

Assault burn injuries in adolescents and adults in South Africa: Risk factors and characteristics

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Assault burns comprise a significant subset of burns, with a greater risk of severe injuries. This South African study used a national dataset from major hospitals to identify risks and injury characteristics of assault burns. The analysis sample comprised 2 658 adolescent and adult cases and employed logistic regression with bootstrapping to examine the risk of assault compared to unintentional burns. The study indicates that 17.4% of burns were due to assault. Males were 1.5 times more likely than females to be burn assault victims. Compared to adults 55 years and older, young adults 22-39 years were at greatest risk, followed by youth 13-21 years. Assault injuries were five times more likely due to chemical attacks and three times more likely to scalds than to flame burns. The head, neck and trunk were most affected. Where alcohol was indicated, assault burns were five times more likely than unintentional burns. The findings may indicate the need for targeted prevention strategies such as conflict resolution, alcohol use management and the control of corrosive chemicals.

Keywords: burn injuries, assault, chemicals, scalding, alcohol

Introduction

Intentional and unintentional burn injury distribution

Burn injuries remain a significant cause of morbidity and mortality, particularly in Africa and South East Asia (James et al., 2019). These injuries are broadly classified as either intentional or unintentional, depending on whether they are inflicted on purpose or the result of an unplanned, inadvertent action. Intentional injuries are disaggregated further into self-inflicted (self-harm) and assault burns. Unintentional burns form the largest proportion of all burn injuries and have consequently received the greatest

attention from researchers and practitioners. In contrast, there has been less focus on intentional burns, especially the subcategory of assault burns. Although assault burns are a small subset of all burns, they carry a greater risk of severe injuries and death (Lama et al., 2015).

Assault burns are inflicted when an individual throws hot liquids, acids or other types of corrosive chemicals on another person or uses flames with the intent to harm, resulting in pain, injury, scarring and in some instances death (Peck, 2012). The global magnitude of the problem of such intentionally inflicted injuries is reported to range from 3% to 10% of all burn hospitalisations (Peck, 2012), but may be even higher in some settings with a recent South African hospital study reporting 34.3% of its burn hospitalisations as due to intentional burns (Cloake et al., 2017). There is, however, uneven information on this debilitating phenomenon due to the irregular and limited reporting of cases (Mannan et al., 2007). The only sources of information are usually hospital records and community agency reports, most often on incidents linked to gender-based violence (Didcott & Taylor, 2019).

Assault burns by age and sex of victims

Studies from South American and Asian countries have highlighted females between 25-30 years as most likely to be targeted (Guerrero, 2013; Lama et al., 2015). India, Bangladesh and Nepal have reported particularly high rates of assault burns in young women, with the most common mode of attack being acid thrown to the face and less commonly by kerosene ignition. In contrast, studies from Africa have highlighted more male victims, especially 30-40 years old (Oloitan & Jibulum, 2008; Asaria et al., 2004) but also younger adult males, e.g., in South Africa (e.g. Cloake et al., 2017), while those from Europe and the USA indicate assault burns as mostly directed at midlife and older

men (Peck, 2012). In other settings, e.g., Jamaica, the sex ratio of assault burn victims was found to be similar to the general burn population.

Burn assault risk factors

Assault burns have been associated with poverty, robbery and social conflicts, such as the rejection of a marriage proposal, marital trouble or divorce (Rasouli et al., 2015). In Asia where the victims of attack are mostly young women, the assault is likely to occur at home and is mostly linked to intimate partner violence (Lama et al., 2015; Murphy et al., 2019). In patriarchal societies, younger females may be intentionally victimised and at higher risk for burn assaults precipitated by family feuds, domestic violence, and conflicts regarding inheritance and other property issues (Kumar et al., 2013; Lama et al., 2015; Patel et al., 2016). In other settings, pre-existing drug and/or alcohol abuse problems, low socio-economic status and underlying psychological or psychiatric disorders have been reported to heighten the risk of assault burns (Lama et al., 2015; Rasouli et al., 2015). A report from the USA indicated that assault burn patients were more likely to have been recently discharged to either a drug or alcohol treatment facility, homeless shelter or the street (Kaufman et al., 2007). However, in an Australian study, all assault victims were burned in domestic or community violence incidents (O'Halloran et al., 2013).

