing data accounted for 4.2% of all scald cases. Most of the scalds reported mugs/cups as the source of injury (51.7%), 722 of 1396 scald cases (see Fig. 8).




As with agent of injury, the "Other" category as seen in Fig. 8 represents a mixture of small fractions of different sources of scald injuries. However, looking at defined sources in Fig. 8, kettles and pans were the next leading source of scalds accounting for 9.9% and 7.8% respectively of all scald cases.

3. Mechanism of Injury

This variable was collected by ED staff from parent/witnesses when the children presented at the hospital for treatment. This variable was 96% complete, i.e. 2668 out of 2969 cases. Missing data accounted for 4% (111 cases). Most of the cases reported touch as the mechanism of injury (37.1%). Next was pulling down (22.3%) and spills (19.4%). Figure 9 below shows a bar chart depicting the different mechanisms.




The above figure infers that touch is the most common mechanism of burn injury whether non-scald or not (95.3% of all touch mechanisms led to a contact burn). However, it should be noted that if all the other mechanism is merged as one, they will outnumber the touch mechanism and are more likely to lead to scalds than contact burns.

4. Was the burn covered?

This variable was collected by ED staff when they asked parents/carers of children presenting with burn event if they covered the wound after the injury occurred. The rationale behind collecting this variable is that it adds to what is known about health-seeking behaviour (which is little) when parents/carers bring their children with burn events to hospital. This variable was 79.5% complete, i.e. 2209 of 2779 cases responded to the question. Missing data accounted for 20.5% of the dataset. Of those with complete numbers, 1070 (48.4% of the 2209 cases) had their wounds covered. When compared with the entire dataset, 1070 (38.5%) of the 2779 cases recorded were reported by parents to have covered the burn injury. However, if only those who applied first aid were used as the denominator, children who had their wounds covered by parents/carers would be 1070 (43.6%) of 2455 cases.

## A.S 5.2 COMPLETE CASE SERIES ANALYSES FOR BASAT DATA

This section presents a summary table showing CCS analyses for Chapter 5 for each of the ten research questions to see if there were any noticeable changes. CCS analyses follow the same format of commands used to run the analyses in STATA. This analysis only uses cases that are complete for all predictors, outcomes, covariates, moderators, mediators and confounders rather than all available data.

Appendix Table 5.2: Table showing a summary of CCS multivariable analyses showing the relationship between predictor variables and burn outcomes.

| | Outcome Variable: Scalds (1) versus Non-Scalds (0) **(n=421)** | | | |
|---|---|---|---|---|
| Predictor Variable: | **UNADJUSTED OR (95% CI)** | **MODEL 1* OR (95% CI)** | **MODEL 2* OR (95% CI)** | **MODEL 3* OR (95% CI)** |
| With defined impairments | **0.84 (0.30-2.36)** | **0.85 (0.29-2.47)** | **0.90 (0.30-2.68)** | **0.95 (0.31-2.88)** |
| Behaviourally Impaired | **0.32 (0.03-3.11)** | **0.32 (0.03-3.72)** | **0.3 (0.03-3.19)** | **0.42 (0.04-4.65)** |
| Non-behaviourally Impaired | **1.15 (0.35-3.84)** | **1.15 (0.34-3.91)** | **1.12 (0.33-3.88)** | **1.21 (0.34-4.24)** |
| Suboptimal supervision | **0.62 (0.45-0.94)** | **0.61 (0.38-0.99)** | **0.58 (0.36-0.96)** | **0.63 (0.39-1.03)** |
| | **Outcome Variable: CRW first aid applied (1) vs No CRW first aid (0) (n=417 to 421)+** | | | |
| | | | | |
| Behaviourally impaired | **1** | **1** | **1** | **1** |
| Non-behaviourally impaired | **0.46 (0.14-1.52)** | **0.47 (0.14-1.62)** | **0.51 (0.16-1.46)** | **0.50 (0.14-1.74)** |
| 2nd Quintile | **0.90 (0.39-2.11)** | **0.80 (0.34-1.90)** | **0.82 (0.34-1.95)** | **0.82 (0.34-1.96)** |
| 3rd Quintile | **0.69 (0.33-1.45)** | **0.63 (0.30-1.35)** | **0.62 (0.29-1.33)** | **0.62 (0.28-1.33)** |
| 4th Quintile | **0.58 (0.29-1.16)** | **0.55 (0.27-1.13)** | **0.57 (0.27-1.17)** | **0.57 (0.27-1.17)** |
| 5th Quintile | **0.42 (0.22-0.79)** | **0.40 (0.21-0.78)** | **0.40 (0.20-0.79)** | **0.40 (0.20-0.79)** |

