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The Epidemiology of Paediatric Burn Injuries in Johannesburg, South Africa

By

Dr Agatha Tafadzwa Banga

A research report for submissible paper submitted to The Faculty of Health Sciences, University of The Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Medicine in Paediatric Surgery.

DECLARATION

I, Agatha Banga, student number 1918337, declare that this research report is my own work. It is being submitted for the degree Master of Medicine within the Department of Paediatric Surgery of the University of the Witwatersrand, Johannesburg.



Agatha Tafadzwa Banga

20 June, 2022

DEDICATION

I dedicate this work to my grandmother, Winnie, in memoriam;

ACKNOWLEDGEMENTS

I would like to acknowledge the following persons, without whom, this report would not have been possible.

1. My supervisors, Dr Christopher Westgarth-Taylor and Dr Andrew Grieve.
2. The staff of the Department of Paediatric Surgery at The Chris Hani Baragwanath Academic Hospital who supported this study and assisted in collecting data for the study.
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PUBLICATIONS AND PRESENTATIONS ARISING FROM THIS STUDY

Pending publication.

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LIST OF ABBREVIATIONS AND ACRONYMS

CHBAH	Chris Hani Baragwanath Academic Hospital
CHC	Community health centre
HICs	High income countries
IQR	Interquartile range
J&JPBU	Johnson & Johnson Paediatric Burns Unit
LMICs	Low- and middle-income countries
MO.	Months
NO.	Number
PBU	Paediatric Burns Unit
TBSA	Total body surface area

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Draft article:

The Epidemiology of Paediatric Burn Injuries in Johannesburg, South Africa

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ABSTRACT

Background

Children remain the most common victim of burns in Sub-Saharan Africa. We investigated the epidemiology of burn injuries of the paediatric patients admitted to the Paediatric Burns Unit (PBU) at the Chris Hani Baragwanath Academic Hospital (CHBAH).

Objectives

To describe the epidemiology of paediatric burn injury among those admitted to CHBAH.

Methods

This was a hospital based cross-sectional study, with data collected at the time of admission via an accompanying caregiver questionnaire and via clinical examination of the patient by the admitting doctor.

Results

A total of 509 patients were admitted to the unit over a 12-month period, with 482 patients included for baseline analysis. 50% of admitted patients were between 15 and 47 months with a median age of 25 months. 58% of participants were male. 53% of all admissions had burns above 10% total body surface area and were considered severe burns. The predominant mechanism of injury was scalding (84%), with most overall in the winter season (32%). The most common site of burn was upper limb (75%). 63% of all admissions received first aid. Among those who received first aid,an appropriate first aid method was provided in 74% of the cases.

226 out of 482 participants (47%) provided sociodemographic information. Access to basic amenities such as electricity was high, with most admissions coming from households with access to electricity (91%) and using electricity for cooking (83%). Basic level education was shown by 90% of caregivers holding at least a high school leaving certificate. Migrant caregivers made 19% of the caregivers, which was four times the proportion of foreign nationals counted in the national census. Over three quarters of admissions (79%) were referrals from other centres.

Severe burns were associated with thermal mechanism of injury ($p<0.01$), multiple burn sites ($p <0.01$), and receiving first aid prior to admission ($p=0.01$). No sociodemographic factors were associated with increased burn severity.

Conclusion

Children under two years of age and minority groups are at greatest risk for burn injury and should therefore be targeted for burn injury prevention. Education on appropriate first aid is essential to educate the community. Future research should investigate caregivers of children with burn injury.

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Manuscript

INTRODUCTION

Globally, almost 10% of all childhood deaths related to injury, are secondary to burn injuries [1]. In Sub-Saharan Africa, over 80% of burns occur in children under 10 years of age, with burns accounting for 20% of childhood deaths [2]. Those who survive, are often left with severe disability and disfigurement and sometimes social stigma. [3] Burns accounts for 10 million disability adjusted life years lost each year. [3] Risk factors for paediatric burn injury are known to be a combination of physical, social, political and economic factors [1]. When burns do occur, appropriate and adequate first aid improves burn injury outcome by preventing progression of tissue damage [4, 5] Despite this massive impact burns has on people in Sub-Saharan Africa there are only a few studies in LMICs exploring first-aid and prevention used for burns within the community [6, 7].

Our unit in CHBAH is housed in the largest hospital in the southern hemisphere [8]. CHBAH is situated within what used to be an informal settlement, but which has become a fast-growing formal urban environment with a cross-section of low, middle and high-income individuals [8]. The high volume specialised paediatric centre for burn management at the CHBAH serves as a local, regional, and multi-provincial referral centre for paediatric burns patients. Investigating patients in this unit provides unique insight into childhood burn injury.

Therefore, the overall aim of this study was to investigate the epidemiology of burn injuries of paediatric patients requiring admission to the PBU at CHBAH by identifying the demographic profiles and the burn injury characteristics. The information provided aimed to bridge the gap in knowledge about burn injury in developing countries, and to assist in addressing possible implementation strategies to decrease the incidence of childhood burn injury.

METHODS

This was a prospective study with data collection completed over a 12-month period from the 19th of September 2018 to the 18th of September 2019. Convenience sampling was used, and all children under the age of 10 whose caregivers consented to participation were recruited. All enrolled participants had a pre-formed questionnaire completed by the admitting doctor. The pre-formed, paper based, questionnaire included demographic and socio-economic information of the child, including physical examination findings on admission.

Statistical Analysis

We used the Stata Statistical Software (Release 14) for data exploration and analysis of cross-sectional data captured at the time that each participant was admitted. Descriptive analysis of baseline and

sociodemographic characteristics of participants was done using appropriate descriptors and diagrams. All continuous variables were not normally distributed as evidenced by the Shapiro-Wilk Test for normalcy and were therefore described using medians and interquartile ranges. Results were tabulated and graphs were used to illustrate appropriately. Associations between burn severity (≤10% total body surface area as not severe, >10% total body surface area as severe) and categorical variables (baseline and socio-demographic) using $\chi 2$ tests with two degrees of freedom were run. For continuous variables, associations between the groups of burn severity were tested by analysis of variance.

RESULTS

We admitted 509 patients to the PBU over the 12-month study enrolment period from 19th September 2018 to 18th September 2019. In baseline demographic data, incomplete data was found in 27 patients (5%) thus leaving a sample of 482 patients for analysis. A response rate of 46.9% (n=226) was achieved from caregivers who provided information on circumstances surrounding the burn (*Figure 1*).

The median age of participants at the time of admission was 25 months (IQR 15 – 47months). Three quarters of patients were 4 years and below (76%, n=361), but with only 5% being six months or younger (n=23). The ratio of male to female participants was 1.38:1 with 58% of participants being male (n=279) (*Table 1*).

Hot water scalds (84%) were the predominant mechanism of injury (n=403). Flame burns were the second most common cause of burn injury (9%, n= 42). Other unexpected mechanisms of burn injury including two firecrackers, and one aerosol can explosion (1%, n = 3) (*Table 1*).

1348 anatomical burn sites were recorded in the 482 participants because three quarters of the children sustained burns in more than one anatomical site (75%, n=362), with upper limb burns being the most common site affected (23%, n=303), followed by lower limb burns (20%, n=255) (*Table 1*).

Most admissions took place in winter (32%, n=156), followed by spring (27%, n=130) and autumn (24%, n=117) (*Figure 2*).

Characteristics of Caregivers

Out of 482 patients only 226 participants completed their socio-demographic profile. Caregivers were not asked whether they were present at the time of the burn injury.

In this cohort of responders, the caregivers were mostly self-identified South African nationals (81%, n= 183). 90% of all caregivers demonstrated having attained at least a school leaving certificate (n=203) *(Table 2*).

Participants came from households where electricity was available 91% of the time (n=205). Our study showed that electricity was also the most common cooking fuel (83%, n=187), followed by paraffin (10%, n=23) *(Table 2).*

Almost two thirds of patients had received some method of first aid prior to arrival (63%, n=142). Of those who received first aid, 9% used more than one method of first aid post burn (n=21). Among those who received first aid, an appropriate first aid method was provided in 75% of the cases (n=123). The most commonly used alternative first aid methods included toothpaste (7%, n = 11) and egg (5%, n= 8) (*Table 2*).

In this group, 79% of patients were referrals from other centres of all levels (n=178), with 21% being walk-ins(n=48) *(Table 1).* Referrals were from within and beyond the provincial border.

In this study, burns above 10% TBSA were classified as severe, without consideration of site, mechanism of burn or other factors that can assist in classifying a burn as severe (*Table 5*). Of all admissions, 47% had severe burns (n= 154).

Table 5 shows participant stratification by burn size above and below 10% TBSA. Those with burns above 10% TBSA were more likely to have been burnt in multiple areas ($p<0.01$) and have thermal burns ($p<0.01$) as compared to those who had smaller burn percentage. Participants with severe burns were more likely to have received first aid ($p=0.01$) in comparison to those whose burns were less than 10% TBSA. Burn severity did not significantly differ by sociodemographic factors including caregiver education status ($p=0.76$), caregiver nationality ($p=0.17$), and accessibility of basic amenities such as formal housing ($p=0.84$) and access to electricity ($p=0.14$). Participants referred to the unit did not have significant difference in burn severity compared to walk-in participants ($p=0.45$).

