

THE PREVALENCE AND CLINICAL PROFILE OF ADULT BURNS DUE TO ASSAULT: A SOUTH AFRICAN ADULTS BURN CENTRE REVIEW

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Medicine in Surgery M.Med (Surgery).

Johannesburg, May 2021

DECLARATION

I, Sheree Koonin, declare that this Research Report is my own, unaided work.

It is being submitted to the Faculty of Health Sciences for the degree of Master of Medicine in Surgery, at the University of the Witwatersrand, Johannesburg.

It has not been submitted before for any other degree or examination at this or any other University.

A handwritten signature in black ink, consisting of several overlapping loops and a trailing line that ends in a small flourish. The name 'Koonin' is partially legible within the signature.

(Signature of candidate)

26 day of May 2021 in Johannesburg.

ABSTRACT

Burn injuries due to assault reflect complex interactions between societal structure, and social and economic circumstances specific to different populations. Chris Hani Baragwanath Academic Hospital is a tertiary referral academic hospital with a specialist service Adult Burns Unit which services the Gauteng Province. To date, the unit has not published its experience with burn injuries due to assault. In this study, the aim was to explore the demographics (age and sex), clinical profile (mechanism of burn, inhalation injury, and percentage total body surface area) and outcomes (mortality, length of hospital stay and need for intensive care unit admission) for burn injuries by assault at Chris Hani Baragwanath Academic Hospital's Adult Burns Unit.

We conducted a retrospective review of 1928 consecutive adult burns patients admitted between 2005 and 2014. We conducted analyses for the whole cohort, and subsequently divided the cohort into two groups, a burn by assault group, and a control group, which included all burn injuries that were accidental, unintentional, or resulted from intentional self-harm. Overall, and for each group, we performed descriptive analyses for the demographics, clinical profile and outcomes, and for between group comparisons the independent T test was performed.

Overall, twenty one percent of all admissions comprised the burn by assault group and the most frequent mechanism of burns in this group was scald injuries. When compared to the control group, there were no significant differences in the assault group for age and sex distribution; mortality; total body surface area percentage; inhalational injury, intensive care admission; and length of stay in the burns unit.

Contrary to the existing literature, in this study patients with burns due to assault do not have more severe injuries or worse outcomes. This is likely due to the relatively higher prevalence of scald injuries in the assault group. Our data can inform public health strategies for burn prevention that focus on interpersonal violence as a significant cause of burns and the uniquely South African complexities involved.

ACKNOWLEDGEMENTS AND DEDICATION

To my other sister, Detective/Warrant-Officer Delene Grobler-Koonin –

All give some but some, like you, give all, including your life to protect and serve this country and her people. Your selflessness and ultimate personal sacrifice in fighting for others, particularly vulnerable woman and children, was the quintessential trait that made you a true and ideal hero. The exceptional soul you were, the passion you disseminated and love you exuded to all of humanity made you, the hero of our family. You will forever inspire me, be remembered and missed dearly. Rest gently and in peace.

My deepest gratitude goes to all who have helped, guided, taught, loved and encouraged me in my life, career and the course of this research.

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LIST OF ABBREVIATIONS

ABU	Adult Burns Unit
AG	Assault Group
CDC	Centres for Disease Control and Prevention
CHBAH	Chris Hani Baragwanath Academic Hospital
CG	Control Group
DALY	Disability adjusted life years
HIC	High income countries
ICU	Intensive care unit
IPV	Interpersonal violence
IQR	Interquartile range
KZN	Kwazulu-Natal
LIC	Low income countries
LMIC	Low and middle income countries
LOS	Length of hospital stay
SD	Standard deviation
%TBSA	Percentage total body surface area
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

1 INTRODUCTION

1.1 The prevalence of burn trauma globally

Burns are the fourth most common type of trauma worldwide, following traffic accidents, falls and interpersonal violence (IPV) (World Health Organization, 2008b). In 2018, the Global Burden of Disease estimated 180 000 fatalities occurred globally as a result of burns, with the majority of deaths occurring in low and middle income countries (LMIC) (World Health Organization, 2018). According to the World Health Organisation (WHO), non-lethal burn injuries are a leading cause of morbidity worldwide. Non-lethal burn injuries are one of the foremost causes of loss of disability adjusted life years (DALYs) in LMIC (World Health Organization, 2018). In 2004 the worldwide estimate was that 11 million people were seeking medical care for burns per annum (World Health Organization, 2018), and burn incidence was 1.3 per 100,000 population in LMIC compared to 0.14 per 100,000 population in high income countries (HIC) (World Health Organization, 2004). Thus globally the annual incidence of burns exceeds the combined annual incidences of tuberculosis and human immunodeficiency virus, and is only slightly lower than the annual incidence rates of all malignant neoplasms (World Health Organization, 2008a). Appropriately, burns injuries are now recognised as a major public health problem (World Health Organization, 2018). The public health impact of burns partly relates to the significant physical, emotional and psychological impact of these injuries on the survivors (World Health Organization, 2018).

In addition to the devastating personal and considerable public health consequences of burns, there is also a marked socioeconomic impact as these are among the most expensive traumatic injuries to treat (Albertyn, Numanoglu & Rode 2014). The economic impact is even larger when indirect costs such as loss in wages, prolonged care for deformities, emotional trauma and commitment of family resources are taken into account (World Health Organization, 2018). In 2010 the Burns Unit at Tygerberg Hospital in the Western Cape estimated the cost of treating burn survivors at between R30 000 and R100 000 per survivor (Household Energy Safety Association of Southern Africa, 2020). For South Africa, Allorto, Clarke and Thomson (2011) costed active management of burns

to be R103 000 for 20% total body surface area (TBSA) involving deep dermal burns (R5150 per 1% TBSA affected), equating to approximately R8500 per 1% TBSA.