| | | | | |
|---|---|---|---|---|
| Suboptimal supervision | **0.53 (0.40-0.85)** | **0.54 (0.33-0.88)** | **0.58 (0.36-0.96)** | **0.57 (0.34-0.94)** |
| Mixed | **0.85 (0.35-2.03)** | **0.79 (0.32-1.92)** | **0.84 (0.34-2.07)** | **0.86 (0.34-2.16)** |
| Asian/Asian British | **1.27 (0.47-3.41)** | **1.33 (0.48-3.65)** | **1.45 (0.52-4.05)** | **1.52 (0.54-4.33)** |
| Black/Black British | **0.70 (0.21-2.35)** | **0.64 (0.19-2.17)** | **0.64 (0.19-2.19)** | **0.74 (0.21-2.59)** |
| "Other" Ethnicity | **4.69 (0.58-37.9)** | **5.21 (0.63-43.0)** | **4.58(0.55-38.2)** | **5.33 (0.63-45.1)** |
| | **+ number of samples was 417 when examining binary impairment as predictor and 421 when examining defined impairment as a predictor. Both numbers remained the same all from Model 1-3.** | | | |
| | **Outcome Variable: Burn Depth (Full thickness (1) versus non-full thickness (0)) (n=350-360)$** | | | |
| With defined impairments | **1.99 (0.25-16.3)** | **1.63 (0.17-15.1)** | **1.08 (0.09-11.9)** | **1.01 (0.09-10.9)** |
| Suboptimal supervision | **1.52 (0.24-2.67)** | **1.92(0.62-5.97)** | **1.62(0.47-5.62)** | **1.62(0.45-5.81)** |
| 2nd Quintile | **1** | **1** | **1** | **1** |
| 3rd Quintile | **0.91 (0.13-6.68)** | **1.08 (0.14-8.21)** | **1.10 (0.14-8.59)** | **1.10 (0.14-8.61)** |
| 4th Quintile | **1.09 (0.18-6.72)** | **1.39 (0.22-8.89)** | **1.26 (0.19-8.46)** | **1.26 (0.19-8.46)** |
| 5th Quintile | **1.87 (0.39-9.05)** | **2.05 (0.41-10.2)** | **1.84 (0.35-9.51)** | **1.84 (0.35-9.51)** |
| Mixed | **1** | **1** | **1** | **1** |
| Asian/Asian British | **1** | **1** | **1** | **1** |
| Black/Black British | **1** | **1** | **1** | **1** |
| "Other" Ethnicity | **1** | **1** | **1** | **1** |
| | **$ number of samples was 350 when examining binary impairment as predictor and 360 when examining defined impairment as a predictor. Both numbers remained the same all from Model 1-2. However, in Model 3, this total became 309 for binary impairment and 319 for defined impairment.** | | | |

***FOR IMPAIRMENT MODELS- Model 1 control for individual factors (Age and sex), Model 2 controls for family factors (Ethnicity, social worker history, overall supervision, and domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

***FOR SUPERVISION MODELS- Model 1 controls for individual factors (Age, sex and Impairment), Model 2 controls for family factors (Ethnicity, social worker history, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

***FOR IMD MODELS- Model 1 controls for individual factors (Age, Sex and Impairment), Model 2 controls for family factors (Ethnicity, Social Worker History, Domestic Violence in the Home and Overall Supervision), and Model 3 controls for environmental factors (Location of Burn Injury event).**

***FOR ETHNICITY MODELS- Model 1 controls for individual factors (Age, sex and Impairment), Model 2 controls for family factors (Social worker history, overall supervision, domestic violence in the home), Model 3 controls for environmental factors (IMD, the location of burn injury event).**

No changes were observed in the CCS analyses results compared to results from all available data analyses in Chapter 5 of this thesis for the following relationships

1. Type of impairment and burn type
2. Type of Impairment and CRW First Aid application
3. Any Defined Impairment and Burn Depth.
4. Overall Supervision and Burns Type
5. Cool Running Water First Aid Application
6. Overall Supervision and Burn Depth (N=417)
7. IMD and CRW First Aid Application
8. IMD and Burn Depth
9. Ethnicity and CRW First Aid Application

These findings suggest that missingness of data may not have affected data outcome. Cells designated an OR of 1 signified collinearity from the regression analyses, i.e. high correlation between predictor variables which reduces the occurrence of statistical significance with the outcome. This collinearity may have resulted from the reduced sample size and power of the sample data.

The only differences observed in the CCS analyses from all available data analyses were that all models now were collinear for the relationship between ethnicity and burn depth. Thus, one could not conclude based on the results. Also, the results may not be trustworthy due to ethnicity being MNAR, the reduced sample size, and power in the analyses. However, the CCS analyses do show that there may be some bias due to missing data, but it did not change the outcome in Model 3, i.e. after controlling for all individual, family and environmental factors available.