Clinical characteristics associated with assault

Compared to unintentional burns, most assault burns tend to be of a severe nature with these affecting a moderate to large part of the total body surface area (TBSA). The most affected body parts are usually the head, face, neck, torso and hands (O'Halloran et al., 2013; Vagardoost et al., 2017). There may be variations depending on circumstances and causal agent; for example, an Iranian study indicated that female acid attack victims

have a comparatively higher TBSA (Vagardoost et al., 2017). The severe injury characteristics and premorbid factors of burn assault victims may cause a more complex and prolonged recovery (Kaufman et al., 2007), leading to longer stays in hospital and intensive care units (ICUs) (Ho et al., 2001) and a comparatively greater in-hospital mortality rate (Kaufman et al., 2007). An Australian study reported that the agent used impacts upon this recovery, with fire assault victims reporting a higher rate of intubation (24%) and ICU admission (1 in 3 cases) compared to those burnt by scalding (O'Halloran et al., 2013). These reports are informed by divergent social, economic and cultural contexts, with notable variations across context in terms of victim demographics, agents used, circumstances of the incident and injury outcomes (Ho et al., 2001; Mannan et al., 2007).

This study builds upon the sparse South African work (e.g., Cloake et al., 2017; Duminy & Hudson, 1993) and describes the demographics, key risks and burn wound characteristics of assault burn victims in South Africa. Looking across all burn injuries, the study identifies the proportion of burn injuries that result from assault; the different types of burn assault as defined by the causal agent; the risk factors for such assault burns; the sex and age cohorts most affected; the role of alcohol; and the clinical attributes of assault burns. The study thus seeks to inform the formulation of targeted prevention programs, and support relevant policy initiatives aimed at the prevention or control and the expedited treatment of assault burns.

Methods

Primary data collection

This study used secondary data related to burn injuries for the period May 2006 to November 2012. Primary data had been collected from 19 South African hospitals principally servicing densely populated low-income settlements situated nearby major

metropolitan areas in eight of the nine South African provinces. The data for the current study was therefore collected from a larger study on household energy-related burn injuries conducted by the Household Energy Safety Association of South Africa (HESASA). The HESASA study sample of 19 hospitals is not representative of all hospitals in the country. However, all the participating hospitals' footprint communities are characterised by high levels of informal dwellings, low electricity connections, and cramped household quarters, all risk factors for burn injuries in South Africa. Using a bespoke data form (Household Energy- Related Morbidity and Mortality Surveillance Data Capture Form) HESASA researchers had interviewed participants or caregivers at admission in their preferred language to obtain their informed consent for the study and collect information on patient demographics, household circumstances, and the nature and circumstances of the presenting injury. Thereafter, the data form was further populated with information from hospital records on burn cause, type and further reported circumstances associated with admission and treatment for burn injuries. No names or any form of personal information were used that could identify participants. Due to low literacy levels amongst the participants, verbal informed consent had been obtained. The current study thus comprised an analysis of data from the HESASA study and received clearance in 2018 from the Health Research Ethics Committee of the South African Medical Research Council (EC021-11/2017).

Sample

The original dataset contained 12 079 cases. Given the focus in this study on adolescent and adult intentional and unintentional burn injuries, only cases 13 years and older with external burn injuries were selected for the analysis, comprising around 2 703 cases. Of these, 48 cases (1.8%) had missing data for one or more of the explanatory variables.

The final analysis samples are thus 2 703 for the descriptive analysis and 2 658 for the explanatory model analysis.

Analysis

Descriptive statistics were used to examine key sample characteristics and logistic regression analysis was used to assess the risk for assault across the different explanatory variables. Analysis was performed using the Statistical Package for Social Sciences (SPSS) version 27, with a $p \leq 0.05$ significance level.