1.2 The prevalence and incidence of burns in South Africa

In the absence of a national burns register, the South African prevalence and incidence of burn injuries is an estimation based on studies that are mainly hospital-based (Blom, Van Niekerk & Laflamme, 2011). Understanding the epidemiological characteristics and associated risk factors for burns makes it possible to establish strategies that are imperative for planning and implementation of burn prevention programmes (Forjuo, 2006, Van der Merwe, 2008). As observed by Brigham and McLoughlin (1996), the epidemiological profiles and risk factors vary in different countries and therefore country-specific data is critical to the understanding of burns in South Africa.

South Africa has an “unrecognised epidemic” of burns, first noted in the literature in 1974 (Nuss, Davies & Van der Riet, 1974). As in South Africa, the burden of burns injuries remains high in sub-Saharan Africa, with little evidence to support a decline in burn-related injuries or deaths (Brigham & McLoughlin, 1996; Mzezwa, et al. 1999; and Eyal, Kemp & Luvhengo, 2007). Burns are preventable thus it is possible to decrease their incidence. In HIC, evidence-based preventative strategies addressing epidemiology and risk factors have reduced burns-related hospital admissions and mortality by up to 50%. This demonstrates that appropriate public health interventions could potentially impact the incidence of burns (World Health Organization, 2014b). The WHO has set out a seven-tiered plan for prevention and care of burns. This comprises, a global rather than country-specific initiative that although applicable, may not address country-specific risk factors and aetiologies. This includes burns intentionally inflicted on another person, which is considered a violent crime (World Health Organization, 2008b).

In South Africa, violent crimes impose a considerable health and economic burden on the population (Norman, et al., 2007). While trauma is a leading cause of death worldwide, the incidence is proportionately higher in LMIC (Peden, McGee & Krug 2000). IPV in particular, is ten times higher in LMIC when compared to HIC based on the socioeconomic circumstances (Hofman, et al., 2005). In South Africa, trauma has been likened to a

“malignant epidemic” with a disproportionately high level of IPV (Lewis & Wood, 2015). While many papers describe intentional burns and their impact on South African children, the opposite applies to South African adults where burns via assault are known to occur frequently but are poorly documented (Fourjuoh, 2006). Henceforth, there is a need to understand the potential differences between burns caused by assault and accidental burns (in terms of adult patient profiles, causal factors and impact), as this could impact policy for reducing the incidence of burns via assault.

1.3 Burns via assault

Burn injuries caused by assault are, by definition, intentionally inflicted. In the literature terms such as “deliberate”, “inflicted” and “non-accidental” are used interchangeably to describe the non-accidental mechanisms of burning (Greenbaum, et al., 2004). In both LMIC and HIC, assault burns result not only in significant medical problems but also in profound social sequelae (Rybarczyk, et al., 2017). The socio-economic impact of this intentional trauma is highly significant because of the resultant loss of productive years and the drain on limited health care funds (Marwa & Tarimo, 2019). Owing to their severity, the management of intentional burns (inclusive of assault burns) necessitates intense monitoring and treatment (Vetrichevvel, et al., 2018). As indicated by Natarajan (2014), the occurrence of intentional (assault or self-inflicted) burn injuries varies across socio-demographic profiles, making it important to understand the risk factors, clinical profiles and behavioural patterns involved.

In a systematic review that included data from 22 European countries, it was established that burns due to assault occurred rarely in this geographic region (Brusselaers, et al., 2012). The reported prevalence of burns by assault in other HIC settings varies. Assault burns accounted for 2.4% of the patients admitted to a tertiary burn centre in the United Kingdom (UK) over an 11-year period (Malic, et al. (2007), and 3.3% of the cohort admitted to a Burns Intensive Care Unit (ICU) in Germany over a 16-year period (Theodorou, et al., 2011). In contrast, burns by assault are relatively more frequent in Southern Africa, although the prevalence varies geographically (Reiland, et al., 2006 and Modjarrad, et al., 2007). Van der Merwe (2008) reported that the Tygerberg Adult Burns Unit in Cape Town had an average of 37% of annual admissions as the result of assault. A review of a major

burns unit in the Western Cape, however, revealed that only 5% of burns were due to assault (Maritz et al., 2012), while 16% of burn admissions in a Kimberly-based accident and emergency department arose from assault (Giaquinto-Cilliers, Links & Van der Merwe, 2014). Currently, this variable prevalence of burns by assault across the country is not well understood.

1.4 Mechanisms of burn injury

Although individual mechanisms of burn injury vary, they can be broadly categorised into burns caused by fire or flame; scalding via a hot liquid such as water, oil, chemicals and electrical burns. Burns by flame or fire are the most common accidental mechanisms globally and account for about 265 000 deaths each year (Murray & Lopez, 2006). This is true not only in LMIC, but also in HIC; in the United States of America (USA) and the UK, flame burns were the most frequent burn injuries in 2010 and 2011 (Malic, et al., 2011).

When examining intentional burns by assault in South Africa, Allorto et al. (2009) reported that in Kwazulu-Natal (KZN) they most commonly result from scalding (53%). Similarly, in HIC the most common mechanism of burns has been reported as scalding. Ho et al. (2001) reported that in Hong Kong, scalding occurred in 21% of burns sustained via assault, with similar numbers (19.5%) in a German study (Theodorou, et al., 2011). The significance of the mechanism of burn injury lies in the impact on survival – for example flame burns are more than likely to be deeper than scald burns, with greater potential to be fatal than scald burns (Allorto, et al., 2009).