Figure 1 Showing Selection of Participants for Data Analysis

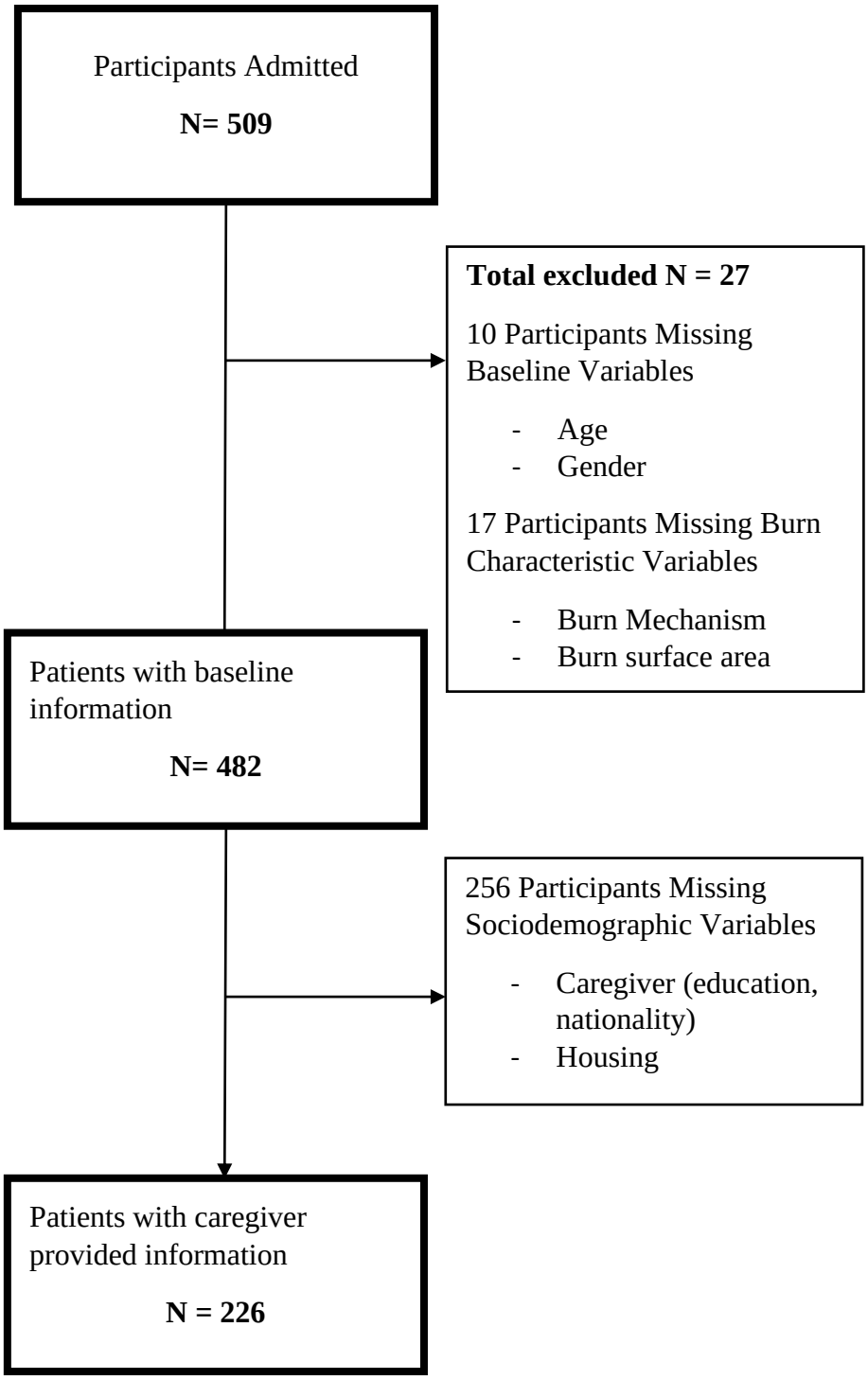


Table 1 Showing Baseline Characteristics of Study Participants

	Count *N=482*	*%*		Count *N=482*	*%*
Age *(months)*			**Burn site***		
0-6	23	5	Upper limb	303	23
7-12	54	11	Lower limb	255	20
13-24	162	34	Chest	219	17
25-36	76	16	Back	191	15
37-48	46	10	Head	138	11
49-60	36	7	Perineum	110	8
61-72	24	5	Neck	89	7
73-84	19	4			
85-96	23	5	Single site	120	25
97-108	4	1	Multiple site	362	75
109-120	15	3			
Age Category month –no. (%)			**TBSA *(%)***		
≤24	239	50	0-5	121	25
>24	243	50	6-10	133	28
			11-15	85	18
≤6	23	5	16-20	66	14
>6	459	95	21-25	22	5
			26-30	19	4
Median age-mo. (IQR)	25	(15-47)	31-50	34	7
			51-75	2	<1
Gender					
Male	279	58	**Season∞**		
Female	203	42	Winter	156	32
			Spring	130	27
Burn mechanism			Summer	79	16
Scald (hot liquid)	403	84	Autumn	117	24
Contact (hot solid)	11	2			
Flame (fire)	42	9	Winter	156	32
Chemical	5	1	Not winter	326	68
Electrical	18	4			
Other**	3	1	**Burn Depth‡**		
			Full thickness	15	4
			Mixed thickness	65	17
			Superficial partial	304	79

*Burn site will be greater than number of study participants as each participant may have had multiple anatomical sites of burn injury. Total sites in 482 participants = 1348. ** Other = 2 firecrackers and 1 aerosol explosion. ‡ Total participants were 384 in which burn depth was recorded. ∞ Seasons were designated as follows: Summer as December to February, Autumn as March through May, Winter as June to August and Spring as September and October [9].

Table 2 Showing Sociodemographic Characteristics of Study Participants

	Count *N=226*	%		Count *N=226*	%
Refer			**Caregiver**		
Referral	178	79	Local	*183*	81
Walk-in	48	21	Foreign	*43*	19
First Aid			**Caregiver Education**		
First Aid	142	63	≤Primary school	23	10
No first aid	84	37	≥School leaving certificate	203	90
Housing Utilities			**Cooking Fuel**		
Electricity	205	91	Electricity	187	83
No electricity	21	9	Paraffin	23	10
			Wood	5	2
			Gas	10	4
			Other	1	<1

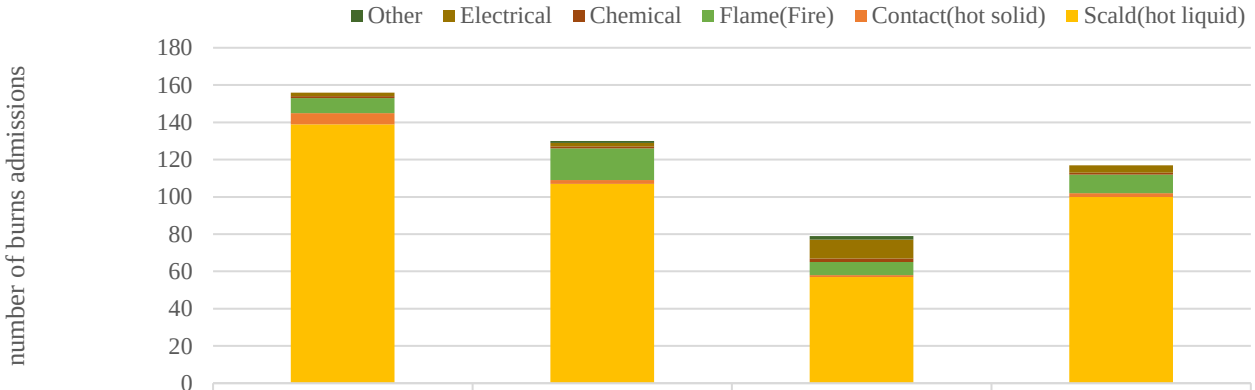
Table 3 Showing First Aid Methods Used

	Count *N=163*[+]	%		*Count*	*%*
Appropriate Methods	**123**	**75**	**Other***	**21**	
Cold water	106	64			
Burn Dressing	17	10	Ointment	7	4
			(Calamine/camphor/mercurochrome/ wintergreen/sulphacetamide/ear)		
Alternative Method	**40**	**25**	Cleaning solution	6	4
Toothpaste	11	7	*(Soap/dishwashing sunlight liquid)*		
Egg	8	5	Foodstuff	4	3
Other*	21	13	*(Milk/flour/sugar)*		
			Towel application	2	1
			Charcoal	1	<1
			Unknown	1	<1

*See right hand side of table for the breakdown of other methods of first aid that were used

[+] 142 participants received first aid, with 21 receiving more than one method and therefore 163 types of first aid methods listed above.

Figure 2 Showing Seasonal Variation of Burns by Type of Burn



	Winter	Spring	Summer	Autumn
Other	0	1	2	0
Electrical	2	2	10	4
Chemical	1	1	2	1
Flame(Fire)	8	17	7	10
Contact(hot solid)	6	2	1	2
Scald(hot liquid)	139	107	57	100

Season*

**Winter= June to August, Spring= September to October, Summer=December to February, Autumn= March to May.*

Other= 2 firecracker burns, 1 aerosol burn.

Table 5 Showing Baseline Characteristics Stratified by Burn Surface area of 10% TBSA (Severity of burn)

			TBSA					
			<= 10%		>10%		Total	P-value
Variable								
BASELINE		*N=482*		%		%		
Median age-mo. (IQR)			24	(14-42)	25	(17-49)	482	0.09
Age Category month–no. (%)	≤24		115	(52)	107	(48)	222	
	>24		139	(53)	121	(47)	260	0.72
	≤6		10	(43)	13	(57)	23	
	>6		244	(53)	215	(47)	459	0.37
Median Weight kg. (IQR)			12	(10-16)	13	(10-16)	482	0.07
Sex–no. (%)	Male		156	(56)	123	(44)	279	
	Female		98	(48)	105	(52)	203	0.10
Season	Winter		88	(56)	68	(44)	156	
	Summer/Autumn/Spring		166	(51)	160	(49)	326	0.26
Burn site	Single site		110	(92)	10	(8)	120	
	Multiple sites		144	(40)	218	(60)	362	<0.01

Variable			TBSA <= 10%		TBSA >10%		Total	P-value
Burn type	Thermal		232	(51)	227	(49)	459	
	Non-thermal		22	(96)	1	(4)	23	<0.01
SOCIODEMOGRAPHIC		*N=226*						
Caregiver Nationality	Foreign		19	(44)	24	(56)	43	
	Local		102	(56)	81	(44)	183	0.17
Housing Type	Formal		78	(53)	69	(47)	147	
	Informal		43	(54)	36	(46)	79	0.84
Caregiver Education	Primary School and below		13	(57)	10	(43)	23	
	Secondary School Level		108	(53)	95	(47)	203	0.76
Electricity	Electricity		113	(55)	92	(45)	205	
	No electricity		8	(38)	13	(62)	21	0.14
OTHER		*N=226*						
Referral	Referral		93	(52)	85	(48)	178	
	Walk-in		28	(58)	20	(42)	48	0.45
First aid	First-aid		67	(47)	75	(53)	142	
	No First aid		54	(64)	30	(36)	84	0.013

DISCUSSION

This study describes the paediatric burn injury admissions over a year in the largest hospital in Sub-Saharan Africa, where burn injury burden is high [8]. It provides data outlining the pattern of burn injuries, which essential for identifying issues of top priority, understanding the underlying causes of burn injury and identifying high risk groups for injury [1, 6]. In an era of evidence based medicine, this evidence forms the building blocks for setting priorities, creating policy and measuring outcomes that have the ability to influence change [1].

Children 2 years old or younger accounted for a large proportion of our admissions. It is known that children between 6 months and 2 years of age are the age group of highest risk for burn injuries that require hospital admissions because they acquire motor skills whilst still lacking the understanding of environmental risk and agility to avoid hazards [10]. Similar to other global literature, upper limb burns were the most common anatomical site of burn injury [6]. Our study showed a predominance of burn injury in males in comparison to female. This disparity was noted in Cape Town, but other series that did not exclusively focus on South Africa showed burn injury predominating in female children [1, 7, 11]. This heterogeneity illustrates the

importance of understanding our own South African population when conceptualising burn prevention strategies tailored to our needs.

In keeping with other LMICs, the most common mechanisms of burn injury were scalding, followed by flame burns [4, 6, 10, 12, 13]. It was unexpected to have a burn injury from an aerosol can explosion, as only some case studies in high income countries (HICs) have reported aerosol cans as sources of burn injuries. Notably, few of the cases reported were paediatric cases [14-18]. Injury mechanisms from aerosols in children are typically spray inflicted rather than explosions [19, 20]. With development, we may now be seeing injury patterns that are evolving to mirror HICs. Fireworks, in South Africa, have been recognised as a significant cause of paediatric injury [21], we however only recorded two injuries that were firework related. It has been shown that certain holiday times have more firework injuries [21]. It would be insightful to investigate whether cultural celebrations, legislation in different provinces or social norms are the possible causes of the discrepancy noted in our study in comparison to the one in a different geographical area. This information could benefit burn prevention strategies in areas experiencing significant firework injury cases.

In our centre, many factors are considered when assessing patient eligibility for admission. Admission criteria at the CHBAH PBU are based on burn severity by TBSA (>10%), as they require fluid resuscitation[4]. With even smaller than 10% TBSA, children may be admitted based on burn site (hands, feet, face, perineum, circumferential, inhalation), cause (e.g., electrical, chemical), age (very young), sepsis, and social circumstance or suspicion of non-accidental injury. The South African Burn Society outlines the minimal requirements for a severe burn requiring specialist care, see detailed criteria in *Appendix 6* [22]. We acknowledge that injury severity is dependent on depth, anatomical site, extent and the cause of the burn [4, 23]. However, for purposes of this study, we chose TBSA as a marker for burn severity in this study because calculating the extent of a burn injury is the often the first step in identifying the severity of a burn [24]. There are various limitations to our approach as we acknowledge that most burns that occur among children have a TBSA less than 10%, and burn injuries with a smaller TBSA may still cause significant morbidity, especially in young infants [4]. One study limitation is potential observer bias as multiple clinicians admitted participants, and were involved in TBSA calculation of different participants, with method of calculation of TBSA not being specified. There are at least three different methods used to calculate TBSA, these include the “rule of nines,” the “Lund and Browder Chart,” and “palmar surface” [4, 24].

