ORIGINAL RESEARCH

Burns among adults in a major Malawian burn unit: epidemiology and factors associated with prolonged hospital stay

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Abstract

Aim

This study sought to describe the epidemiology of burns and factors associated with prolonged hospital stay among adult patients admitted in the Queen Elizabeth Central Hospital burns unit.

Methods

All files of patients aged at least 17 years and admitted in the Queen Elizabeth Central Hospital burns unit between 1 June 2007 and 31 May 2017 with acute burns, were reviewed. Data on socio-demographic characteristics, injuries sustained, comorbidities, length of hospital stay, and clinical outcomes were extracted from the files. Summary statistics, independent sample T-test, and odds ratios were computed to determine the distribution and associations of the variables collected.

Results

A total of 515 patient files, all from rural or informal urban settlements, were reviewed. The median age at the time of presentation was 32 years (IQR: 25-45), and 52% (n=279) were male. Most of the burns occurred at home (81.0%; n=379), were of flame etiology (75.7%; n=385), and were reported to have been accidental (94.7%, n=445). The mean monthly rate of new burn injury patients was highest in the cool-dry season, and epileptic seizures were a common precedent of burn injury (30.7%; n=158). Most (62.7%) of the patients with recorded burn sites sustained multiple burns injuries, and more than half of the patients had upper and lower limb burns (64.6% & 59.5% respectively). Thirty patients sustained additional non-burn injuries, and 26.4% (n=132) of all patients with recorded outcomes died in the hospital.

Conclusion

The data on burn injuries among adults presenting at the QECH burns unit suggests the existence of socio-economic inequalities associated with burn incidence. There is also a need for improvement in the quality and uptake of epilepsy care in primary care facilities.

Keywords: Adult, Biomass, Burns, Comorbidity, Epidemiology, Epilepsy, Malawi, Southern Africa

Introduction

Burns are the fourth most common type of trauma worldwide, following traffic accidents, falls, and interpersonal violence; responsible for at least 7.1 million injuries, almost 18 million disability adjusted life years (DALYs) lost and over 250,000 deaths globally[1–4]. Many burn victims and their families also experience adverse emotional, psychological, and economic effects secondary to burn-related disabilities and disfigurement[1,5]. Over 90% of the global burden of burn injuries is borne by low and middle-income countries (LMICs), with the WHO-defined Africa region contributing two-thirds of injuries and 15% of the mortality burden worldwide[3,6,7]. The exact epidemiology of burns in Africa remains largely unknown, but a systematic review of studies from 14 African countries showed that Malawi has the highest published burns related-mortality rate in Southern Africa (22%)[8,9]. This rate was also higher than the mean rate recorded among the countries included in the review (17%)[9].

Despite the significant burden of disease, there is a paucity of contemporary burns related epidemiological data in Malawi and Sub-Saharan Africa in general. Furthermore, most burn studies in Malawi exclude adult patients[10–14]. We undertook a retrospective audit of burns among adult patients admitted in the Queen Elizabeth Central Hospital (QECH) burns unit from 1st June 2007 to 31st May 2017 to describe the epidemiology of burns among them, and factors associated with prolonged hospital stay.

Methods

Study setting

QECH, located in Blantyre city in the southern region of Malawi, is the largest referral hospital in the country, with a total bed capacity of just over 1000. It is also the hospital where the first burn unit in the country was established, and

https://dx.doi.org/10.4314/mmj.v35i3.1

to this day, continues to care for burn patients with a bed capacity of 32 during the study period. The QECH burn unit was the only specialty burn center in Malawi until 2012, and adult burn patients constitute approximately 30% of all annual admissions in the unit.

Study population and selection criteria

Patients were included in the study if all of the following criteria were met at the time of admission: the presence of acute burn injury, patient age at least 17 years, and an admission date between 1 June 2007 and 31 May 2017. Patients were excluded from the study if they had any of the following: (1) records contained only admission notes, (2) they were pronounced dead on arrival, or (3) the index admission was for a complication from a previous burn injury or non-burn-related indication(s).

Data collection

We searched the QECH surgery department electronic database and physical burns unit registers for patients that met the inclusion criteria. Eligible patient files were then retrieved from the Health Management Information Systems (HMIS) office and further screened to ascertain their validity.