1.5 Demographic data

Certain demographic factors, including sex and age, are risk factors for increased burn incidence globally in both intentional and unintentional burns (Sarhadi, Murray & Reid, 1995). In a systematic review of global trends in burns epidemiology, the mean male to female ratio was 1.92:1 (Smolle, et al., 2017). The studies of Malic et al. (2006) and Outwater et al. (2013) show a male predominance among assault burn patients. Other studies conducted in both HIC and LMIC report a higher proportion of females being burnt intentionally, but the reasons for this disparity are not explored in the literature (Vetrichevvel, et al., 2018).

While a review of 14 countries in sub-Saharan Africa indicate equal ratios between the sexes for burns incidence (Nthumba, 2016), studies from South Africa are conflicting. Some demonstrated a male predominance of intentional burns (Den Hollander, et al., 2014), and others an even distribution between men and women (Allorto, et al., 2009). Other African countries, for example Ghana, have no significant sex differences with intentional burn injuries (Forjuoh, 1995); but Egypt and Pakistan have a female predominance of assault-related burns (Hemeda, Maher & Mabrouk, 2003).

In addition to sex, the age profiles of burn patients vary between LMIC and HIC. The mean ages of patients with burn injuries in HIC tend to be higher, with studies reporting a mean age of 45 to 46 years (Burton et al., 2009). In LMIC, those sustaining burns appear to be younger. For example, in Sri Lanka the median age for burns is reported as 22 years (Laloë, 2002), which is the same age as Iran (Maghsoudi, Pourzand & Azarmir, 2005); and in South Africa – from data collected over a ten-year period at Kalafong Hospital – the majority of patients were 26 to 30 years of age (Eyal, Kemp & Luvhengo, 2007).

1.6 Burns severity

The overall mortality rate from burns varies, depending on the income status of countries. It can be as low as 1% in HIC such as Canada (Burton, et al., 2009), but can increase to ten times this rate in LMIC such as Ecuador (10.2%) (Ortiz-Prado, Armijos & Iturralde, 2015). In a systematic review conducted in the Eastern Mediterranean Region (which comprises 22 countries of which only three are HIC; the rest being LMIC) the mortality rate varied, with the highest above 20% (Othman & Kendrick, 2010).

South African studies show mortality rates varying from 13.5%, 15.1% (Den Hollander, et al., 2014), 18% (Eyal, Kemp & Luvhengo, 2007) to 22% (Mzezewa et al., 1999). One South African study conducted by Allorto et al. (2009) remains an exception, with a lower reported mortality rate of only 2%.

The severity of burns depends on several factors, including percentage TBSA and whether inhalation injuries are sustained as part of the burn injury (Miller, et al., 2005). All

of these vary between assault and intentional groups, as well as by country. In HIC such as the UK, the percentage TBSA of the group that sustained burns due to assault ranged between 1% and 93%, with a median of 17.2% (Malic, et al., 2006). Data from the USA reports a mean percentage TBSA of 24.8% in burns via assault. Nevertheless, comparison to accidental burn TBSA remains scarce in the literature. South African studies, such as those conducted by Allorto, et al. (2009), Den Hollander, et al. (2014) and Maritz, et al. (2012) found the mean percentage TBSA for intentional burns in South Africa to range between 10% and 40%, which is broader and has a higher TBSA than comparative studies in HIC.

In HIC, burns admissions with associated inhalation injury is similar among countries such as the USA (7%) (Miller, et al., 2005) and Canada (6.5%) (Burton, et al., 2009), but appears to be almost double that in South Africa, as seen in a study from KwaZulu-Natal (KZN), where Den Hollander et al. (2014) reported inhalation injury of 13.6% in all adult admissions. Inhalation injury has been linked to increased length of stay in the hospital (LOS), which in turn may be associated with greater burn thickness, increased percentage TBSA, and poor quality of burns care (Miller, et al., 2005).

In HIC such as Canada, Burton et al. (2000) mean LOS was 20.4 days, and in Hong Kong the LOS in patients admitted with burns via assault was up to 65 days (Ho, et al. 2001). The American Burns Association reports a downward trend in the LOS for burn injured patients: in 1995 it was 13.07 days which decreased to 8.22 days in 2005 (Miller, et al., 2005). LMIC report a higher LOS e.g. in Ecuador the average LOS was 23 days (Ortiz-Prado, Armijos & Iturralde, 2015); in Zimbabwe the average LOS was 15 days (Mzezewa, et al., 1999) and two South African studies established an average LOS of 15 days (Allorto, et al., 2009) and 17 days in burns via assault (Duminy & Hudson, 1993).

2 IMPORTANCE OF THE STUDY

It is clear that burn injury statistics are region specific and that data from other countries cannot be extrapolated to South Africa. Apart from a high trauma rate, South Africa also has a complex IPV paradigm. The potential link between IPV the incidence of accidental burns could be vital in addressing burns prevention strategies for public health

intervention. Additionally, successful burns prevention strategies will have a positive socioeconomic impact. At present there is no formalised, national collection of medical or epidemiological data regarding burns trauma in South Africa. Data is needed on the aetiology of burns for a multitude of reasons. These include the need for the provision of local data to the South African government to enable informed public health policy for implementation of a burns prevention strategy, and to liaise with non-governmental organisations; social workers and communities on burns prevention (Giaquinto-Cilliers, Links & Van der Merwe, 2014). Data from the Adult Burns Unit (ABU) of the Chris Hani Baragwanath Academic Hospital (CHBAH) presents an opportunity to add to this effort. The CHBAH is the largest hospital in South Africa and although it has been collecting burn data for several years, data on burns via assault have not been formally analysed nor made publicly available.