Intuitively, larger TBSA was associated with multiple burn sites compared to those with single burn sites. Furthermore, more severe burns were associated with the use of first aid. This may be explained by caregivers being more concerned about burns that involved larger areas, and therefore providing first aid. Thermal burns were associated with severe burns, and we postulate it is because hot liquids are fluid in nature and therefore cover greater body surface area than burns caused by other mechanisms such as flame and chemicals.

We demonstrated the expected seasonal variation in burn injury that peaked in winter. Unlike tropical climates, countries with marked seasonal variation have a higher occurrence of burn injuries in winter months than in warmer months [6]. This is likely due to the use of more heat generating activities taking place in colder months, and therefore more exposure to substances causing burn injury in children. Although first aid uptake was acceptable, there were participants who received inappropriate methods, outlining the need to educate communities on acceptable methods to provide first aid.

Our high referral rate was expected because this is specialised burn unit existing as part of a quaternary centre [25]. However, we did not see a relationship between referral and severe burn, despite knowing that the decision to refer a paediatric patient to a specialised burns centre is determined by the potential morbidity and complexity of a burn injury [4]. This is likely because we only defined severity by TBSA and not by other factors affecting severity or warranting referral. It may highlight the need to educate referring centres on appropriate referral guidelines, but that would require further studies on referral patterns first.

The large non-response rate from caregivers was shown to be unrelated to the sociodemographic characteristics we collected in this study *(Appendix 1)*. We therefore concluded that there were other factors that kept caregivers from disclosing further information. It may be fear related to blame, or immigration status. According to the 2011 census, almost 5% of the total country's population comprises of foreign nationals [26]. In contrast, our study showed over four times more foreign caregivers having children admitted to our unit than the census proportion. This may highlight increased migration, identify undocumented foreign nationals or genuinely show a disproportionately higher rate of burn injury in foreign national children. Studies show higher burn rates in children from minority populations [10]. Furthermore, a correlation between children with an immigration background from low income countries and significantly higher incidence of burns has been shown [27].

It was not known whether the caregivers who accompanied the children to the hospital, were the same caregivers who were present at the time that the children sustained their burns. Therefore, it may not provide insight on risk factors for burn severity in admitted patients. Several studies investigate risk for burn injury, but not necessarily at risk for burn severity. Contrary to risk for burn injury being inversely related to proxies for socioeconomic status (low parental education, overcrowding, lack of basic amenities), we found no other sociodemographic risks for burn injury [1, 4, 6, 7, 10, 12]. Further studies are needed to look specifically at risk factors for severe burns.

CONCLUSION

Target populations for burn prevention strategies include families with children under two years old and minority groups. Areas of education must include, but should not be limited to, appropriate first aid management and emerging mechanisms of burn injury such as aerosols. Local healthcare facilities can be

used at education platforms when caregivers follow-up for services such as vaccinations for the target age group.

Areas for further study include characterising caregivers of children sustaining burn injury, referral patterns and appropriateness and risk factors for severe burn injury.

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CONFLICT OF INTEREST

None

AUTHOR CONTRIBUTIONS

Dr Agatha Banga:	Primary author. Project conception, proposal writing, data collection, data analysis and write-up.
Dr Andrew Grieve:	Research supervisor, paper review.
Dr Chris Westgarth- Taylor:	Research supervisor, paper review.

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APPENDICES

Appendix 1: Table 4 Showing Referring Facilities

Facility Name	**Location**	**Count** *N=178*	**Percentage %**
Bertha Gxowa Hospital	Germiston	3	2
Bheki Mlangeni District Hospital	Soweto	7	4
Buhle Park Clinic	Germiston	1	1
Carltonville Hospital	Carltonville	1	1
Charlotte Maxeke Johannesburg Academic Hospital	Johannesburg	6	3
Chiawelo CHC	Soweto	23	13
Diepkloof Clinic	Soweto	1	1
Discoverers CHC	Randburg	1	1
Dobsonville Clinic	Soweto	5	3
Edenvale Hospital	Edenvale	2	1
Eldorado Fire Station	Eldorado Park	1	1
Far East Rand	Springs	1	1
Fourways Life Hospital	Fourways	1	1
Freedom Park Clinic	Soweto	5	3
Itireleng CHC	Soweto	7	4
Joe Moroleng Memorial Hospital	Vryburg	1	1
Kopanong Provincial Hospital	Vereeniging	1	1
Lenasia South Clinic	Lenasia	16	9
Leratong Hospital	Krugersdorp	2	1
Lillian Ngoyi Clinic	Soweto	16	9
Location Five CHC	-	1	1
Mafikeng Provincial Hospital	Mafikeng	2	1
Maponya Clinic	Soweto	1	1
Moroka Clinic	Soweto	1	1
Noordgesig Clinic	Soweto	1	1
Orange Farm Clinic	Orange Farm	4	3
Orlando Clinic	Soweto	3	2
Unnamed Private Doctor	N/A	1	1
Protea South Clinic	Soweto	2	1
Rahima Moosa Memorial Children's Hospital	Johannesburg	7	4
Sebokeng Hospital	Vereeniging	7	4
Sinethemba Clinic	Poortjie	2	1
Sinqobile Clinic	Soweto	1	1
South Rand Hospital	Johannesburg	2	1
Stretford CHC	Orange Farm	13	7
Tambo Memorial Referral Hospital	Boksburg	6	3
Thelle Mogoerane Regional Hospital	Vosloorus	11	6
Tshepo Themba Private Clinic	Soweto	1	1
Tshepong Clinic	Klerksdorp	4	2
Umfuleni Clinic	Vanderbijlpark	1	1
Unnamed Local Clinic	N/A	3	2
Vlakfontein Clinic	Lenasia	2	1
Zola Clinic	Soweto	1	1

**CHC = community health centre, N/A = Not applicable*

Appendix 2: Table Showing Whether There is a Relationship Between Missing Data and Participant Characteristics

			Missing		Not missing			
Baseline Variable							**Total**	**P-value**
Demographics								
Age		*(n=482)*						
Median age-yr. (IQR)			2	(1-3)	2	(1-4)	482	0.03
Median age-mo. (IQR)			25	(15-45)	25	(16.49)	482	0.35
Age Category –no. (%)	<2		113	(51)	109	(49)	222	
	≥2		143	(55)	117	(45)	260	0.37
	≤6/12		16	(70)	7	(30)	23	
	>6/12		219	(48)	240	(52)	459	0.11
Weight		*(n=403)*						
Median Weight kg. (IQR)			12	(10-16)	12	(10-16)	403	0.91
Sex–no. (%)		*(n=482)*						
	Male		142	(51)	137	(49)	279	
	Female		114	(56)	89	(44)	203	0.25
Season		*(n=482)*						
	Winter		88	(56)	68	(44)	156	
	Not winter		168	(52)	158	(48)	326	0.32
Burn site		*(n=482)*						
	Single site		64	(53)	56	(47)	120	
	Multiple sites		192	(53)	170	(47)	362	0.96
Caregiver Nationality		*(n=467)*						
	Foreign		36	(53)	32	(47)	68	
	Local		213	(53)	186	(47)	399	0.946
Housing Type		*(n = 237)*						
	Formal		67	(44)	84	(56)		
	Informal		48	(56)	38	(44)		0.09
Burn type		*(n = 482)*						
	Thermal		248	(54)	211	(46)	459	
	Non-thermal		8	(35)	15	(65)	23	0.071
		(n=241)						
First aid	First-aid		74	(49)	77	(51)	151	
	No First aid		42	(47)	48	(53)	90	0.73
		(n=292)						
	Referral		114	(49)	119	(51)	233	
	Walk-in		32	(53)	28	(47)	60	0.54
Caregiver Education		*(n=230)*						

Baseline Variable			Missing		Not missing		Total	P-value
	Primary School and below		11	(46)	13	(54)	24	
	School leaving certificate		98	(48)	108	(52)		0.87
Electricity		*(n=238)*						
	Electricity		103	(48)	111	(52)	214	
	No electricity		12	(50)	12	(50)		0.86

Appendix 3: Accepted Protocol

Protocol

The Epidemiology of Paediatric Burn Injuries in Johannesburg, South Africa

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Background

Epidemiology of Burn Injury

Globally, almost a tenth of all childhood deaths, related to injury, are secondary to burn injuries[1]. In Africa, literature shows that more than 300,000 burn cases occur annually among children under the age of 5 years[2]. Of these cases, between 18,000 to 30,000 mortalities occur[2]. In Sub-Saharan Africa, almost one in every five burn victims dies[3]. The vast majority of burns in this region occur in children, with those between 0 and 10 years of age accounting for 83.6% of all burns[3]. In low and middle income countries LMICs, burns and fire related mortality remains the leading cause of death for children under the age of 14 years[4]. Children thus, in comparison to adults, experience disproportionately higher levels of mortality and complications such as scarring, contractures and risk of malignancy after experiencing a burn injury[3, 5]. Globally, mortality occurs in almost 10% of inpatients and outpatients combined sustaining burn injury. At the Johnson & Johnson Paediatric Burns Unit (J&JPBU) at Chris Hani Baragwanath Academic Hospital (CHBAH), the overall inpatient mortality was shown to be 7.9% amongst paediatric burn admissions between 2009 and 2012[6].

Definition of a Burn

A burn is defined as body tissue or skin injury that is caused by heat, contact with chemicals, electricity, radioactivity, friction or radiation [1, 7, 8]. Burns caused by heat are also called thermal burns and are sub-classified as scalds (hot liquid), contact burns (hot solid) and flame burns (flames) according to the mechanism of injury[7]. The majority of burn injuries in children are due to scalding [4, 5, 9]. The second most common cause of burn in children in LMICs are flame burns[5]. Reviews have shown that chemical and electrical burns are rare in LMICs(5). Burn injuries are diverse and results in a wide variety of patterns of injury and outcomes[5].

