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# A study of energy-related injuries from hospital admissions among children and adults in South Africa

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## ABSTRACT

**Introduction:** Burn and ingestion injuries are common in developing countries because of poor access to safe energy sources, crowded living conditions, and insufficient knowledge of potential risks. The purpose of this study is to understand the scope of burn and ingestion injuries due to various energy source usages in South Africa.

**Methods:** Patients at 16 regional hospitals throughout South Africa presenting with an energy-related injury between 2006 and 2012 were interviewed to obtain demographics and injury characteristics.

**Results:** A total of 12,443 patients were included in this study. Children aged 1–2 years predominantly experienced burn and ingestion injuries (21%). Liquid burns (30%) were more common than flame burns (14%). Chi-squared tests show that age was significantly related to degree of burn, type of burn, and severity of burn ( $p < 0.001$ ). Non-intentional injuries (45%) were more frequent than self-inflicted or assault injuries. Temporal and seasonal injury trends reflect usage patterns. Burn injuries result in longer hospital length of stay than ingestion injuries.

**Conclusion:** Non-intentional liquid burns and ingestions to infants and babies were most common in this study, with many injuries also occurring among young adults. It is advised that interventions targeting low-income communities be conducted to increase awareness of burn and ingestion injuries.

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## 1. Introduction

Unintentional injuries remain one of the leading causes of death in the world, with burns accounting for a large portion of mortality; a disproportionately high percentage (over 95%) of these injuries occur in developing countries [1]. Africa in particular has a high prevalence of burn injuries due to poverty, overcrowding in housing communities, and poor living conditions [2]. The proportion of deaths among children due to burns is twice the level in low-income countries than it

is in high-income countries, and infants in Africa specifically experience burns three times more than the world average [3]. While South Africa is viewed as one of the more developed African countries, rates of unintentional injuries such as burns and ingestions, remain high.

Many African countries utilize unsafe energy sources and lack infrastructure, putting them at even greater risk for injury [2]. Energy source usage refers to the pattern and combination of materials used in the home for cooking, heating, and/or lighting purposes. These usage patterns differ greatly between electrified and non-electrified homes. Examples of common

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energy sources include electricity, paraffin, firewood, candles, and gas [4]. South Africa in particular does not follow a typical energy ladder scheme in which higher income homes climb the ladder, but instead utilizes a mix of multiple energy sources [4]; the reason for this is multifactorial. Human factors such as knowledge of fuel source and appliances, physical environment setting such as dwelling size and escape points, and cultural practices all affect energy source usage [5]. Perhaps the biggest determinant of energy source usage is level of poverty; this affects the choice and quality of fuels, appliances, dwellings and frequently forces children to be left unattended [5].

Many South African low-income homes turn to paraffin (also known as kerosene) as their primary fuel source due to its lower cost and ease of accessibility for many families [6]. Paraffin, not to be confused with paraffin wax, is a hydrocarbon fuel created through the distillation of petroleum and is used most commonly for cooking and boiling water, however it is also used for lighting and heating purposes [7,8]. As many as 92% of homes in South African informal settlements use paraffin on a daily basis [6]. Studies have found trends in injury patterns, commonly depending on age, gender, and race. Allorto and colleagues (2009) found that among pediatric burn patients aged 0–12 years, the median patient age is 3 years, but among burn patients over 12 years of age, the median patient age is 40 years [2]. Additionally, adults were found to sustain deeper burns to the skin than were children [2]. Children are at greater risk for experiencing a burn injury due to their reduced mobility, undeveloped risk perception, long sleeping hours, greater likelihood to sleep deeply, smaller surface area to body volume ratio, and physiological immaturity; these characteristics also put them at higher risk of experiencing adverse outcomes [8]. Generally speaking, population risk factors of childhood burn injury are low literacy and income levels, overall health status, and household crowding, with further risk associated when there is low socio-economic status (SES) of the family, low education level of the mother, and stress in the family [9]. More injuries likely occur in South Africa as a result of higher rates of poverty and unsafe use of paraffin [10].

While a number of studies have attempted to present the scope of energy-related burn and ingestion injuries in South Africa, none have been published with data from the number of hospitals and length as this study. Much of the literature has focused primarily on a small cohort or geographic region, however this study hopes to give a more inclusive view of the problem in South Africa. Current research also tends to focus on only one injury type—either burns or ingestions—but rarely focus on both of them [11–13].

Burns are any thermal injury that damages skin cells by hot liquid (scalds), hot solids (contact burns), flames (flame burns), electricity, friction, or radiation [14]. While burns have a higher incident rate overall, it is important to remember that ingestion injuries occur from paraffin and other fuels as well. Paraffin is considered a poison if ingested [12]. Paraffin enters the body through ingestion into the stomach or by inhalation of fumes and smoke [8]. The fatality rate is low, but can result due to respiratory failure from aspiration of paraffin into the lungs [7]. Because poisoning incidence among children is poorly documented, especially in developing countries [11],

this study hopes to add to this documentation. It has also been noted that accurate and thorough injury surveillance and analysis is crucial in the planning of interventions, and that the lack of such data is a major problem in the battle against burn injuries [14]; this study seeks to strengthen this knowledge base. Overall, the objective of this study is to establish the scope of the problem of paraffin and other energy-related burn and ingestion injuries among children and adults in South African townships by determining demographic distribution of injuries, investigating when injuries occur, and analyzing characteristics of these injuries.

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## 2. Methods

### 2.1. Settings and participants

Sixteen regional hospitals throughout South Africa were chosen for participation in this study if surrounding areas were known to have high incidence of energy-related injuries, which typically corresponded to areas of densely populated low-income housing. Participants were then selected from these institutions upon presentation of an energy-related injury from both hospital and emergency admissions. According to the 2011 South African Census, approximately 7 million people live in informal settlements [15], which were originally the result of post-Apartheid labor migration when men moved to cities looking for work [16]. Today, these housing areas commonly lack basic amenities such as access to clean water, electricity, and sanitation facilities [16]. These homes, or shacks as they are commonly called, are densely populated and built close together, often out of materials such as tin, wood, and other scrap supplies, many of which are highly flammable [6]. Shacks that have access to electricity frequently do so through an illegal connection, further increasing the risk of injury [6]. Home interiors are small and cramped with little space for using stoves and candles safely or storing poisonous items [17]. Children have little room to play and in the event of a fire, it spreads quickly from one shack to another due to their close proximity [17]. While it cannot be assumed that everyone in this study lived in an informal settlement, it is likely that the majority of individuals resided in a similar environment given the hospital locations and the populations they serve.

### 2.2. Data collection

Paraffin Safety Association of Southern Africa (PASASA) research assistants located at each institution collected the data used in this study (see Fig. 1 for institution information). Upon presenting with an energy-related injury, patients were verbally asked in their native language for consent to be interviewed and to obtain access to their medical records (verbal consent was obtained due to low literacy among the sample population). Once participants gave consent, research assistants captured patient data on the Household Energy-Related Morbidity and Mortality Surveillance Data Capture Form created by PASASA for the purpose of this study, which includes information on gender, race, age, cause of injury, energy source involved, location and activity when injury occurred, intentionality, injury characteristics (including burn

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