3 AIMS AND OBJECTIVES OF THE STUDY

The aim of this study was to compare a range of factors associated with both assault and non-assault adult burn patient admissions over a nine-year period (2005–2014) in a tertiary referral hospital in Johannesburg, South Africa.

The study objectives were to:

1. Describe the demographic and clinical profile of adult burn patients admitted during the study period;
2. Compare the demographic and clinical profiles of the assault group (AG) versus the control group (CG); and
3. Compare clinical outcomes of adult burns admissions, as well as those between the AG and CG (mortality, total LOS and ICU admission).

4 RESEARCH METHODOLOGY

4.1 Definitions for this study

- 4.1.1 *Assault group (AG)* includes all adults who have suffered from a burn injury as a consequence of intentional injury by others (assault). Assault was assessed on patient history and/or collateral history.
- 4.1.2 *Control group (CG)* includes all adults who have sustained burn injuries accidentally (unintentionally) or resulting from intentional self-harm.
- 4.1.3 *Intent of the burn injury* describes whether the burns have been sustained as a result of assault/intentional injury or accidental/unintentional/self-harm.
- 4.1.4 *Mechanisms of burn injury* describe the cause of the physical burn:
- 4.1.4.1 *Flame burn* is used interchangeably with *fire burn* in the literature. A flame burn/fire burn is a burn resulting from the burning of gas or vapour of a fire that causes dry heat.
 - 4.1.4.2 *Scald burn* refers to a thermal burn resulting from wet heat, such as hot water, oil or steam.
 - 4.1.4.3 *Chemical burn* refers to a burn caused by corrosive or caustic chemicals, which can be either acids or bases.
 - 4.1.4.5 *Electrical burn* is a burns that occurs when high-energy current travels through the body due to contact with an electrical source.
 - 4.1.4.5 *Inhalation injury* refers to a spectrum of clinical diseases that occurs when the respiratory system is acutely exposed to extreme heat or toxic substances. It produces injury through several mechanisms, including thermal injury to the upper airway, irritation or chemical injury to the airways from soot, asphyxiation and toxicity from carbon monoxide and other gases. The gold standard of diagnosis is via bronchoscopy, but in this study, inhalation injury was based on a clinical diagnosis.

4.2 Study design and sample selection

The University of the Witwatersrand Health Research Ethics Committee approval was granted prior to commencement of the study (see Appendix A). A retrospective review was conducted of all adults admitted to the Adult Burns Unit (ABU) at Chris Hani Baragwanath Academic Hospital (CHBAH) between September 2005 and December 2014. The ABU at CHBAH is a specialist burn referral centre for public hospitals and primary health care clinics in the greater Johannesburg area and receives referrals from other parts of Gauteng province as well as neighbouring provinces.

The cohort was divided into a control group (CG) and an assault group (AG). All adults, (18 years and older) requiring acute emergency admission for a new burn injury (less than 7 days old) were eligible for inclusion in the study. Patients younger than 18 years of age and any patients readmitted for elective or reconstructive surgery because of a prior burn injury (chronic) were excluded from the study.

4.3 Data collection and statistical analysis

The following variables were collected from the data base (see data collection sheet: Appendix B):

4.3.1 Descriptive/demographic characteristics: age and sex

4.3.2 Clinical characteristics: intent of burn injury (assault, accidental/self-inflicted); mechanisms of burn injury (flame, scald, electrical, chemical, other); percentage TBSA burnt (assessed using the rule of 9's); inhalation injuries

4.3.3 Outcomes: requirement for ICU admission; (LOS) in ABU; mortality (limited to death during admission to ABU)

Study variables were collected using an EXCEL spreadsheet for a graphical summary and exported to Stata 15 (V. 11.0) for statistical analysis. To test the differences between assault and control groups in respect of the means of age, sex, percentage TBSA and LOS, the independent t-test was used. Samples were first checked for equal variances by using Levene's test. The AG and CG mortality, inhalation injury, mechanisms of injury and ICU admission, were analysed for significant associations ($p < 0.05$). Where indicated, the

choice of statistical test was informed by determining whether the data were normally distributed. If the distribution was normal, parametric tests were conducted. If the distribution was non-normal, the skewness kurtosis was calculated and non-parametric tests were done.

5 RESULTS

The researcher reviewed 1987 records for inclusion in this study and of these, 27 records were excluded due to missing data and 32 patients did not meet inclusion criteria (23 were younger than 18 years of age and nine admissions were for chronic injuries). The number remaining for inclusion in the analysis for this study totalled 1928.

5.1 Demographic and clinical profile of all adult burn patients admitted during the study period (Objective 1) (Table 1.1)

Table 1.1 summarises the demographic data and clinical profiles of all the ABU admissions for the study period, stratified by sex. The majority (65.5%) of all admissions were male (1263 records). The mean age was 31 years (standard deviation (SD) 15 years). Overall, the clinical profile for all adult admissions showed the main mechanisms of burn injury in men and woman was as a result of flame burns. Most admissions were for non-assault related burns (74.1%). Assault related burns comprise 21.4% of the study cohort and self-harm cases comprise the remainder. The self-harm cases were grouped into the CG for analysis. Taking all acute admissions to the ABU into account, 350 patients (18.2%) had inhalation injuries. The median percentage TBSA was 15.0, with a range of 1–90 (Table 1.1).