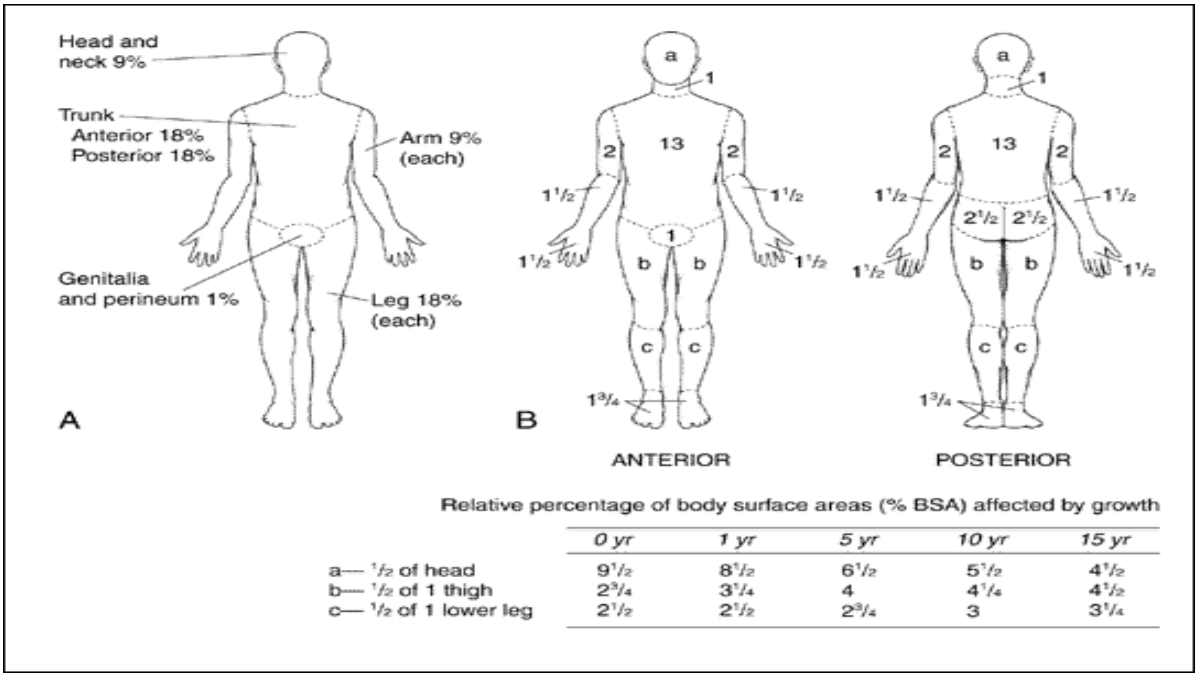
Burn Injury Assessment

Burn injury severity is dependent on depth, anatomical site, extent and the cause of the burn[5, 10]. Calculating the extent of a burn injury is the often the first step in identifying the severity of a burn[11]. Total burns surface area (TBSA) is a term used to describe the size (in percentage) of the body that has been injured, and guides correct calculation of fluid for resuscitation when required [5]. There are at least three different methods used to calculate TBSA, these include the "rule of nines," the "Lund and Browder Chart," and "palmar surface" [5, 11]. [See Figure 1 Showing the Estimation of Total Body Surface Area of Burns in Children below.] The rule of nines is efficient as it relies on dividing body regions into predefined multiples of nine, but is however not precise enough for use in children[11]. The Lund and Browder Chart relies on assigning sizes to different body regions relative to age-specific body proportions, therefore increasing accuracy of calculated burn surface area even in children[5, 11]. The palmar rule specifies that the patient's palmar surface is equal to 1% of body surface area, and can therefore be used to estimate total burn surface area[11]. Although TBSA assessment is useful, it remains a subjective measure regardless of which methods is used[11]. Burns involving more than 10% TBSA are considered major burns in paediatrics, and require fluid resuscitation[5]. Most burns that occur among children have a TBSA less than 10%[4]. However, a burn injury with a small TBSA may still cause significant morbidity, especially in young infants[5].

The next stage of assessment of burn injury entails identifying severity by depth of skin involved[11]. Burn wound depth can be classified as full-thickness, deep partial thickness or superficial thickness[11]. Burn depth is often diagnosed through clinical examination and observation of the skin thickness affected[11]. Other methods such as laser doppler and punch biopsy are more accurate than clinical observation but are costly[11] and not available in the J&J PBU. Notably, secondary injury may occur despite removal from initial contact resulting in deeper involvement[5]. Increased burn depth correlates with longer healing time, and it known that delayed healing increases risk of infection, morbidity and mortality[5]. The burn wound depth thus remains a significant factor in selecting appropriate choice of treatment [12]. Burn depth enables clinicians to estimate probability of spontaneous healing and degree of expected scaring[5]. Non-operative treatment can be used for superficial burns as they generally heal without scar formation, whereas deeper burns will require early excision and grafting in order to avoid contractures and hypertrophic scarring (12). However, burn wound depth can convert; with resultant wound depth progression over time. Therefore burn wounds are difficult to

strictly categorize, and may require re-assessment over time (12) Mechanisms causing the progression of wound depth are not well understood but were previously described by Jackson, identifying a burn zone called the zone of stasis which is at risk of deepening burn damage due to factors related to oxidative damage, perfusion compromise and cytokine mediated response (12). Therefore, accurately describing burn wound depth is an essential aspect of assessing burn injury patients[12].

Figure 1 Showing the Estimation of Total Body Surface Area of Burns in Children[13]



Relative percentage of body surface areas (% BSA) affected by growth

	0 yr	1 yr	5 yr	10 yr	15 yr
a— ½ of head	9½	8½	6½	5½	4½
b— ½ of 1 thigh	2¾	3¼	4	4¼	4½
c— ½ of 1 lower leg	2½	2½	2¾	3	3¼

(A) The Rule of "Nines" and (B) The Lund-Browder Chart (Adapted from: The Treatment of Burns, edition 2, Artz CP and Moncrief JA, Philadelphia, WB Saunders Company, 1969)

Burns can also be described by anatomical region affected. The anatomical location of a burn significantly affects management and the outcome of injury[5]. Limb involvement may require splinting to avoid contractures and functional disability, whereas head and neck injuries may require early intubation to protect the airway from swelling and subsequent obstruction[5]. Despite this, there are very few studies that describe burns by the body part or anatomical region that is burnt[4]. Out of 117 studies systematically reviewed by Forjuoh, only a few studies identify anatomical location of burn, with the upper extremities as the most common site of burn followed by the lower extremities[4]. Flame injuries are unique as they primarily affect the lower extremities[4]. Burns can be classified as inhalational or non-inhalational[5]. Inhalational burns are burns of the airway, and can involve the lower respiratory tract and upper respiratory tract[5]. The mechanism of inhalational injury in the upper respiratory tract mucosa occurs by direct thermal insult to mucosa,

chemical pneumonitis affecting the lower respiratory tract, or cyanide and poisons causing systemic toxicity[5]. Methods of diagnosing inhalational injury include suspicion on history, suggestive clinical signs, carboxyhaemoglobin level and bronchoscopy[13]. Although inhalational burns are less common in LMIC compared to other regions[11], they remain significant contributors to morbidity and mortality in burn injury[5, 13-16]. Expected mortality increases by 20% when inhalational injury accompanies a burn injury[17]. Early diagnosis of inhalational injury has the potential to mitigate morbidity and mortality[15]. There is a relationship between TBSA and inhalational injury, with an increasing incidence of inhalational injury seen with increasing TBSA[17].

The Relevance of First Aid Management of Burn Injuries

There are a few studies in LMICs that explore first-aid used for burns within the community[4]. It has been shown that lower socioeconomic status is correlated with inadequate first aid provision of burn injury[18]. Appropriate and adequate first aid is known to improve burn injury outcome by preventing progression of tissue damage[5, 18]. In a Nigerian study, cold water was applied to the burn region in a third of those receiving first aid[19], a further third had a traditional poultice applied[4]. Traditional poultice had a broad variety of base ingredients including mud, urine, eggs, and cow dung[4]. The herbal preparations studied were either acidic or alkaline, and not prepared aseptically, as a result they may cause wound infection, chemical burns, delay healing and therefore prolong hospital stay[19]. Best practice was shown to be cooling, and that cooling the affected area up to three hours post burn was most beneficial[5, 19], whilst making sure to keep the paediatric patient warm to avoid hypothermia[5].

Referral Pattern

The decision to refer a paediatric patient to a specialised burns centre is determined by the potential morbidity and complexity of a burn injury[5].The CHBAH is the largest hospital in the southern hemisphere[20] and is situated within what used to be an informal settlement, but which has become a fast-growing formal urban environment with a cross-section of low, middle and high-income individuals[20]. The CHBAH also

693 serves as a local, regional and multi-provincial referral centre for paediatric burns patients[20]. The J&JPBU
694 is a specialised paediatric centre for burn management nested in CHBAH, which is considered one of the
695 leading burn treatment centres in Africa[21]. The J&JPBU was opened in 1995, and mostly admits children
696 under the age of nine years[21].

697 *Risk Factors and Current trends of Burn Injury*

698

699 Successful burn prevention requires sufficient knowledge of burn risk factors and the population[4]. Risk
700 factors for paediatric burn injury are physical, social, political and economic[1] . Differences in the incidence
701 of burn injury have been shown by socio-economic status and gender[1, 22]. Unintentional injuries, including
702 burns, are over ten times more common in low income compared to high income countries[1]. The inverse
703 relationship between socio-economic status and risk of burn injury has been illustrated in multiple settings,
704 with poorer populations presenting with childhood burn injury more frequently than more affluent
705 populations [1, 5, 22]. Factors correlating with lower socioeconomic status, such as overcrowding, low parental
706 level of education and lack of basic amenities, have been associated with increased risk of burn injury[4].
707 While factors indicating higher socio-economic status, such as improved housing, have been associated with
708 decreased risk of childhood burn injury[4, 9]. Various estimates show a discrepancy between the gender most
709 commonly affected by burn injuries[1, 22]. In developing countries, gender roles and age dependent
710 developmental ability and gender often determine the mechanism of burn injury[5]. Below the age of four
711 years, male children are more likely to sustain burns, however above this age, females become more
712 susceptible to burns as they start being involved in household work such as cooking[4]. However, limited data
713 still exists from low income countries exists with respect to gender differences in paediatric burns[22].

714 Higher maternal educational status is protective against the occurrence of burn injury in children, namely
715 above secondary school or matric level[9].

716 Temporality of burn injury can be looked at by peak times in the day and climatic seasons. Evening and late
717 mornings are peak times for thermal burns as this is when food preparation is takes place. Countries with
718 marked seasonal variation have a higher occurrence of burn injuries in winter months than in warmer

months[4]. Tropical climates in Sub-Saharan Africa do not necessarily have a seasonal rise in burn injuries[4]. Despite geographical location, there is seasonal variation in admissions at The J&JPBU , where an increased number of admissions are recorded in the winter months[20].

Research shows that there is paucity in burn data from low and middle income regions, despite burns being more prevalent there[22]. Evidence forms the building blocks for setting priorities, creating policy and measuring outcomes, therefore evidence has the ability to influence change[1]. Data outlining the scope and pattern of burn injuries are essential for identifying issues of top priority, understanding the underlying causes of burn injury and identifying high risk groups for injury[1]. It is known that implementation of proven strategies to prevent child injuries are effective and have in other regions shown drastic improvement in child outcomes[1]. Through research, data can be provided to better understand the demographics and associations of burn injury in the population served by CHBAH.

Therefore, the aim of this study is to bridge the gap in knowledge about burn injury in developing countries by describing the epidemiology of paediatric burns admitted to the J&JPBU at CHBAH; in order to address possible implementation strategies to decrease the incidence in our environment.

Study Objectives

The overall aim of this study is to investigate the epidemiology of burn injuries of paediatric patients admitted to J&JPBU, CHBAH). These are the specific study objectives:

1) To describe the demographic profile of children admitted with skin and airway burns at the J&JPBU of CHBAH.

    a. To determine the aetiology of burn injuries (e.g. water, oil, fire, etc.)

    b. To determine the TBSA of patients admitted with burn injury.

    c. To determine where children admitted with skin and airway burns come from (referrals and geographic location).

2) To determine first aid management of burn injuries

   a. To describe what percentage of patients receive first aid management

   b. To describe first aid management rendered to burn injury victims

3) To investigate the association between burn injury (TBSA, depth) and the demographic profile (e.g. caregiver educational status) of children admitted to J&JPBU of CHBAH.

Methods

Study Design

This study will be cross-sectional, descriptive analysis of data collected prospectively.

Site of Study

The study site will be the J&JPBU at the CHBAH, Johannesburg, South Africa.

Study Population and Sampling

The study will include all paediatric patients under the age of 10 completed years of age, admitted to the J&JPBU at the CHBAH with burns of the skin. Convenience sampling will be used, and all participants will be recruited and enrolled into this study from the J&JPBU at the CHBAH. Approximately 500 patients will be enrolled into the study over a period of one calendar year. This has been estimated based on admissions to the unit over the past 3 years (2015, 2016, and 2017). A total of 1482 patients were admitted from 2015-2017, with a mean of 494 patients per year.

Inclusion and Exclusion criteria

Inclusion criteria:

- All children admitted to the J&JPBU CHBAH during the defined study period under the age of ten years.

Exclusion criteria:

- Parent/ legal guardian not providing consent for inclusion in the study.