The following data were extracted from all eligible files: admission date, discharge date, demographic data (age, sex, name of referring facility/place of origin), burn injury-related data (place of injury, time of injury, time of presentation, etiology of burn, Total Burn Surface Area [TBSA], location of the burn injury, and associated complications), comorbidities present, and patient outcomes.

Data analysis

Data analysis was done using Stata 15 statistical package. All socio-demographic and burn-related continuous variables were transformed into categorical variables using a priori criteria. Potential burn sites were divided into the following four major regions: Head and neck, trunk, upper limbs, and lower limbs. The dates for burn injury were classified into three categories according to the seasons of Malawi as categorized by the Malawi department of climate change and meteorological services namely: warm-wet (November to April), cool-dry (May to August), and hot-dry (September to October)[15]. Questions concerning the site of burn and comorbidities were processed as multiple response variables to determine the number of people affected and the frequency of injury for each region. Frequencies of entries under each variable were computed, and independent sample T-tests were done to compare the means of binary variables. Parametric tests related to site specific data were only done on records of burns that occurred within Malawi due to the small sample size of expatriate patients.

Prolonged hospital stay was defined a length of hospital that is at least equivalent to the 75th percentile length of hospital stay observed in the sample. Crude associations between relevant independent variables of interest and prolonged hospital stay were tested, and variables with crude odds ratios less than 0.1 were entered in a binary logistic regression model to determine factors associated with prolonged hospital stay.

Results

Patient demographics

Out of the 779 patient names obtained from the patient registers, 515 patient files met the criteria for inclusion in the study.

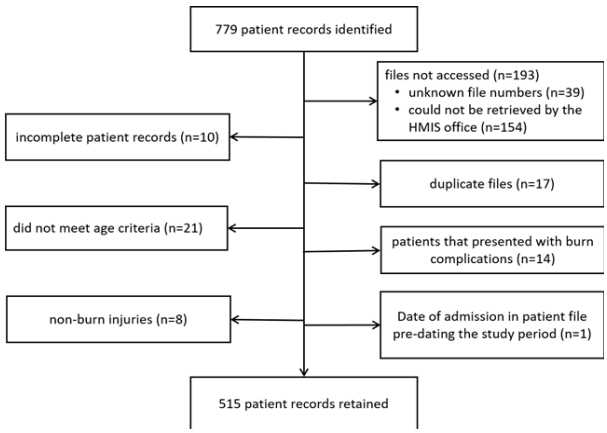

Figure 1: flow diagram of participant records selection for the study

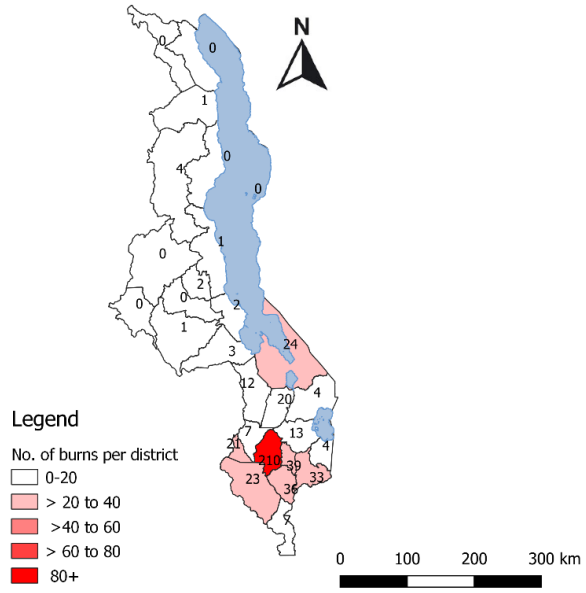

Figure 2: Number of Burns per District from 2007 to 2017

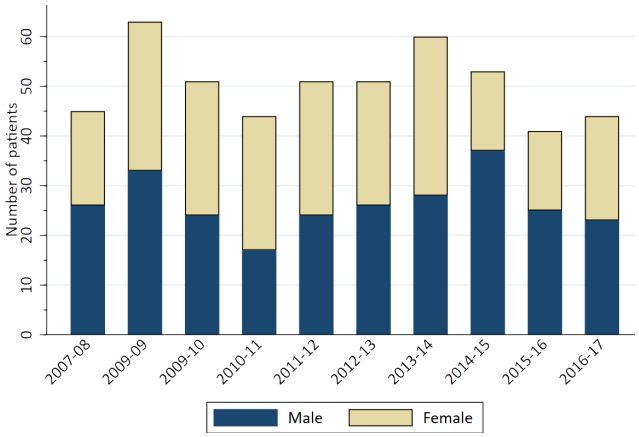

Figure 3: Number of adult patients admitted in the QECH burns unit (June 2007- May 2017)