5.2 Demographic and clinical profiles of the assault group versus the control group (Objective 2) (Table 1.2)

When comparing the AG and CG, there was no significant difference with respect to sex and age. In the AG, almost equal proportions of scald and flame burns were recorded - the most common burns were scald burns. In the CG, by far the most common mechanism of injury was flame burns. For both the CG and AG, the combined frequencies of burns due to chemical or electrical injury were less than 10%. There were only two records of assault burns through electrical means over the time-period.

Table 1.1: Demographic data and clinical profile of overall cohort admitted to ABU (2005–2014), stratified by sex

Variable	Male N (%)	Female N (%)	All N (%)	p value
Sex N (%)	1263 (65.5)	665 (31.5)	1928	< 0.001
Age years (mean; SD)	33.125 (8)	30.4 (13)	31 (15)	< 0.001
Inhalational injury	196 (10.2)	154 (8)	350 (18.2)	0.12
Percentage TBSA (median; IQR)	14.4 (13.8–17.9)	18.8 (18.0–21.3)	15 (14.85–20.4)	0.012
<i>Mechanism of burn injury</i>				
Flame	683 (35.5)	479 (24.8)	1162 (60.3)	< 0.001
Scald	340 (17.7)	251 (13)	591 (30.7)	0.01
Chemical	23 (1.3)	20 (1)	45 (2.3)	0.56
Electrical	96 (4.9)	21 (1.1)	117 (6)	< 0.001
Other	6 (0.3)	7 (0.4)	14 (0.7)	0.72
<i>Intent of the burn injury</i>				
Accidental	980 (77.6)	448 (67.4)	1428 (74.1)	< 0.001
Assault	259 (20.5)	154 (23.2)	413 (21.4)	0.17
Self-harm	24 (1.9)	63 (9.4)	4.5 (87)	< 0.001

Table 1.2: Demographic data and clinical profile of assault and control groups admitted to ABU (2005–2014)

Variable	AG N (%)	CG N (%)	p value
Age years (mean; SD)	31 (17)	33 (14)	0.466
Sex (M:F)	259:154 (62.7:37.3)	1004:511(66.2:33.7)	0,197
Inhalation injury	66 (16)	284 (19)	0.22
Percentage TBSA (median; IQR)	21.24 (21.2–22.6)	23.65 (23.7–25.2)	<0.05
Mechanism of burn injury			
Flame	185 (44.8)	976 (64.4)	<0.001
Scald	196 (47.5)	395 (26.1)	
Chemical	30 (7.3)	15 (1)	
Electrical	2 (0.4)	115 (7.6)	
Other	0	14 (0.9)*	

* 1 x unknown herbal application; 1 x spontaneous unknown aetiology; 12 x Stevens-Johnsons syndrome/toxic epidermal necrolysis

5.3 Clinical outcomes of overall study cohort, assault group and control group (Objective 3) (Table 1.3)

Table 1.3 details the outcomes in terms of mortality, LOS and ICU admissions. Of the 1928 admissions, 1550 (80.4%) were discharged. This includes patients discharged to other wards at CHBAH and other hospitals as a step-down facility. Thus, the overall mortality rate was 19.6% (n = 378). Nonetheless, there was a significantly lower mortality in the AG, when compared to the CG (p<0.01).Of the entire cohort, 650 adults (33.9%), that were admitted required ICU admissions at some point during their hospital stay. The remaining 1275 patients (66.1%) were admitted to either the high care area and/or the main ward. There was a significantly fewer admissions to ICU for the AG when compared

to the CG ($p < 0.01$). The mean LOS in the ABU was 15 days overall, with a range of 1 to 67 days, and there were no significant differences between LOS for the AG and CG ($p = 0.062$).

Table 1.3: Outcomes of the cohort, assault and control group

Variable	All Cohort N (%)	AG N (%)	CG N (%)	p value
Mortality	378 (16.9)	62 (15)	316 (21)	<0.01
ICU admissions	650 (33.8)	117 (28)	536 (35)	<0.01
LOS days (mean; SD)	15 (24.65)	21.2 (22.6)	23.6 (25.2)	0.062

6 DISCUSSION

Assault by burning is a severe form of trauma. Globally the circumstances surrounding assault by fire and scald are consistent with the themes of IPV (Duminy & Hudson, 1993; Ho, et al., 2001; Peck, 2012). Rates of this form of assault, however, are unevenly distributed throughout the world. To the best of our knowledge this study is one of the largest audits of adult burns from a dedicated ABU in South Africa, and the only study specifically looking at clinical profile and outcomes of burns by assault in South Africa. There is a paucity of data on assault burns in adults as, especially in LMIC, the majority of studies focus on children (Fourjuoh, 2006). Additionally, most studies compare intentional (assault and self-harm) and unintentional burns; with very few studies including a subgroup analysis within the intentional group i.e. self-inflicted versus assault burn injury. Even fewer studies look exclusively at characteristics of assault burns. This study showed that the incidence of burns from assault is significantly higher than in the majority of LMIC and in all HIC. Many of our findings in this study do not concur with previous studies conducted across the world.