Measuring Instrument and Data Collection

All data will be collected on a pre-designed data collection form (see Appendix 1: Data Collection Tool). This tool will be completed by the admitting officer (medical officer or registrar) at the time that patient is stable and admitted. All staff in the paediatric surgery unit will receive a brief and guidelines on how the form should be completed correctly. Data will then be captured using Research Electronic Data Capture (REDCap)[23]. This data inputting platform will mirror the format of the data collection tool (See Appendix 1: Data Collection Tool). The following admission information will include: demographic information (age, sex, housing, address, presence of electricity, cooking fuel in the home, caregiver educational status and nationality); relevant history (first aid given, time from burn to healthcare facility, referring centre, recurrent burn and aetiology of burn); clinical assessment (weight, %TBSA[total body surface area], depth, type of burn, location of burn);and management on admission (ICU admission, intubation, insertion of central venous or urinary catheters).

Data Safety and Monitoring

All data that will be collected with an anonymous participant identification number, which will be kept apart from all linking information (GT number, name, date of birth), kept in a locked facility with access only to the principal investigator. The electronic data collection tool will be password protected.

Sources of Bias

This cross-sectional analysis will miss those patients who were not admitted because of less severe burns, as well as those that potentially die prior to arrival at the CHBAH.

Data Analysis

Raw data will be captured, uploaded to REDCap, exported from REDCap as a comma separated values file (.CSV) to Stata 13 product version 421.13.1.20915[24] or available statistical software. The statistical data analysis will be done by the candidate using STATA product version 421.13.1.20915[24]. All data will undergo a process of initial data exploration prior to in depth data analysis. Relevant summary statistics for various types of variables (categorical variables: percentage frequency and frequency; continuous variables: medians, interquartile ranges, standard deviations, histograms, means accompanied by confidence intervals). Appropriate measures of central tendency will be selected and used to describe non-normal and normal distributions. The prevalence of various burn severity (% TBSA category, depth category and type of burn, ICU admission) will be calculated in STATA 13 (STATA for Windows, version 13, STATAcorpLP; College Station, TX[24]). Multivariate analysis will be used to investigate potential factors that are associated with burn severity (% TBSA) using a manual, backward selection process.

Ethics

Approval to carry out this study will be obtained from Human Research Ethics Committee (Medical) of The University of the Witwatersrand, Johannesburg, South Africa; the CHBAH research committee; and the MMED protocol committee, prior to commencement of the study. Informed consent will be taken from caregivers/legal guardians prior to data collection.

Description of Risks and Benefits

The risks to participants in this study are minimal. This is an observational study where there will be no invasive procedures or interventions in this study. No sensitive clinical information such as HIV status will be collected in this study. The potential risks include potential loss of confidentiality of study participants and their families during data collection process. The loss of confidentiality will be minimised throughout the study by ensuring that all patient identifiers will be kept apart from research data in a password protected

computer and file. All hardcopy research data will be kept in a locked facility where only principal investigator will have access, as well as the Human Research Ethics Committee (medical).

The major foreseen benefit from this study is improvement in healthcare. Knowledge of the epidemiology of burn injuries seen at the CHBAH will allow for understanding the population that we serve, outline the resources that we need and identify areas for further research. Understanding the referrals that we receive will also identify other referring units that need training and equipping in burn management in order to decentralise care and alleviate the burden on the J&JPBU of CHBAH. The knowledge of burn injuries will allow for better patient care. The most powerful tool for policy change and advocating remains evidence and this study will provide evidence[1].

Use of Information and Publication

The information from this study will be used to improve healthcare management as described in the "potential benefits" section of this study. The findings will be presented and published as part of the candidate's Master of Medicine in Paediatric Surgery. Target journals and abstract presentations will be platforms where burn injuries are of interest and of potential benefit to the platform. This information may be presented to policy making platforms and budget determining platforms and funders of the unit.

Timing

Table1.1 Showing Proposed Timeline



Funding

All stationery costs will be borne by the candidate.

Problems and solutions

Anticipated problems and mechanisms to minimise them are listed below:

1) Incomplete data/data collection difficulty:
    a. Data will be captured in paper form, but will be uploaded onto REDCap online from the paper data collection tool. This extra step is a checkpoint for data completeness
    b. If missing data requires discussion with a guardian who has consented to be enrolled in the study, guardian will be contacted to make enquiries.
    c. A study research team has been identified, and is composed of in-department doctors and the candidate, who will assist and ensure data collection is carried out correctly. Study team members are voluntary, and are key members in the department including one who is a permanently assigned member of staff of the PBU.
    d. Data collection sheets will be made available in all admission areas and the burns unit to ensure easy access. All members of staff will be notified where forms are available. The candidate will ensure that they remain available at all times.
    e. Periodic presentation of how to complete the data collection forms will take place in the department at every research meeting. Departmental research meetings are periodically scheduled meetings with mandatory attendance from all members of staff.
    f. Daily handover meetings take place in the department where all admissions are presented. At this opportunity all burns admissions will be captured and checked if study form has been filled by the candidate or team member on site.
    g. Candidates will cross-check data collections forms and compare them to admission book to ensure that all admissions have been captured. This check will be done on a weekly basis

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924 *Appendix 1: Data Collection Tool*

The Paediatric Burns Admissions Study Sheet			
			Date of record completion:__DD/MM/YYYY_ *(Date on which admission sheet filled in)*
			Date of patient admission:__DD/MM/YYYY_ *(Date on which patient arrived in Burns unit)*
			Record completed by:_____ *(Name of medical officer or registrar filling form)*
Demographic information			
Unique identifier	_ _ _ _ _ _ _ _		
Age	years		
Sex *(Please tick one box only)*	Male Female Unknown	☐ ☐ ☐	
Location of burn *(Please write area/postal code of where burn occurred)*			
Referral *(If yes, please specify referring centre)*	Yes No	☐ ☐	Referral centre: _____
Caregiver and Socioeconomic Information			
Educational status of caregiver *(Please tick one box only for highest level of education attained by caregiver who was with child.)*	Primary Secondary Tertiary	☐ ☐ ☐	Education level: _____ *(Please specify year level attained, eg. Grade 10 or Masters)*
Type of housing	Formal	☐	

The Paediatric Burns Admissions Study Sheet			
(Only tick formal if housing is brick)	Informal	☐	*(This should be housing in which the burn occurred or housing around area of burn if outdoor burn)*
Electricity *(If yes, is there a formal, individual, metered electrical connection?)*	Yes No	☐ ☐	
Nationality of caregiver *(Caregiver who presents with the patient)*	Foreign Local	☐ ☐	
Cooking fuel *(Please tick one predominant cooking fuel)*	Paraffin Wood Electricity Gas Other	☐ ☐ ☐ ☐ ☐	
Clinical history			
Time of burn *(According to best recollection)*	hh:mm		Day/night *(Please select)*
Time from burn to care	hh:mm		*(Time between burn and patient presenting to first healthcare facility, eg. Local clinic)*

The Paediatric Burns Admissions Study Sheet			
First Aid rendered *(If yes, please specify subcategory)*	Yes		
	Toothpaste	☐	
	Egg	☐	
	Cold water	☐	
	Burn dressing	☐	*(Eg. Burn shield)*
	Other	☐	If other, please specify_____
	No	☐	_____
Aetiology of Burn *(Please pick one category, i.e. Thermal/non-thermal, then choose a sub-category)*	Thermal		
	Scald	☐	*(Hot liquid)*
	Contact	☐	*(Hot solid)*
	Flame	☐	*(Fire)*
	Non-thermal		
	Electrical	☐	*(Electrical current)*
	Lightening	☐	
	Chemical	☐	Please specify: *eg. Acid*_____
	Other	☐	Please specify_____
Recurrent burn *(Please tick if this is NOT the first time the patient has had a burn)*	Yes	☐	
	No	☐	
Physical Examination			
Weight	_____		*(In kilograms, to 1 decimal place)*
Total body surface area	% of body:_____		*(% calculated by admitting doctor after scrub-down using Wallace rule of nines/ Lund and Browder/Palmer surface)*
Depth of burn	Full thickness	☐	

The Paediatric Burns Admissions Study Sheet			
	Partial thickness	☐	*(Please tick one box only. Superficial-partial and deep-partial fall under partial thickness)*
	Partial & full thickness	☐	
Area of burn *(May be more than one box ticked. For non-inhalation please choose sub-category)*	Non-inhalation		
	Lower limb	☐	*(Includes feet)*
	Upper limb	☐	*(Includes hands)*
	Perineum	☐	
	Chest/back	☐	
	Head/neck	☐	
	Inhalation	☐	*(This includes clinical suspicion)*
Admission Management			
ICU admission	Yes	☐	
	No	☐	
Intubation	Yes	☐	
	No	☐	
Central line	Yes	☐	
	No	☐	
Urinary catheter	Yes	☐	
	No	☐	

Appendix 2: Patient information sheet

INFORMATION DOCUMENT

Study title: The Epidemiology of Paediatric Burn Injuries in Johannesburg, South Africa

Greeting: Good day sir/madam

Introduction: The Paediatric Burns unit is doing research on treatment for paediatric burns injuries. Research is the best way to learn the answer to a question. In this study we want to learn how burns are treated before the patients come to hospital, and what factors indicate the outcomes of the treatment once inside the hospital.

Invitation to participate: We are asking for your permission to include your child in the research study.

What is involved in the study?
The study will investigate burns of the skin or airway which happen to young children less than 10 years old, who are admitted at the Johnson and Johnson Paediatrics Burns Unit at Chris Hani Baragwanath Academic Hospital. Once the record has been taken at admission, it will be reviewed. The patient will not be needed to stay in hospital longer or answer any further questions after admission.
There will be about 500 patients in the study, and there will not be any requirements on children to be from a certain geographic location.
There are up to 25 questions which will be asked to each patient/parent/guardian, and it should not take more than 5 minutes of your time for asking questions. NO BLOOD samples will need to be taken, nor samples of any other type, as this is a non-clinical study.

Risks: since this is not a clinical study, there are no physical risks to the patient. The risk of breaching confidentiality is low, since only the investigator has full access to the data once captured. NO HIV DATA will be captured. No compensation is forseen to be necessary.

Benefits: information collected during the course of the study will be used to improve treatment of children with skin burns at Chris Hani Baragwanath hospital.

The participant will be given pertinent information on the study while involved in the project and after the results are available.

Participation is voluntary: refusal to participate will involve no penalty or loss of benefits to which the participant is otherwise entitled, and that the subject may discontinue participation at any time without penalty loss of benefits to which the participant is otherwise entitled.
The patient may terminate their participation in the study at any time, without negative consequences, by contacting the investigator on the details below.
The investigator may terminate the participation of any patient at any time, without consent, if they are of the professional opinion that continued participation will impact the patient negatively.
Any information which comes to light during the study which may affect the patient's willingness to be involved, will be communicated to the patient where possible.

Reimbursements: no "out of pocket" expenses are expected; no extra costs will be incurred by the patient through being part of this study.

Confidentiality: Efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Personal information may be disclosed if required by law.
Organizations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as the Research Ethics Committee and the Medicines Control Council (where appropriate).
If results are published, may lead to individual / cohort identification.

Contact details of researcher/s: for further information / reporting of study related adverse events, contact Dr Agatha Banga through the hospital staff.
Contact details of REC administrator and chair: for reporting of complaints / problems contact the REC administrator and chair through the hospital staff.



Informed Consent Form & Information Letter

Faculty of Health Sciences, University of the Witwatersrand

The Epidemiology of Paediatric Burn Injuries in Johannesburg, South Africa

Hello. I am Dr Agatha Banga and I work in the Department of Paediatric Surgery, University of the Witwatersrand while I am enrolled with the Faculty of Health Sciences studying for a Master of Medicine degree in Paediatric Surgery.