Male patients comprised 269 (52.2 %) of the study population (table 1). The patient's ages ranged from 17 to 92 and the median age was 32.0 years (IQR 25-45 years). Young adults under 44 years age (n=381; 74.0%) comprised the majority of the patient population followed by the middle-aged (n=87; 16.9%), and geriatric patients (n=44; 8.5%).Seven of the patients (1.4 %) were from Mozambique, and 363 (70.5 %) of burns that occurred in Malawi originated from rural areas. All urban patients came from densely populated informal settlements of Blantyre city but there was no data on socioeconomic variables[16].

Table 1: distribution of participant characteristics and factors associated with prolonged hospital stay

		sex			Crude Odds of prolonged stay		Adjusted odds of prolonged stay
	Total	female	male	χ^2 p-value	95% CI	p-value	95% CI
Sex							
Female	246 (47.8)				1 (ref)	<0.001	1 (ref)
Male	269 (52.2)				0.97 (0.66—1.41)		0.64 (0.27—1.52)
Area of origin							
rural	363 (71.5)	192 (52.9)	171 (47.1)		1 (ref)		1 (ref)
urban	145 (28.5)	52 (35.9)	93 (64.1)	0.001	0.6 (0.38—0.95)	0.024	0.76 (0.27—2.14)
Mozambique	7	2 (47.8)	5(52.2)				
Age							
17—44	381(68.7)	169(44.4)	212(55.6)		1 (ref)		
45—64	87(18.3)	45(51.7)	42(48.3)	0.006	1.18 (0.72—1.96)	0.804	
≥65	47(13)	32(68.1)	15(31.9)		1.06 (0.55—2.06)		
Comorbidities							
none	284(46.3)	114(40.1)	170(59.9)	0.001	1 (ref)	<0.001	1 (ref)
epilepsy	189(44.3)	109(57.7)	80(42.3)		3.19 (2.11—4.82)		0.5 (0.18—1.38)
other	42(9.4)	23(54.8)	19(45.2)		2.08 (1.03—4.22)		0.5 (0.1—2.54)
Total burn surface area							
unknown	48(10.2)	25(52.1)	23(47.9)		1.42 (0.72—2.78)		
0— <10%	203(40.2)	99(48.8)	104(51.2)	0.383	1 (ref)	0.417	
10— <20%	126(21.1)	52(41.3)	74(58.7)		1.47 (0.9—2.38)		
≥20%	138(28.5)	70(50.7)	68(49.3)		1.11 (0.69—1.81)		
Modified Baux score							
0— <30	63(15.4)	34(54)	29(46)		0.78 (0.42—1.46)		
30— <60	247(46.2)	102(41.3)	145(58.7)	0.04	1 (ref)	0.291	
60— <90	102(23.5)	52(51)	50(49)		1.1 (0.67—1.8)		
≥90	56(14.9)	33(58.9)	23(41.1)		0.56 (0.27—1.14)		
Depth of burn							
partial thickness	148(27.5)	58(39.2)	90(60.8)		0.36 (0.21—0.59)		0.96 (0.27—3.45)
mixed thickness	113(28)	59(52.2)	54(47.8)	0.048	0.63 (0.38—1.04)	<0.001	2.2 (0.72—6.68)
full thickness	184(44.6)	94(51.1)	90(48.9)		1 (ref)		1 (ref)
Additional injuries							

The district of Blantyre had the largest share of patients (n=210; 40.8%), and all other patients were clustered in nearby districts (figure 1). Thus, the southern, central, and northern regions of Malawi contributed 428 (94.3%), 21 (4.6%), and 5 (1.1%) of the 454 patients whose district of origin was recorded respectively. Whilst the place where the burn occurred was not recorded in 70 files, domestic and workplace burns accounted for 359 (80.7 %) and 55 (12.4%) of all recorded places of burn respectively with the rest (n=31; 7.0%) occurring in various public places.