The outcome variable for the study was a binary categorical variable recording the occurrence of intentional injury (specifically assault burns) as compared to unintentional injury (Reference Category). The coding of the presenting burn injury as either intentional (and specifically assault) or unintentional was based on reporting at the time of admission by the patient and/or persons who accompanied them to the hospital for treatment. This reporting was further cross referenced with hospital data incorporated in hospital records (Gevaart-Durkin, Swart & Chowdhury, 2014).

The following explanatory variables were employed:

- **Burn Injury Type:** Burn injury categories were aligned to ICD-9 convention. Only external burns were considered due to attendant information on burn severity. The three types of external burns were scalds, chemical burns and flame burns (Reference Category). Chemical burns comprise burns as a result of chemical agents such as acid, household detergents, solvents and similar compounds.
- **Age Cohort:** Age was entered into the analysis as a categorical variable comprising four cohorts as follows: adolescents/youth: 13-21 years, young adults: 22-39 years, mature adults: 40-54 years and older adults: 55 years and older (Reference Category).

- Sex: Sex was recorded as either male or female (Reference Category).
- Presence of Alcohol: The presence or absence of alcohol was based on reporting and/or observation at time of admission and measured as a binary categorical variable indicating Alcohol Present/Alcohol Not Present (Reference Category). The measure does not include information on prior history of use/abuse or related biomarker testing at admission or during hospitalisation.
- Body Part Affected: Body part affected refers to the area of the body which was affected by the burn injury. This was assessed from hospital records and recorded in four variables as follows:
 - Head and Neck – the body area affected was the patient’s neck and head
 - Trunk - the body area affected was the patient’s trunk, either front or back
 - Arms and Fingers - the body area affected was the patient’s arms, hands and fingers
 - Feet and Legs – the body area affected was the patient’s feet, legs and toes.

All variables are categorical with coding for Yes/No (Reference Category) to indicate if the relevant body part was affected. More than one body part may be recorded per injury.

Results

Descriptive statistics

The analysis sample comprised slightly more males (58.1%) than females (see Table 1). The primary burn type for assault injury was scalds (59.2%), followed by flame burns (37.4%), and then chemical burns (3.4%). The body areas most affected for assault were trunk, head and neck, while arms and hands and feet and legs were more affected for unintentional injury. Alcohol involvement was reported in 40.9% of assault burn injury admissions and in 12.6% of unintentional burn injury admissions.

[Table 1. Sample descriptive characteristics]

Logistic regression analysis

A logistic regression analysis was performed to assess the impact of the various predictor variables in differentiating risk for assault from unintentional burn injury. To account for any potential model estimation problems due to small cell size, the logistic regression analysis was conducted using the bootstrapping method. The bootstrapping method is a procedure whereby the model and parameter estimation are undertaken on multiple different samples drawn from the same base sample. This analytic method returns more robust parameter estimates for each variable. The bootstrapping procedure used in this analysis entailed the drawing and testing of 1000 samples from the base sample. It was conducted by using the bias corrected and accelerated (BCa) intervals rather than the percentile intervals for robust estimation of the 95% confidence intervals. All Odds Ratio values reported are adjusted for all other variables in the model. The results of the analysis are presented in Table 2.

[Table 2. Logistic regression analyses assessing Risk for Assault vs Unintentional Injury]

The -2 Log Likelihood test returned a statistically significant result for the specified model ($\chi^2= 523.93$, $p = .00$), indicating that the overall model as comprised of all explanatory variables was a good fit to the data. This was also supported by the estimate of the Nagelkerke pseudo- R^2 at 0.297.