As part of my study programme, I will undertake a research project on paediatric burns patients at the Chris Hani Baragwanath Academic Hospital. The research aims to investigate the epidemiology of burn injuries of paediatric patients admitted to the Johnson and Johnson Paediatric Burns Unit at Chris Hani Baragwanath Academic Hospital, Johannesburg, South Africa. I therefore invite you to assist me by participating in the study.

The study will require your admission notes to be reviewed, and a short questionnaire during the course of your normal admission process, and this will probably take 5 minutes.

Participation in the study is voluntary. If you do not wish to participate, or withdraw at any time during the study, your wishes will be complied with, and nothing will be held against you. Your identity will be protected and all data will be stored under lock and key and available only to me. The findings will be used for academic purposes only.

I _____,

Parent/Guardian of _____ (**name of patient**),

Admitted to Chris Hani Baragwanath Hospital Paediatric Burns Unit, having understood the following aspects of the study:

1. That participation is purely voluntary.

2. That my child/ward may withdraw at any time with any reasons and without any adverse consequences to his/her medical treatment.

3. Participation or non-participation will not influence any aspect of my Child/ward's medical treatment.

4. Results obtained in the study will be strictly confidential and not used for promotion purposes.

Hereby grant/do not grant (delete whichever is not applicable) permission for my child/ward to be a participant in this study.

_____ _____

Signature of **Parent/Guardian** Date

I, _____, having understood the above, as explained by my parent/guardian, do agree/disagree to be part of this study.

_____ _____

Signature of **Patient** Date

_____ _____

Signature of **investigator** Date

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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Agatha Banga

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M180431

NAME: (Principal Investigator)	Dr Agatha Banga
DEPARTMENT:	Paediatric Surgery Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	The epidemiology of paediatric burn injuries in Johannesburg, South Africa
DATE CONSIDERED:	04/05/2018
DECISION:	Approved Unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Christopher Westgarth-Taylor and Dr Andrew Grieve
APPROVED BY:	Professor CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	30/07/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **April** and will therefore be due in the month of **April** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 4: South African Medical Journal Submission Guidelines

General article format/layout

Accepted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction, which will delay publication.

General:

- Manuscripts must be written in UK English.
- The manuscript must be in Microsoft Word format. Text must be single-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes).
- Please make your article concise, even if it is below the word limit.
- Qualifications, ***full*** affiliation (department, school/faculty, institution, city, country) and contact details of ALL authors must be provided in the manuscript and in the online submission process.
- Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.
- Include sections on Acknowledgements, Conflict of Interest, Author Contributions and Funding sources. If none is applicable, please state ‘none’.
- Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dL).
- Litres is denoted with an uppercase L e.g. 'mL' for millilitres).
- Units should be preceded by a space (except for % and ºC), e.g. '40 kg' and '20 cm' but '50%' and '19ºC'.
- Please be sure to insert proper symbols e.g. µ not u for micro, a not a for alpha, b not B for beta, etc.
- Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160.
- Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'
- Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.
- If you wish material to be in a box, simply indicate this in the text. You may use the table format –this is the *only* exception. Please DO NOT use fill, format lines and so on.

SAMJ is a generalist medical journal, therefore for articles covering genetics, it is the responsibility of authors to apply the following:

- Please ensure that all genes are in italics, and proteins/enzymes/hormones are not.

- Ensure that all genes are presented in the correct case e.g. TP53 not Tp53.

**NB: Copyeditors cannot be expected to pick up and correct errors wrt the above, although they will raise queries where concerned.

- Define all genes, proteins and related shorthand terms at first mention, e.g. '188del11' can be glossed as 'an 11 bp deletion at nucleotide 188.'

- Use the latest approved gene or protein symbol as appropriate:

- Human Gene Mapping Workshop (HGMW): genetic notations and symbols
- HUGO Gene Nomenclature Committee: approved gene symbols and nomenclature
- OMIM: Online Mendelian Inheritance in Man (MIM) nomenclature and instructions
- Bennet et al. Standardized human pedigree nomenclature: Update and assessment of the recommendations of the National Society of Genetic Counselors. J Genet Counsel 2008;17:424-433: standard human pedigree nomenclature.

Research

Guideline word limit: 4 000 words

Research articles describe the background, methods, results and conclusions of an original research study. The article should contain the following sections: introduction, methods, results, discussion and conclusion, and should include a structured abstract (see below). The introduction should be concise – no more than three paragraphs – on the background to the research question and must include references to other relevant published studies that clearly lay out the rationale for conducting the study. Some common reasons for conducting a study are: to fill a gap in the literature, a logical extension of previous work, or to answer an important clinical question. If other papers related to the same study have been published previously, please make sure to refer to them specifically. Describe the study methods in as much detail as possible so that others would be able to replicate the study should they need to. Results should describe the study sample as well as the findings from the study itself, but all interpretation of findings must be kept in the discussion section, which should consider primary outcomes first before any secondary or tertiary findings or post-hoc analyses. The conclusion should briefly summarise the main message of the paper and provide recommendations for further study.

Select figures and tables for your paper carefully and sparingly. Use only those figures that provided added value to the paper, over and above what is written in the text.

Do not replicate data in tables and in text.

Structured abstract

- This should be 250-400 words, with the following recommended headings:
    - **Background:** why the study is being done and how it relates to other published work.
    - **Objectives:** what the study intends to find out
    - **Methods:** must include study design, number of participants, description of the intervention, primary and secondary outcomes, any specific analyses that were done on the data.
    - **Results:** first sentence must be brief population and sample description; outline the results according to the methods described. Primary outcomes must be described first, even if they are not the most significant findings of the study.
    - **Conclusion:** must be supported by the data, include recommendations for further study/actions.
- Please ensure that the structured abstract is complete, accurate and clear and has been approved by all authors.
- Do not include any references in the abstracts.

Here is an example of a good abstract:

Main article

All articles are to include the following main sections: Introduction/Background, Methods, Results, Discussion, Conclusions.

The following are additional heading or section options that may appear within these:

- Objectives (within Introduction/Background): a clear statement of the main aim of the study and the major hypothesis tested or research question posed
- Design (within Methods): including factors such as prospective, randomisation, blinding, placebo control, case control, crossover, criterion standards for diagnostic tests, etc.
- Setting (within Methods): level of care, e.g. primary, secondary, number of participating centres.
- Participants (instead of patients or subjects; within Methods): numbers entering and completing the study, sex, age and any other biological, behavioural, social or cultural factors (e.g. smoking status, socioeconomic group, educational attainment, co-existing disease indicators, etc)that may have an impact on the study results. Clearly define how participants were enrolled, and describe selection and exclusion criteria.

- Interventions (within Methods): what, how, when and for how long. Typically for randomised controlled trials, crossover trials, and before and after studies.

- Main outcome measures (within Methods): those as planned in the protocol, and those ultimately measured. Explain differences, if any.

Results

- Start with description of the population and sample. Include key characteristics of comparison groups.

- Main results with (for quantitative studies) 95% confidence intervals and, where appropriate, the exact level of statistical significance and the number need to treat/harm. Whenever possible, state absolute rather than relative risks.

- Do not replicate data in tables and in text.

- If presenting mean and standard deviations, specify this clearly. Our house style is to present this as follows:

- E.g.: The mean (SD) birth weight was 2 500 (1 210) g. Do not use the ± symbol for mean (SD).

- Leave interpretation to the Discussion section. The Results section should just report the findings as per the Methods section.

Discussion

Please ensure that the discussion is concise and follows this overall structure – sub-headings are not needed:

- Statement of principal findings

- Strengths and weaknesses of the study

- Contribution to the body of knowledge

- Strengths and weaknesses in relation to other studies

- The meaning of the study – e.g. what this study means to clinicians and policymakers

- Unanswered questions and recommendations for future research

Conclusions

This may be the only section readers look at, therefore write it carefully. Include primary conclusions and their implications, suggesting areas for further research if appropriate. Do not go beyond the data in the article.

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Appendix 5: Turn It In Report

a0039871:MMED_Report_submission_version_Banga.docx

by Ekene Nweke

Submission date: 25-Feb-2022 01:10PM (UTC+0200)
Submission ID: 1770617591
File name: 4856-8613-be38566eba73_MMED_Report_submission_version_Banga.docx (129.19K)
Word count: 3588
Character count: 18836

1065



The Epidemiology of Paediatric Burn Injuries in Johannesburg, South Africa

By

Dr Agatha Tafadzwa Banga

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Draft article:

The Epidemiology of Paediatric Burn Injuries in Johannesburg, South Africa

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ABSTRACT

Background

Children remain the most common victim of burns in Sub-Saharan Africa. We investigated the epidemiology of burn injuries of the paediatric patients admitted to the Paediatric Burns Unit (PBU) at the Chris Hani Baragwanath Academic Hospital (CHBAH).

Objectives

To describe the epidemiology of paediatric burn injury among those admitted to CHBAH.

Methods

This was a hospital based cross-sectional study, with data collected at the time of admission via an accompanying caregiver questionnaire and via clinical examination of the patient by the admitting doctor.

Results

A total of 509 patients were admitted to the unit over a 12-month period, with 482 patients included for baseline analysis. 50% of admitted patients were between 15 and 47 months with a median age of 25 months. 58% of participants were male. 53% of all admissions had burns above 10% total body surface area and were considered severe burns. The predominant mechanism of injury was scalding (84%), in the winter season (32%). The most common site of burn was upper limb (75%). 63% of all admissions received first aid. Among those who received first aid, a described first aid method was provided in 74% of the cases.

226 out of 482 participants (47%) provided sociodemographic information. Access to basic amenities such as electricity was high, with most admissions coming from households with access to electricity (91%) and using electricity for cooking (83%). Basic level education was shown by 90% of caregivers holding at least a high school leaving certificate. Migrant caregivers made 19% of the caregivers, which was four times the proportion of foreign nationals counted in the national census. Over three quarters of admissions (79%) were referrals from other centres.

Severe burns were associated with thermal mechanism of injury ($p<0.01$), multiple burn sites ($p<0.01$), and receiving first aid prior to admission ($p=0.01$). No sociodemographic factors were associated with increased burn severity.

Conclusion

Children under two years of age and minority groups are at greatest risk for burn injury and should therefore be targeted for burn injury prevention. Education on appropriate first aid is essential to educate the community. Future research should investigate caregivers of children with burn injury.

(Word count = 356 words)

3

Manuscript

INTRODUCTION

Globally, almost 10% of all childhood deaths related to injury, are secondary to burn injuries [1]. In Sub-Saharan Africa, over 80% of burns occur in children under 10 years of age, with burns accounting for 20% of childhood deaths [2]. Those who survive, are often left with severe disability and disfigurement and sometimes social stigma. [3] Burns accounts for 10 million disability adjusted life years lost each year. [3] Risk factors for paediatric burn injury are known to be a combination of physical, social, political and economic factors [1]. When burns do occur, appropriate and adequate first aid improves burn injury outcome by preventing progression of tissue damage [4,5] Despite this massive impact burns has on people in Sub-Saharan Africa there are only a few studies in LMICs exploring first-aid and prevention used for burns within the community [6,7].

Our unit at CHBAH is the largest hospital in the southern hemisphere [8]. CHBAH is situated within what used to be an informal settlement, but which has become a fast-growing formal urban environment with a cross-section of low, middle and high-income individuals [8]. The high volume specialised paediatric centre for burn management at the CHBAH serves as a local, regional, and multi-provincial referral centre for paediatric burns patients. Investigating patients in this unit provides unique insight into childhood burn injury.

Therefore, the overall aim of this study was to investigate the epidemiology of burn injuries of paediatric patients requiring admission to the PBU at CHBAH by identifying the demographic profiles and the burn injury characteristics. The information provided aimed to bridge the gap in knowledge about burn injury in developing countries, and to assist in addressing possible implementation strategies to decrease the incidence of childhood burn injury.