227 patients had documented comorbidities with 211 (93.0%) having one comorbidity. Neuropsychiatric conditions (Epilepsy, Psychosis, Stroke, and cerebral palsy) affected 203 (89.4%) of the patients with known comorbidities (table 2).

https://dx.doi.org/10.4314/mmj.v35i3.1

Table 1 Cont

no	486(95.5)	235(48.4)	251(51.7)	0.275	1 (ref)	0.521	
yes	29(4.5)	11(37.9)	18(62.1)		0.76 (0.32—1.81)		
Etiology of burn							
flame	385(73.6)	178(46.2)	207(53.8)		1 (ref)		1 (ref)
scald	88(21.5)	52(59.1)	36(40.9)	**0.024**	0.46 (0.26—0.82)	**<0.005**	0.33 (0.1—1.13)
other	35(5)	12(34.3)	23(65.7)		0.43 (0.17—1.05)		0.07 (0.01—0.7)
Days to hospital presentation							
0. ≤0.5	161(30.4)	73(45.3)	88(54.7)		1 (ref)		1 (ref)
>0.5— ≤1.0	98(20)	48(49)	50(51)	**0.901**	1.31 (0.82—2.73)	<0.001	0.6 (0.13—2.73)
>1.0— ≤7.0	131(26.7)	64(48.9)	67(51.2)		2.76 (1.24—3.66)		0.57 (0.12—2.71)
>7.0	112(22.9)	55(49.1)	57(50.9)		4.53 (2.04—6.07)		0.62 (0.13—2.93)
Time to first surgery							
0—7 days	54(21.7)	20(37)	34(63)		1.6 (0.77—3.3)		3.78 (1.33—10.75)
8–30 days	68(40.2)	37(54.4)	31(45.6)	**0.216**	1 (ref)	**<0.001**	1 (ref)
>31—60 days	50(28.3)	26(52)	24(48)		7.84 (3.27—18.77)		13.28 (4.23—41.72)
>60 days	22(9.8)	9(40.9)	13(59.1)		10.89 (0.0—2.93)		9.45 (1.61—55.41)
Head & neck burns							
No	333(68.5)	161(48.4)	172(51.7)		1 (ref)		1 (ref)
yes	162(31.5)	74(45.7)	88(54.3)	**0.577**	0.68 (0.44—1.04)	**0.072**	1.12 (0.37—3.43)
Trunk burns							
No	255(51.1)	120(47.1)	135(52.9)	0.849	1 (ref)	0.395	
yes	240(48.9)	115(47.9)	125(52.1)		0.85 (0.57—1.25)		
Upper limb burns							
No	178(36.6)	86(48.3)	92(51.7)		1 (ref)		
yes	317(63.4)	149(47)	168(53)	0.779	0.92 (0.62—1.38)	**0.703**	
Lower limb burns							
No	23(5.3)	13(56.5)	10(43.5)	0.390	1 (ref)	0.879	
yes	492(94.7)	233(47.4)	259(52.6)		0.83 (0.07—9.2)		
Number of burn sites							
1	108(23.4)	55(50.9)	53(49.1)		1.37 (0.81—2.32)		
2	145(28.5)	67(46.2)	78(53.8)	**0.783**	0.99 (0.6—1.64)	**0.462**	

Epilepsy was the most common comorbidity affecting 189 patients, thus accounting for 76.8% of all comorbidities, 83.3% of all patients with comorbidities, and 36.7% of the patient population. Patients with epilepsy also accounted for 47 (90.4 %) of patients who had a known history of having a previous burn, and the rural patient subset accounted for 157 (83.1 %) of all patients known to have epilepsy.

All of the 25 HIV patients had an established diagnosis at the time of admission, and HIV testing was done on nine patients only during the whole study period. Table 2 shows the characteristics of the patients in terms of their comorbidities and place of residence.