This study showed assault accounted for 21.4% of burns admitted to the ABU which is the highest prevalence reported for assault burns globally. In other South African studies looking at assault burns, the incidence ranges between 5.7% and 18%. A Western Cape based study reported an incidence of 18% between 1986 and 1995, but a more recent study from the same institution reported a decline in burns via assault with an incidence of 5.7% between 2003 and 2008 (Maritz, et al., 2010). In a study conducted in a Bloemfontein hospital in 2018, 22.4% of the burn injuries were intentional but only 14.3% were resulted from assault (Daffue, et al., 2018). A study from KZN showed an incidence of 11.7% of burns secondary to assault (Scheven, Barker & Govindasamy, 2012), while another South African study reported an incidence of 25.3% for intentional burns but did not specify assault versus self-harm (Boissin, et al., 2019).

The incidence of burns by assault in sub-Saharan Africa has been reported as far higher than in HIC (Nthumba, 2016) but other LMIC report more variable and contrasting data. Studies from the following LMIC show the incidence of burns secondary to assault: Sri Lanka 3.5% (Laloe, 2002); Nepal 3% (Lama, et al., 2015); Brazil 5.3% (Duarte, Neumann & Weber, 2015); and Pakistan only 0.72% (Adil, et al., 2016). These figures are all significantly lower than both the reported South African numbers and the findings of our study, and are more in keeping with reports from HIC. An annual incidence of between 0.4% and 3.3% is reported in HIC (Forjuoh, 2006; Peck, 2011; Theodorou, et al., 2011 and Vetrichevvel, et al., 2018) and hospitalised burn patients globally have incidence rates for assault by fire and scalds ranging from 3% to 10% (Peck, 2012).

South Africa has been described as having the highest rates of IPV burden in the world (Norman, et al., 2007) which may account for the volume of assault burns this study has shown; one in five admissions to the ABU was as a result of assault. Of major concern is that hospital-based data often underestimate true incidence at population level (Dissanaike and Rahimi, 2009). A complex combination of factors including geographic, cultural (Laloe, 2002) and historic play a role. A consistent theme across published international studies is that burns arising from IPV are more frequent in socioeconomically disadvantaged groups, the unemployed, ethnic minorities and migrants (Murphy, et al., 2019). Alcohol is a risk factor for violent behaviour in South Africa (Norman, et al., 2007),

and along with psychiatric illnesses are associated with assault burns globally (Peck, 2012). Assessment of all these variables was not part of the scope of this study, but may account for the higher incidence of assault burns identified and as such needs exploration and examination in future studies.

In this study, the overall ratio of men to women in the cohort was 1.9 and when comparing the AG to the CG, the male to female ratios were 1.68 and 1.98 respectively. There was a higher ratio of male to female assault burns in the ABU but this was not statistically significant. In terms of gender, victims of assault by fire and scalds were more likely to be male in a German study (Theodorou, et al., 2011). This study shows there is not a significant difference in sex distribution even though a higher percentage of males were assaulted via burns. Our findings are different to multiple other studies in South Africa and other countries where assault by fire and scalds had a male prevalence (Stone, 1988; Duminy & Hudson, 1993; Theodorou, et al., 2009; Maritz, et al., 2012). The sex distribution in studies from LMIC all show a significantly higher incidence in male victims of assault burns as follows: Pakistan with a 56.43% incidence (Adil, et al., 2016) and Nepal 79% (Lama, et al. 2015). In contrast, a study from India indicated that more burns from assault were sustained by females (Bhate-Deosthali & Lingam, 2016). HIC studies (Malic, et al., 2007; World Health Organization, 2008b; Peck, 2012; Atwell, et al., 2020) including a recent study from Australia and New Zealand (Toppi, Cleland & Gabbe, 2019), all showed a higher male prevalence of burns via assault. An exception to this was an Australian study that had a higher incidence of burns via assault in females (O'Halloran, et al., 2013).

Young men in South Africa have been known to use violence as a way of asserting their dominance and may consider violence an accepted strategy for resolving conflict (Norman, et al., 2007). Most assault burns described in other studies is linked to domestic conflict and extra-marital affairs; are often unplanned, emotive reactions of females to male victims; or related to domestic violence and is in self-defence (Peck, 2012). From the literature above, it appears that community violence and interaction could therefore also be considered as potentially impacting the sex distribution in this study. In the literature it is also suggested that females seem to use burning and in particular scald

burns as a means of retaliation and defence in conflict, thus, causing burn injuries in males. This could be a potential reason for more male victims in the study..

In this study, scalding was the most common mechanism of burn assault, which is similar to other South African studies that show scalding as the most common agent involved in burns related to IPV in adults in South Africa (Godwin & Hudson, 1998). This is consistent with the findings of a systematic review on burns in sub-Saharan Africa as an intentional injury, where the majority (59%) was secondary to scalds (Nthumba, 2016). While scald burns appear to be the most common mechanism of assault burns in Africa (with the exception of Nigeria, where flame burns were most common (Peck, 2012), other LMIC showed that flame burns were most common in assault. In Nepal, 96% of assault burns were due to flame (Lama, et al., 2015) and in Sri Lanka these comprised 67% (Laloe, 2002). HIC also have a mixed picture. Flame burns as the main mechanism of assault was reported in Germany with 68.3% (Theodorou, et al., 2011) and the UK with 71% (Malic, et al., 2007). In the USA, however, 67% of assault burns were via scalding (Atwell, et al., 2020), with the exception of Detroit where flame burns were more prevalent (Peck, 2012). Assault by fire is often related to poverty and criminal activity (Ho, et al., 2001). Assault by scalding is usually an impulsive violent act and has been associated with alcohol abuse, low socio-economic status, poor education, the so-called “lovers’ quarrel” and unemployment (Stone, 1988). Duminy and Hudson (1993) found that assault by hot fluids is underestimated. Duminy and Hudson’s (1993) assertions are concurred in the findings of this study where the majority of assault victims were burnt via scolding.