The confirmed model revealed several key risk factors for suffering burn injuries as a result of assault rather than unintentional causes. Firstly, in terms of demographics,

men are at one and a half times greater risk than women for assault burn injuries as compared to unintentional injuries (AOR = 1.446, BCa 95% CI: 1.154 – 1.874), while all persons aged 13 to 44 years are at significantly greater risk for assault burn injury compared to those aged 55 years and above. Specifically, when compared to adults aged 55 years and older, persons aged 13 to 21 years are almost twice as likely to suffer assault burn injury (AOR = 2.034, BCa 95% CI: 1.335 – 2.965), with those aged 22 to 39 years being at a slightly higher risk for such injury (AOR = 2.561, BCa 95% CI: 1.966 – 3.251), and those aged 40 to 54 years being one and a half times more likely than their older counterparts to suffer injuries due to assault (AOR = 1.568, BCa 95% CI: 1.070 – 2.293). Overall, then, women and older adults face the least risk for assault burn injury.

In terms of the type of burn injury, and when compared to flame burns, the analysis confirmed a three-fold greater risk for suffering scalds (AOR = 2.956, BCa 95% CI: 2.261 – 3.931) and a greater than five-fold increase in risk for suffering chemical burns (AOR = 5.624, BCa 95% CI: 3.028 – 9.708).

In terms of burn characteristics, the logistic regression revealed that assault burn injuries are most likely to be directed towards and affect the head and neck (AOR = 2.494, BCa 95% CI: 1.900 – 3.245), followed by the trunk (AOR = 2.292, BCa 95% CI: 1.818 – 2.936), whereas injuries due to assault were 24% less likely to be directed at and affect the arms and fingers (AOR = 0.761, BCa 95% CI: 0.610 – 0.941), and about 60% less likely to be directed towards and affect the legs and feet (AOR = 0.412, BCa 95% CI: 0.318 – 0.526).

Further, the analysis confirmed that alcohol plays a key role in differentiating assault burns from unintentional burn injuries, with injuries being five times more likely

to be due to assault when alcohol is present (AOR = 5.215, BCa 95% CI: 3.947 – 6.986) than when it is not.

Discussion

The overall objective of this study was to identify, firstly, the risk factors associated with assault burns and secondly, the unique set of injury characteristics that differentiate these injuries from unintentional burns. The results indicate that assault burns made up 17.4% of all burn cases, higher than global indications (Peck, 2012) but lower than a recent hospital study from Cape Town (Cloake et al., 2017). The preponderance of such cases is consistent with the high rates of violence reported in South Africa, which are well above regional and international norms (South African Police Service, 2020; United Nations Office on Drugs and Crime, 2016). The current findings indicate that assault burn injuries are most likely to affect males and those aged between 13 and 39 years. Furthermore, alcohol use significantly increases the likelihood of an assault burn injury, with chemicals the most likely causal agent.

The findings of this study indicate that males are at a one and a half times greater risk for burn injuries due to assault. This over-representation of men in burns sustained through interpersonal violence is consistent with findings reported in previous South African studies (Blom et al., 2016; Gevaart-Durkin et al., 2014; Maritz et al., 2012; Duminy & Hudson, 1993) and from elsewhere (e.g., Theodorou et al., 2009), but in contrast to those from South America and Asia where the predominant victims are young adult females (Guerrero, 2013; Lama et al., 2015). This study data does not provide information on the specific circumstances of the burn assaults although other South African studies and reports indicate that burn assaults may result from conflict with family members, neighbours or strangers (Daffue et al., 2018), from a criminal gang (Desai, 2016), socio-political opponents (Maregele, 2011) and partners or spouses

(Duminy & Hudson, 1993). The male preponderance in assault burns is consistent with empirical evidence indicating higher risk of males as victims of severe interpersonal violence in South Africa across several causes, including fatal firearm discharge (Ratele et al., 2011; South African Police Service, 2020) and sharp object assault (Ahmed, 2017), with other men indicated as the assailants (Ratele, 2010; Seedat et al., 2009). However, assault burns are not necessarily only perpetrated by men, with an earlier South African study highlighting the involvement of women (Duminy & Hudson, 1993). However, while there is burgeoning South African and global research on male victimisation from extreme physical violence, more detailed information on the interpersonal and social circumstances surrounding male burn assault in settings such as South Africa remains limited.