Table 1 Cont

3	155(29.8)	70(45.2)	85(54.8)		1 (ref)		
4	87(18.3)	43(49.4)	44(50.6)		0.85 (0.6—0.47)		
Antibiotics administered							
no	297(56.5)	139(46.8)	158(53.2)	0.609	1 (ref)	<0.001	1 (ref)
yes	218(43.5)	107(49.1)	111(50.9)		2.42 (1.64—3.56)		1.6 (0.7—3.65)
physiotherapy							
not indicated	142(26.2)	58(40.9)	84(59.2)		0.8 (0.4—1.8)		1.88 (0.58—6.1)
indicated but not done	81(14.5)	32(39.5)	49(60.5)	**0.015**	1.8 (0.9—3.9)	**<0.001**	0.83 (0.32—2.16)
indicated & done	244(59.3)	131(53.7)	113(46.3)		1 (ref)		1 (ref)
Fluid resuscitation							
not indicated	222(48.9)	108(48.7)	114(51.4)		1 (ref)		1 (ref)
indicated but not done	145(26.7)	59(40.7)	86(59.3)	**0.105**	0.97 (0.62—1.52)	**0.0086**	5.04 (1.49—17.03)
indicated & done	100(24.4)	54(54)	46(46)		0.43 (0.24—0.77)		1.36 (0.21—8.59)
Season of the year							
cool-dry	201(38.7)	94(46.8)	107(53.2)		0.84 (0.56—1.28)		
hot-dry	82(16.1)	39(47.6)	43(52.4)	**0.925**	0.75 (0.43—1.33)	**0.542**	
warm-wet	226(45.3)	110(48.7)	116(51.3)		1 (ref)		
History of previous burn							
no	463(88.6)	218(47.1)	245(52.9)	0.355	1 (ref)	0.035	1 (ref)
yes	52(11.4)	28(53.9)	24(46.2)		1.9 (1.06—3.41)		0.97 (0.31—2.99)

Annual incidence, seasonal incidence and diurnal variation of burns

The mean number of patients presenting each year was 50.4 (95%CI: 45.0—55.8) (figure 3). The greatest proportion of patients (44.4%) occurred in the warm-wet season, spanning 6 months, although the mean monthly rate was highest in the cool-dry season (May to August).

Table 4 shows the distribution of burn injuries across the three seasons. Among those with a known time of burn incidence, there was a general increase in the number of burns that occurred across the day from 0600hrs to 2000hrs, followed by a steep decline. The three-hour period between 1800hrs and 2100hrs showed the greatest peak in burn incidence (figure 4).

Circumstances of burn injury

The circumstances leading to the burn injury were recorded in 470 patient files only, and most of these n=445 (94.7%) were accidental burns associated with cooking. Among the accidental burns, 424 (95.2%) injuries were sustained with cooking fires, 158 (35.5%) injuries were sustained during an epileptic seizure, and 18 (4.9 %) occurred whilst the patients were intoxicated with alcohol. Twenty-five (5.3%) patients were classified as intentional since they were due to self-immolation, mob justice, or physical abuse. Twenty-nine sustained additional injuries at the time of the burn injury namely: inhalation burns (n=25), fractures (1), traumatic amputation (1), and lacerations (1).

Burn etiology, size, depth, and site

Thermal injuries made up 94.5% (n=480) of the 508 documented burn etiologies, and the overall leading causes of burns were flames (n=385; 75.8%) and scalds (n=88; 17.3%) (figure 5). Electric burns contributed another 23 (4.5%) burns with 19 due to electrical appliances and 4 due to lightning strikes. Chemical, contact, and friction burns constituted the remaining 2.4%. The mean TBSA among those with the relevant record (n=467) was 17.7% (95%CI: 16.0—19.3).

Patients from rural areas and those with comorbidities had larger TBSA compared to their counterparts (19.3%; 95%CI: 17.3—21.3 versus 12.7%; 95%CI: 10.0—15.4; T-test p-value<0.001, and 22.0%; 95%CI: 19.4—24.7 versus 12.2%; 95%CI: 10.7—13.8; T-test p-value<0.001) whilst other demographic variables had no statistically significant association with TBSA. Presence of comorbidities was however associated with higher prevalence of full thickness burns (54.8% versus 30.5%; χ^2 p-value<0.001).

The anatomical burn sites of 20 patients were not recorded and 108(21%) patients were burnt in one region of the body. The rest of the patients with recorded burn sites (n=387; 78.2 %) had burn injuries in multiple regions with the highest proportion of injuries (n=155; 31.3%) affecting three regions, and the lowest proportion affecting four regions (n=87; 17.6%).