METHODS

This was a prospective study with data collection completed over a 12-month period from the 19th of September 2018 to the 18th of September 2019. Convenience sampling was used, and all children under the age of 10 whose caregivers consented to participation were recruited. All enrolled participants had a pre-formed questionnaire completed by the admitting doctor. The pre-formed, paper based, questionnaire included demographic and socio-economic information of the child, including physical examination findings on admission.

Statistical Analysis

We used the Stata Statistical Software (Release 14) for data exploration and analysis of cross-sectional data captured at the time that each participant was admitted. Descriptive analysis of baseline and

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sociodemographic characteristics of participants was done using appropriate descriptors and diagrams. All continuous variables were not normally distributed as evidenced by the Shapiro-Wilk Test for normalcy and were therefore described using medians and interquartile ranges. Results were tabulated and graphs were used to illustrate appropriately. Associations between burn severity (≤10% total body surface area as not severe, >10% total body surface area as severe) and categorical variables (baseline and socio-demographic) using $\chi 2$ tests with two degrees of freedom were run. For continuous variables, associations between the groups of burn severity were tested by analysis of variance.

RESULTS

We admitted 509 patients to the PBU over the 12-month study enrolment period from 19th September 2018 to 18th September 2019. In baseline demographic data, incomplete data was found in 27 patients (5%) thus leaving a sample of 482 patients for analysis. A response rate of 46.9% (n=226) was achieved from caregivers who provided information on circumstances surrounding the burn (*Figure 1*).

The median age of participants at the time of admission was 25 months (IQR 15 – 47months). Three quarters of patients were 4 years and below (76%, n=361), but with only 5% being six months or younger (n=23). The ratio of male to female participants was 1.38:1 with 58% of participants being male (n=279) (*Table 1*).

Hot water scalds (84%) were the predominant mechanism of injury (n=403). Flame burns were the second most common cause of burn injury (9%, n= 42). Other unexpected mechanisms of burn injury including two firecrackers, and one aerosol can explosion (1%, n = 3) (*Table 1*).

1348 anatomical burn sites were recorded in the 482 participants because three quarters of the children sustained burns in more than one anatomical site (75%, n=362), with upper limb burns being the most common site affected (23%, n=303), followed by lower limb burns (20%, n=255) (*Table 1*).

Most admissions took place in winter (32%, n=156), followed by spring (27%, n=130) and autumn (24%, n=117) (*Figure 2*).

Characteristics of Caregivers

Out of 482 patients only 226 participants completed their socio-demographic profile. Caregivers were not asked whether they were present at the time of the burn injury.

In this cohort of responders, the caregivers were mostly self-identified South African nationals (81%, n= 183). 90% of all caregivers demonstrated having attained at least a school leaving certificate (n=203) *(Table 2*).

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Participants came from households where electricity was available 91% of the time (n=205). Our study showed that electricity was also the most common cooking fuel (83%, n=187), followed by paraffin (10%, n=23) *(Table 2)*.

Almost two thirds of patients had received some method of first aid prior to arrival (63%, n=142). Of those who received first aid, 9% used more than one method of first aid post burn (n=21). Among those who received first aid, a described first aid method was provided in 75% of the cases (n=123). The most commonly used alternative first aid methods included toothpaste (7%, n = 11) and egg (5%, n= 8) (*Table 2*).

In this group, 79% of patients were referrals from other centres of all levels in and beyond our catchment area (n=178) *(Table 4)*. Referrals were from within and beyond the provincial border.

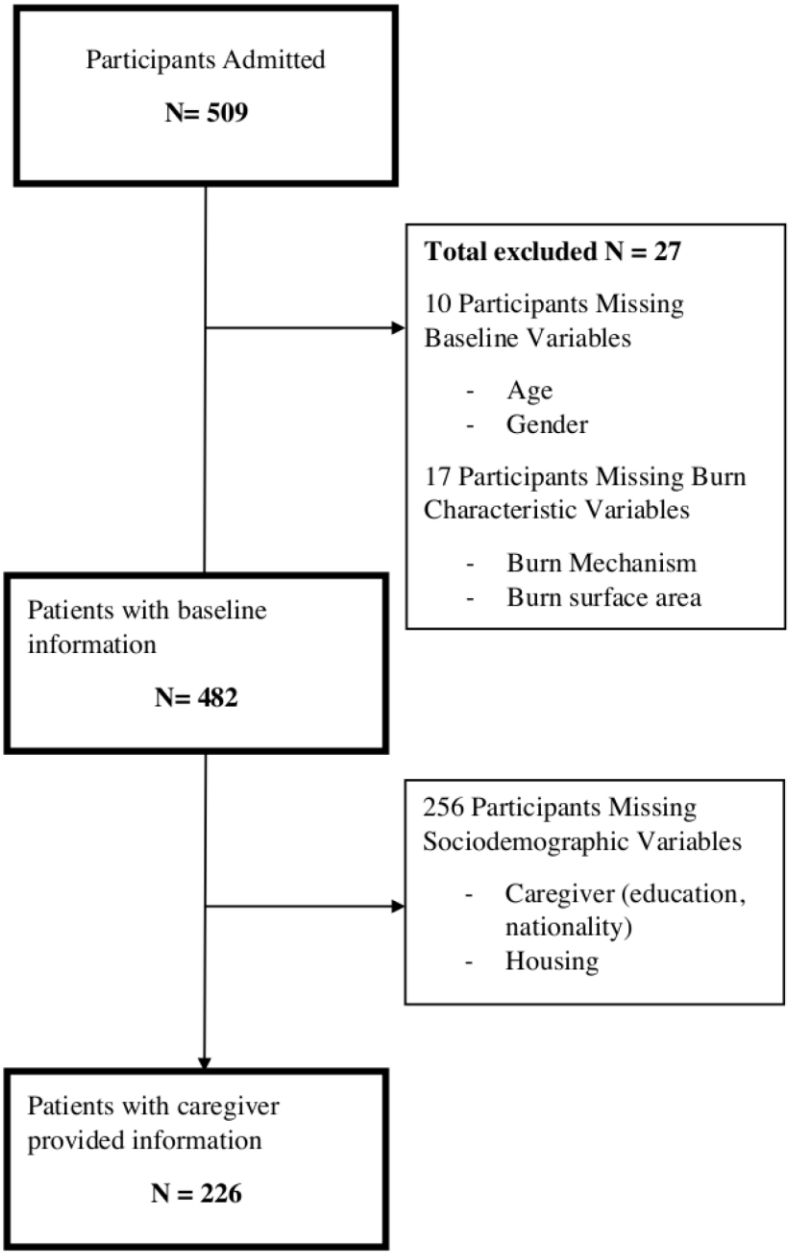
In this study, burns above 10% TBSA were classified as severe, without consideration of site, mechanism of burn or other factors that can assist in classifying a burn as severe (*Table 5*). Of all admissions, 47% had burns had severe burns (n= 154).

Table 5 shows participant stratification by burn size above and below 10% TBSA. Those with burns above 10% TBSA were more likely to have been burnt in multiple areas ($p<0.01$) and have thermal burns ($p<0.01$) as compared to those who had smaller burn percentage. Participants with severe burns were more likely to have received first aid ($p=0.01$) in comparison to those whose burns were less than 10% TBSA. Burn severity did not significantly differ by sociodemographic factors including caregiver education status ($p=0.76$), caregiver nationality ($p=0.17$), and accessibility of basic amenities such as formal housing ($p=0.84$) and access to electricity ($p=0.14$). Participants referred to the unit did not have significant difference in burn severity compared to walk-in participants ($p=0.45$).

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Figure 1 Showing Selection of Participants for Data Analysis



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Table 1 Showing Baseline Characteristics of Study Participants

	Count N=482	%		Count N=482	%
Age *(months)*			**Burn site***		
0-6	23	5	Upper limb	303	23
7-12	54	11	Lower limb	255	20
13-24	162	34	Chest	219	17
25-36	76	16	Back	191	15
37-48	46	10	Head	138	11
49-60	36	7	Perineum	110	8
61-72	24	5	Neck	89	7
73-84	19	4			
85-96	23	5	Single site	120	25
97-108	4	1	Multiple site	362	75
109-120	15	3			
Age Category month –no. (%)			**TBSA *(%)***		
≤24	239	50	0-5	121	25
>24	243	50	6-10	133	28
			11-15	85	18
≤6	23	5	16-20	66	14
>6	459	95	21-25	22	5
			26-30	19	4
Median age-mo. (IQR)	25	(15-47)	31-50	34	7
			51-75	2	<1
Gender					
Male	279	58	**Season∞**		
Female	203	42	Winter	156	32
			Spring	130	27
Burn mechanism			Summer	79	16
Scald (hot liquid)	403	84	Autumn	117	24
Contact (hot solid)	11	2			
Flame (fire)	42	9	Winter	156	32
Chemical	5	1	Not winter	326	68
Electrical	18	4			
Other**	3	1	**Burn Depth‡**		
			Full thickness	15	4
			Mixed thickness	65	17
			Superficial partial	304	79

*Burn site will be greater than number of study participants as each participant may have had multiple anatomical sites of burn injury. Total sites in 482 participants = 1348. ** Other = 2 firecrackers and 1 aerosol explosion. ‡ Total participants were 384 in which burn depth was recorded. ∞ Seasons were designated as follows: Summer as December to February, Autumn as March through May, Winter as June to August and Spring as September and October [9].

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Table 2 Showing Sociodemographic Characteristics of Study Participants

	Count N=226	%		Count N=226	%
Refer			**Caregiver**		
Referral	178	79	Local	*183*	81
Walk-in	48	21	Foreign	*43*	19
First Aid			**Caregiver Education**		
First Aid	142	63	≤Primary school	23	10
No first aid	84	37	≥School leaving certificate	203	90
Housing Utilities			**Cooking Fuel**		
Electricity	205	91	Electricity	187	83
No electricity	21	9	Paraffin	23	10
			Wood	5	2
			Gas	10	4
			Other	1	<1

Table 3 Showing First Aid Methods Used

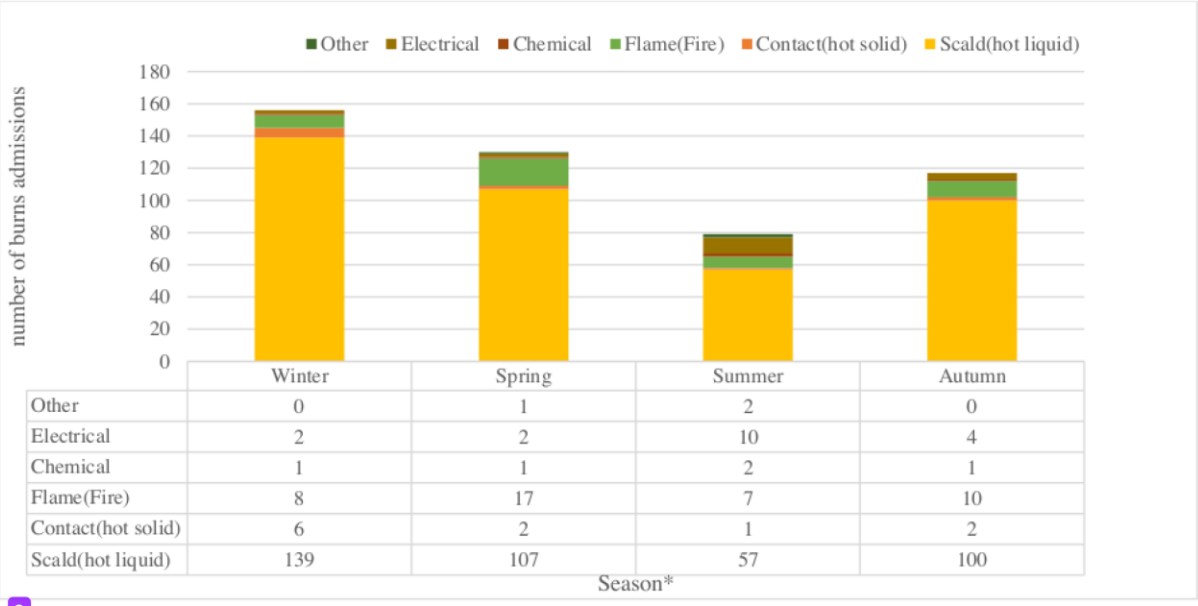
	Count N=163+	%		*Count*	%
Described Methods	**123**	**75**	**Other***	**21**	
Cold water	106	64			
Burn Dressing	17	10	Ointment *(Calamine/camphor/mercurochrome/ wintergreen/sulphacetamide/ear)*	7	4
Alternative Method	**40**	**25**	Cleaning solution *(Soap/dishwashing sunlight liquid)*	6	4
Toothpaste	11	7	Foodstuff *(Milk/flour/sugar)*	4	3
Egg	8	5	Towel application	2	1
Other*	21	13	Charcoal	1	<1
			Unknown	1	<1

*See right hand side of table for the breakdown of other methods of first aid that were used

+ 142 participants received first aid, with 21 receiving more than one method and therefore 163 types of first aid methods listed above.