This study indicates that younger victims are most vulnerable to assault burns. This is consistent with the greater risk profile in South Africa for violence victimisation amongst these age cohorts through guns and sharp object assault (Ratele, 2010). The current pattern differs from that reported in Europe, the United States and elsewhere in Africa, where assault burns are mostly directed at midlife and older male victims (Peck, 2012). In general, there are multiple influences and complex dynamics associated with young men's risk to violence, though many assault incidents appear to be the consequence of disputes that escalate into physical altercations, often between young men, those who ascribe to notions of 'fearless masculinity', and where alcohol is involved (Ratele, 2010). Consistent with other research from South Africa (Blom, et al., 2011; Blom et al., 2016; Van Niekerk et al., 2019), the current study also confirms the greater risk for alcohol, in this instance it was found to be almost five times higher than when alcohol is not present. This may be explained by the role of alcohol in diminishing social judgement and decision making, both of which increase the risk for conflict with

others, the vulnerability of the victim to attack, and the reduced ability to avoid or respond to an attack. The high-risk hypothesis has been indicated as a mechanism through which individuals are more likely to engage in unsafe behaviours, and thereby increase their risk for trauma exposure (Haller & Chassin, 2014).

Regarding the causal agent, chemical burns were more than five times and scalding more than twice as likely to be the cause of a burn assault compared to flame burns. Chemicals are especially portable as weapons and can be used more readily in an assault. These may also be the preferred weapon, if the intention is for revenge (Abdulrasheed et al., 2014) or to mutilate and shame, but not to kill (Peck, 2011). The emphasis in the current study is furthermore of burn assaults to the head and neck, with the consequent facial disfigurement and in some instances blindness which would align to such motives of punishment. The use of chemicals in assaults may however also reflect the limited access to more lethal weapons such as firearms, as in South Africa where there has been increasingly stringent firearm legislation (Mayosi et al., 2012). In such instances the use of chemicals, especially where surprise is a key element, would therefore be sufficiently disabling to enable an attack for economic gain.

In South Africa, cases of assault burns have previously been indicated as primarily due to hot liquids, foods and cooking oils used in interpersonal violence (Cloake et al., 2017; Blom et al., 2016; Duminy & Hudson, 1993), with fewer local reports of chemical attacks (Daffue et al., 2018). Hot liquids are also highlighted in the current study and may predominate in certain domestic settings where these are more readily available e.g., on the stove, as compared to chemical agents that may be stored away or more difficult to immediately access (Ho et al., 2001). Internationally, chemical burn assaults have become increasingly prominent, perhaps a reflection of the increased availability and accessibility of a wide range of chemicals. This may arguably have

been facilitated by the global surge of a DIY culture, also increasingly seen in South Africa, despite safety concerns about the highly corrosive and harmful characteristics of such substances (Hardwicke et al., 2012).

Strengths and limitations

This study benefits from large sample data which on this subject matter is generally rare and costly to collect, especially in Sub Saharan settings and despite the regional preponderance of burn injury cases. The data provides good national coverage although with a bias towards facilities situated close to major urban and metropolitan centres, though these do account for the majority population in the country. The data is one of very few that have focussed on energy induced injury in a country where the burden of both burn injuries and violence is high. Such a platform offers great utility in its description of burn assaults and the factors associated with such attacks, which may inform prevention planning and further research efforts. However, patterns of violence may have changed since data collection, e.g., with the increasingly strengthened firearm legislation there may be even greater use of chemicals as a weapon in both interpersonal but also economically motivated assaults. The current findings could nevertheless still inform the formulation of burn assault preventative strategies through a comparison of previous and current situations.

Conclusion

This study indicates that men are one and a half times more likely than women to sustain assault burns than unintentional burns. Youth and young adults (13-39 years) are at greatest risk of suffering assault burns. Compared to unintentional burn injuries, chemical burns are more likely to be the causal agent and alcohol involvement may profoundly increase the likelihood of such an assault. The findings may benefit the formulation of burn assault injury prevention strategies with a special focus on conflict

resolution, alcohol use and the availability of corrosive chemicals. The findings may also support more targeted care, including psychosocial support, with the latter pertinent for dealing with the trauma from such attacks.

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