In this study, the mortality rate was significantly higher for the CG compared to the than the AG. Other South African studies show a similar trend with mortality from assault that, while high tends to be lower than in the unintentional group of burns. The assault mortality rate was 22.9% versus 25.5% overall mortality in the Western Cape (Maritz, et al., 2010) and similarly in KZN there was a 13.5% assault mortality versus 16.2% overall mortality (Scheven, Barker & Govindasamy, 2012). This appears to be unique to South Africa. The mortality of burns via assault is higher than the unintentional burns in other LMIC namely: Brazil 25.7% versus 8.8% (Duarte, Neumann & Weber, 2015) and Nepal 39% versus 22% (Lama et al., 2015). A similar pattern is seen in HIC, where the mortality of assault is

significantly higher than unintentional burns. The assault burn to unintentional burn mortality rate is 10% versus 2.3% in Hong Kong (Ho, et al., 2001); 7.2% versus 2.5% (Modjarrad et al., 2006) in the USA in a review of the National Burns Repository and 13.9% versus 2.5% (Reiland, et al., 2006) in a epidemiological study in Alabama, USA. Two studies from HIC show that while the assault mortality rate is higher than in unintentional burns, it was not significantly higher in Germany (Theodorou, et al., 2011) and the USA (Atwell, et al., 2020). The mortality pattern of this study can potentially be explained by considering that most assaults in the AG were scald induced which usually cause less severe burns (both in depth and in size), and thus a shorter hospital stay with better outcomes than flame burns (which was the major mechanism of burns in the CG).

Analysis of the clinical profile and outcomes in this study (as a marker of severity) of assault burns did not show an increased severity when compared with the CG. The incidence of inhalation injuries was lower in the AG (16%) versus the CG (19%). The LOS and ICU admissions were also lower in the AG (21.2 days and 28% respectively) than the CG (23.6 days and 35% respectively). The percentage TBSA burned was also lower in the AG (21.21) versus 23.65 in the CG. While there are no studies from South Africa that look at these factors specifically in assault burns, there are some findings with regard to percentage TBSA burned and assault. One study shows a lower percentage TBSA burned in assault burns (13%) than the average of 23% reported in that burns unit (Allorto, et al., 2009), which is similar to this study. Findings in most studies from both LMIC and HIC differ significantly to ours in that they report significantly more severe injuries and worse outcomes in assault burns, with higher percentage TBSA burned; a higher proportion of inhalation injury; more likely to need ICU admission; and longer LOS (Ho, et al., 2001; Modjarrad, et al., 2007; Duarte, Neumann & Weber, 2015; Atwell, et al., 2020). The exception to these is a study from Germany which did not report a significant difference in percentage TBSA burned ($p = 0.295$) and ICU admissions ($p = 0.422$) between their AG and CG (Theodorou, et al., 2011).

In the absence of a National Burns Repository in South Africa, countrywide epidemiological data is not available and it is thus impossible to know whether or not the findings in this study are representative of the country as a whole. Our finding that the AG

burns are not as severe and the outcomes are better than the CG is both a relatively novel finding and unexpected, and may be related to the mechanism of burn being more scald burns as opposed to flame burns.

7 LIMITATIONS OF THE STUDY AND RECOMMENDATIONS FOR FUTURE RESEARCH

One of the limitations of this study was the specific sample population, which was limited to the admissions to a specialist ABU in an urban tertiary hospital setting. The sample population is not necessarily representative of the entire population across different provinces and of more rural environments. Additionally, the data relied on retrospective hospital records for which the accuracy of the information and the lack of certain data points could not always be accounted. This study is limited by its retrospective methodology and that it is derived from a single regional burn centre, which may limit the general application.

This study set out to assess the differences in profiles between assault and non-assault burn injuries. For analysis, this study combined accidental and self-inflicted burns into one group to specifically compare with assault burns as a standalone group. Although self-inflicted burns were a very small proportion of the data analysed, separating these causal factors may provide a deeper understanding of adult burn profiles. Likewise including a comparison to paediatric burn injuries, although beyond the scope of this study, is recommended for future studies as self-inflicted burns in children is very limited so most intentional burns most likely assault based. This may also provide further insight into the complexity of IPV and, if it has strong gender related roles, the role the environment may play on the children. In addition, paediatric data is required to ascertain if the mechanisms, intent and severity of the burns are similar to the data relating to adults.

The mortality data used in this study were from deaths that occurred only in the ABU. Information was not available on mortality within a specific time frame after discharge (either at home or following transfer to other wards within the hospital or discharge to other hospitals) thus more long-term mortality rate may be underestimated. The findings and preliminary understanding of the magnitude of assault as an intent of burns in South Africa

should lead to more in-depth research on this important public health subject. This facet of burns epidemiology is likely to uncover more complex public health issues that are beyond the scope of this study.

The diagnosis of inhalation injury was based on clinical diagnosis as opposed to the widely accepted gold-standard of bronchoscopy findings. This may have under or overestimated the inhalation injury data which in turn may have altered the results yielding them as subjective rather than objective.

Future research should focus on data such as racial distribution, socioeconomic status, marital status, employment, alcohol intoxication at time of burn and psychiatric illnesses to try and tease out risk factors and reasons for assault burns. This is likely to assist in defining previously unrecognised complexities in IPV and gender based violence and thus identifying potential intervention opportunities.