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Figure 2 Showing Seasonal Variation of Burns by Type of Burn



	Winter	Spring	Summer	Autumn
Other	0	1	2	0
Electrical	2	2	10	4
Chemical	1	1	2	1
Flame(Fire)	8	17	7	10
Contact(hot solid)	6	2	1	2
Scald(hot liquid)	139	107	57	100

*Winter= June to August, Spring= September & October, Summer=December to February, Autumn= March to May.

Other= 2 firecracker burns, 1 aerosol burn.

Table 5 Showing Baseline Characteristics Stratified by Burn Surface area of 10% TBSA (Severity of burn)

			TBSA					
			<= 10%		>10%		Total	P-value
Variable								
BASELINE		*N=482*		%		%		
Median age-mo. (IQR)			24	(14-42)	25	(17-49)	482	0.09
Age Category month–no. (%)	≤24		115	(52)	107	(48)	222	
	>24		139	(53)	121	(47)	260	0.72
	≤6		10	(43)	13	(57)	23	
	>6		244	(53)	215	(47)	459	0.37
Median Weight kg. (IQR)			12	(10-16)	13	(10-16)	482	0.07
Sex–no. (%)	Male		156	(56)	123	(44)	279	
	Female		98	(48)	105	(52)	203	0.10
Season	Winter		88	(56)	68	(44)	156	
	Summer/Autumn/Spring		166	(51)	160	(49)	326	0.26
Burn site	Single site		110	(92)	10	(8)	120	
	Multiple sites		144	(40)	218	(60)	362	<0.01

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Variable			TBSA <= 10%		TBSA >10%		Total	P-value
Burn type	Thermal		232	(51)	227	(49)	459	
	Non-thermal		22	(96)	1	(4)	23	<0.01
SOCIODEMOGRAPHIC		*N=226*						
Caregiver Nationality	Foreign		19	(44)	24	(56)	43	
	Local		102	(56)	81	(44)	183	0.17
Housing Type	Formal		78	(53)	69	(47)	147	
	Informal		43	(54)	36	(46)	79	0.84
Caregiver Education	Primary School and below		13	(57)	10	(43)	23	
	Secondary School Level		108	(53)	95	(47)	203	0.76
Electricity	Electricity		113	(55)	92	(45)	205	
	No electricity		8	(38)	13	(62)	21	0.14
OTHER		*N=226*						
Referral	Referral		93	(52)	85	(48)	178	
	Walk-in		28	(58)	20	(42)	48	0.45
First aid	First-aid		67	(47)	75	(53)	142	
	No First aid		54	(64)	30	(36)	84	0.013

DISCUSSION

This study describes the paediatric burn injury admissions over a year in the largest hospital in Sub-Saharan Africa, where burn injury burden is high [8]. It provides data outlining the pattern of burn injuries, which essential for identifying issues of top priority, understanding the underlying causes of burn injury and identifying high risk groups for injury [1,6]. In an era of evidence based medicine, this evidence forms the building blocks for setting priorities, creating policy and measuring outcomes that have the ability to influence change [1].

Children 2 years old or younger accounted for a large proportion of our admissions. It is known that children between 6 months and 2 years of age are the age group of highest risk for burn injuries that require hospital admissions because they acquire motor skills whilst still lacking the understanding of environmental risk and agility to avoid hazards [10]. Similar to other global literature, upper limb burns were the most common anatomical site of burn injury [6]. Our study showed a predominance of burn injury in males in comparison to female. This disparity was noted in Cape Town, but other series that did not exclusively focus on South Africa showed burn injury predominating in female children [1,7,11]. This heterogeneity illustrates the

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importance of understanding our own South African population when conceptualising burn prevention strategies tailored to our needs.

In keeping with other LMICs, the most common mechanisms of burn injury were scalding, followed by flame burns [4,6,10,12,13]. It was unexpected to have a burn injury from an aerosol can explosion, as only some case studies in high income countries (HICs) have reported aerosol cans as sources of burn injuries. Notably, few of the cases reported were paediatric cases [14-18]. Injury mechanisms from aerosols in children are typically spray inflicted rather than explosions [19,20]. With development, we may now be seeing injury patterns that are evolving to mirror LMICs. Fireworks, in South Africa, have been recognised as a significant cause of paediatric injury [21], we however only recorded two injuries that were firework related. It has been shown that certain holiday times have more firework injuries [21]. It would be insightful to investigate whether cultural celebrations, legislation in different provinces or social norms are the possible causes of the discrepancy noted in our study in comparison to the one in a different geographical area. This information could benefit burn prevention strategies in areas experiencing significant firework injury cases.

In our centre, many factors are considered when assessing patient eligibility for admission. Admission criteria at the CHBAH PBU are based on burn severity by TBSA (>10%). With even smaller than 10% TBSA, children may be admitted based on burn site (hands, feet, face, perineum, circumferential, inhalation), cause (e.g., electrical, chemical), age (very young), sepsis, and social circumstance or suspicion of non-accidental injury. The South African Burn Society outlines the minimal requirements for a severe burn requiring specialist care, see detailed criteria in *Appendix 4* [22]. We acknowledge that injury severity is dependent on depth, anatomical site, extent and the cause of the burn [4,23]. However, for purposes of this study, we chose TBSA as a marker for burn severity in this study because calculating the extent of a burn injury is the often the first step in identifying the severity of a burn [24]. Furthermore, burns involving more than 10% TBSA are considered major burns in paediatrics, as they require fluid resuscitation [4]. There are various limitations to our approach as we acknowledge that most burns that occur among children have a TBSA less than 10%, and burn injuries with a smaller TBSA may still cause significant morbidity, especially in young infants [4]. One study limitation is potential observer bias as multiple clinicians admitted participants, and were involved in TBSA calculation of different participants, with method of calculation of TBSA not being specified. There are at least three different methods used to calculate TBSA, these include the “rule of nines,” the “Lund and Browder Chart,” and “palmar surface” [4,24].

Intuitively, larger TBSA was associated with multiple burn sites compared to those with single burn sites. Furthermore, more severe burns were associated with the use of first aid. This may be explained by caregivers being more concerned about burns that involved larger areas, and therefore providing first aid. Thermal burns were associated with severe burns, and we postulate it is because hot liquids are fluid in nature and therefore cover greater body surface area than their counterparts.

We demonstrated the expected seasonal variation in burn injury that peaked in winter. Unlike tropical climates, countries with marked seasonal variation have a higher occurrence of burn injuries in winter months than in warmer months [6]. This is likely due to the use of more heat generating activities taking place in colder months, and therefore more exposure to substances causing burn injury in children. Although first aid uptake was acceptable, there were participants who received non-described methods, outlining the need to educate communities on acceptable methods to provide first aid.

Our high referral rate was expected because this is specialised burn unit existing as part of a quaternary centre [25]. However, we did not see a relationship between referral and severe burn, despite knowing that the decision to refer a paediatric patient to a specialised burns centre is determined by the potential morbidity and complexity of a burn injury [4]. This is likely because we only defined severity by TBSA and not by other factors affecting severity or warranting referral. It may highlight the need to educate referring centres on appropriate referral guidelines, but that would require further studies on referral patterns first.

The large non-response rate from caregivers was shown to be unrelated to the sociodemographic characteristics we collected in this study *(Appendix 1)*. We therefore concluded that there were other factors that kept caregivers from disclosing further information. It may be fear related to blame, or immigration status. According to the 2011 census, almost 5% of the total country's population comprises of foreign nationals [26]. In contrast, our study showed over four times more foreign caregivers having children admitted to our unit than the census proportion. This may highlight increased migration, identify undocumented foreign nationals or genuinely show a disproportionately higher rate of burn injury in foreign national children. Studies show higher burn rates in children from minority populations [10]. Furthermore, a correlation between children with an immigration background from low income countries and significantly higher incidence of burns has been shown [27].

It was not known whether the caregivers who accompanied the children to the hospital, were the same caregivers who were present at the time that the children sustained their burns. Therefore, it may not provide insight on risk factors for burn severity in admitted patients. Several studies investigate risk for burn injury, but not necessarily at risk for burn severity. Contrary to risk for burn injury being inversely related to proxies for socioeconomic status (low parental education, overcrowding, lack of basic amenities), we found no other sociodemographic risks for burn injury [1,4,6,7,10,12]. Further studies are needed to look specifically at risk factors for severe burns.

CONCLUSION

Target populations for burn prevention strategies include families with children under two years old and minority groups. Areas of education must include, but should not be limited to, appropriate first aid management and emerging mechanisms of burn injury such as aerosols. Local healthcare facilities can be

used at education platforms when caregivers follow-up for services such as vaccinations for the target age group.

Areas for further study include characterising caregivers of children sustaining burn injury, referral patterns and appropriateness and risk factors for severe burn injury.

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CONFLICT OF INTEREST

None

AUTHOR CONTRIBUTIONS

Dr Agatha Banga:	Primary author. Project conception, proposal writing, data collection, data analysis and write-up.
Dr Andrew Grieve:	Research supervisor, paper review.
Dr Chris Westgarth- Taylor:	Research supervisor, paper review.

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None

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Appendix 6 : South African Burn Society Burn Stabilisation Protocol Minimal Criteria for Transfer to a Burn Centre

Burn services are provided throughout the country and are not only limited to Burns units or Burn centres although not all burn injuries require admission to a Burns Unit.

The stabilisation protocol has listed the following transfer criteria:

- All burn patients less than 1 year of age
- All burn patients from 1 – 2 years of age with burns > 5% total body surface area (TBSA)
- Patients in any age group with deep partial thickness burns of any size
- Patients older than 2 years with partial-thickness burns greater than 10% TBSA
- Patients with burns of special areas – face, hands, feet, genitalia, perineum or involving major joints
- Patients with electrical burns, including lightning burns
- Chemical burn patients
- Patients with inhalation injury or suspected inhalation injury resulting from fire or scald burns
- Patients with circumferential burns of the limbs or chest
- Burn injury patients with pre-existing medical disorders that could complicate management, prolong recovery or affect mortality
- Any patient with burns and concomitant trauma
- Pregnant patient that has sustained a Burn
- Paediatric burn cases where child abuse is suspected non accidental burns
- Burn patients with treatment requirements exceeding the capabilities of the referring centre
- Septic burn wound cases

It must be noted that each unit or centre has their own admission criteria and it is therefore recommended that the referring doctor calls the Burns unit before transfer.

References

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