Should future studies evaluate and prove the trends that have been suggested in South African literature and the findings of this study, then these factors may be targeted in potential future prevention programmes to potentially include the following:

- Assault burns involve contributory factors often associated with domestic violence at home. Most of these factors could be targeted in prevention programmes and include: abuse of alcohol by husband or partner; verbal and physical abuse; quarrels over family matters; money issues; job issues; infidelity; lack of help in resolving disputes; mental health (including the victim's frustration, anger and depression before the incident); lack of family support; anger management; no knowledge of self-defence skills. Perhaps introducing practical strategies to ensure the ongoing safety of burn victims.
- Burn clinicians should remain cognisant that the complexity of managing such patients goes beyond simply achieving timely burn wound closure. Awareness of at-risk populations such as socioeconomically disadvantaged groups; the unemployed, ethnic minorities and migrants should be emphasised.

8 CONCLUSION

The incidence of burns via assault was higher than other countries and in keeping with other South African studies. The majority of assault burns were as a result of scald injuries. There was no significance in the sex and age demographics between the AG and CG. The results of this study were contrary to most global studies published in that the CG tended to have more severe burns (by TBSA, LOS, ICU admission rates, inhalation injuries and mortality rates) than the AG.

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10 APPENDICES

Appendix A: Data sheet

	YEAR
Total admissions	
ICU admission	
Male	
Female	
Mean age	
LOS	
TBSA	
Accidental (Control)	
Assault	
Flame	
Scald	
Chemical	
Mortality	

Appendix B: Ethical clearance

Human Research Ethics Committee (Medical)

Research Office Secretariat: Senate House Room SH 10004, 10th floor. Tel +27 (0)11-717-1252
Medical School Secretariat: Phillip Tobias Building, 2nd Floor Tel +27 (0)11-717-2700
Private Bag 3, Wits 2050, www.wits.ac.za. Fax +27 (0)11-717-1265



03 July 2015

To Whom It May Concern

SUBJECT: CONFIRMATION OF STUDY APPROVAL

Protocol Ref No: M150633

Protocol Title: The Prevalence and Clinical Profile of Adult Burns due to Assault: A South African Adult Burn Centre Review

Principal Investigator: Dr Sheree koonin

Department: Surgery

This letter serves to confirm that the Human Research Ethics Committee (Medical) has approved the above mentioned study. In order for a clearance certificate to be issued, the researcher is required to submit written approval to conduct the study in your district/institution.

Should you have any queries, you may contact me at tel 011 717 1252/1234/2700 or by email Zanele.ndlovu@wits.ac.za.

Yours Faithfully,

A handwritten signature in black ink, appearing to read 'Zanele Ndlovu', written over a dotted line.

Ms Zanele Ndlovu
Administrative Officer
Human Research Ethics Committee (Medical)





The Faculty of Health Sciences
c/o Ms Sandra Benn, Faculty Registrar

cc: Ms Natacha Searle - Wits Legal Office

26 February 2021

RE: DECISION REGARDING MATTER CONCERNING OUTSTANDING ETHICS CLEARANCE FOR DR SHEREE KOONIN (STUDENT NUMBER 9501722V)

1. I have received feedback from the University's Advisory Committee on Ethics ("ACE") which convened in order to provide advice in relation to the matter concerning Dr Koonin's outstanding final ethics clearance certificate.
2. As per the advice of ACE, the University's position on the matter of final ethics clearance remains unchanged. By way of explanation, I note that HREC:M, which is the body seized with the responsibility of issuing both ethics approval and clearance, is unable to issue an ethics clearance certificate after the fact, because this would constitute a contravention of the National Health Act and in particular of paragraph 1.6.9 of the Department of Health's Ethics in Health Research: Principles, Process and Structures 2015 Guidelines document which specifically provides that '*retrospective review and approval or clearance is not permitted*'. Accordingly, no final ethics clearance can be issued to Dr Koonin.
3. Notwithstanding this, and under the circumstances, the University is willing to allow for the examination of Dr Koonin's research report in accordance with the University's rules, regulations, policies and procedures (the 'University's Rules') in order to enable her to progress with her studies and potentially graduate. Dr Koonin, must however be reminded that she may not be in a position to publish in academic journals, because no final ethics clearance letter has been issued and it is the established practice of most journals that research may not be published without an ethics clearance certificate.
4. The Faculty of Health Sciences is accordingly requested to engage with Dr Koonin to facilitate the submission of her research report for examination in accordance with the University's Rules.
5. The University now considers this matter to be finalised.

Yours faithfully

A handwritten signature in black ink, appearing to read 'João AP Rodrigues'.

Professor João AP Rodrigues
Acting Deputy Vice-Chancellor: Research and Innovation

Appendix C: Turnitin report

Dear Dr Koonin

Herewith your MMed plagiarism report attached.
Your similarity index is 8% with a maximum single match of $\leq 1\%$.

Therefore, your similarity index is **acceptable** within the Department of Surgery.

For PG submissions - Please only print out the Turnitin report pdf pages in the attached report showing the similarity index (page 23-26), as well as this email stating that your plagiarism report is acceptable within the Department of Surgery.

Kind regards,

Deirdré

 <p>WITS UNIVERSITY</p>	<p>Associate Professor Deirdré Kruger <i>BSc, PGCHE, PhD (UK)</i> Head of Research & Laboratories in Surgery Department of Surgery, Room 9M09 Address: 7 York Road, Parktown, Johannesburg Tel: +27 (0)11 717 2376 Email: Deirdre.Kruger@wits.ac.za Website: www.wits.ac.za</p>	 <p>WITS SCHOOL OF CLINICAL MEDICINE</p>	 <p>FACULTY OF HEALTH SCIENCES</p>
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ORIGINALITY REPORT

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