Lower and upper limbs were the most common burn sites

https://dx.doi.org/10.4314/mmj.v35i3.1

Table 2: distribution of disease and residential characteristics of patients with comorbidities

Comorbidity	Number of people with the comorbidity	Proportion of responses (%)* (N=246)	Proportion of patients (%) ** (N=227)	Residence		
				Rural	Urban	Mozambique
Epilepsy	189	76.8	83.3	155	32	2
HIV	25	10.2	11.0	17	8	0
Psychosis	12	4.9	5.3	8	4	0
Hypertension	11	4.5	4.9	7	4	0
Stroke	3	1.2	1.3	1	2	0
Cerebral palsy	2	0.8	0.9	1	1	0
Diabetes mellitus	1	0.4	0.4	0	1	0
Syphilis	1	0.4	0.4		1	0
Brain Aneurysm	1	0.4	0.4	1	0	0
Blindness	1	0.4	0.4	1	0	0
TOTAL	246	100		191	53	2

*proportion of responses: proportion of all recorded comorbidities constituted by the comorbidity of interest.

**proportion of patients: proportion of all people known to have comorbidities that had the condition of interest. The total for the column is 108.3% due to presence of multiple comorbidities among some of the patients.

Table 3: Location and depth of burns

Burn site	Number of burns	Percentage of responses* (N=1211)	Percentage of patients** (N=495)	Burn depth		
				Full thickness	Mixed thickness	Partial thickness
Head & neck	162	13.38	32.7	61	50	42
Trunk	240	19.82	48.5	76	72	73
Upper limbs	317	26.18	64.0	91	88	106
Lower limbs	492	40.63	99.4	146	112	180
Total	1211	100%		374	322	401

* Percentage of responses: proportion of all recorded burn injuries constituted by injuries affecting the region of interest.

**percentage of patients: proportion of all patients with known sites who had burns in the body region of interest. The total for the column in 244.6% due to the presence of multiple burn sites among some patients.

Table 4: distribution of burn injuries across the seasons of Malawi

Season	Frequency	Percent	Mean monthly rate
Cool-dry	201	39.5	5.0
Hot-dry	82	16.1	4.1
Warm-wet	226	44.4	3.8

with nearly all patients with recorded burn sites having lower limb burns (n=492; 99.4%) and 64% having upper limbs burns. Table 3 below shows a summary of the location and depth of burns. Although facial burns were the least common, they affected a third of the patients (32.7%; 95%CI: 28.6—37.1)

Time lapse to hospital presentation and length of hospital stay

Women, ambulance users, and patients from rural areas presented at least 4.7 days later than their counterparts although only the rural-urban comparison was statistically significant (mean 9.8 days; 95 %CI: 7.2—12.4 days vs. mean 5.1 days; 3.5—6.7 days; T-test p value=0.036).

The mean length of hospital stay after admission was five weeks (34.8 days; 95%CI: 31.4—38.2), although there was a statistically significant difference in the length of stay of rural and urban patients (37.1 days; 95%CI: 33.0—41.1 versus 28.2 days; 95%CI: 22.2—34.2; p=0.022 respectively).

Prolonged hospital stay, as defined in this study, was reached at 48 days of hospital stay, and it had a 29.3% (95% CI: 25.4—33.5; n=151) prevalence. The odds of prolonged hospital stay were 5.04 (1.49—17.03) times higher among patients who did not receive intravenous fluid resuscitation at the time of admission when indicated as per hospital guidelines when compared to patients for whom intravenous fluids were not indicated (table 1). The odds of prolonged hospital stay were also increased if surgical procedures were conducted within the first week of admission or after spending at least 30 days in the ward. Burns from non-thermal causes were however associated with 15 fold lower odds (OR: 0.07; 95%CI: 0.01—0.65) of prolonged hospital stay.

Burn outcome

One hundred and thirty-two (26.4%) of the 500 patients with a documented disposition at the time of discharge died. The risk factors of mortality are reported by the authors in a separate paper (17). Among the patients that survived their burn injury, 300 (60%) were discharged home without follow up whilst 46 (9.2%) were discharged with planned follow-up in the QECH outpatient burns clinic, and 14 (2.8%) were transferred to another facility. Another eight (1.6%) patients absconded from the burns unit (Figure 6)

Discussion

This study delineates the epidemiology and trends of adult burns in the QECH burns unit. The results of this study indicate that injuries were more common among young and middle aged adults who are probably most economically active and might have greater exposure to etiologies of burn as part of their occupation or regular daily activities. Most (78.2%) of the patients with known burns sites sustained injuries in multiple regions of the body, which may have implications on cost of care and quality of life after recovery. Although facial burns were the least common burns by

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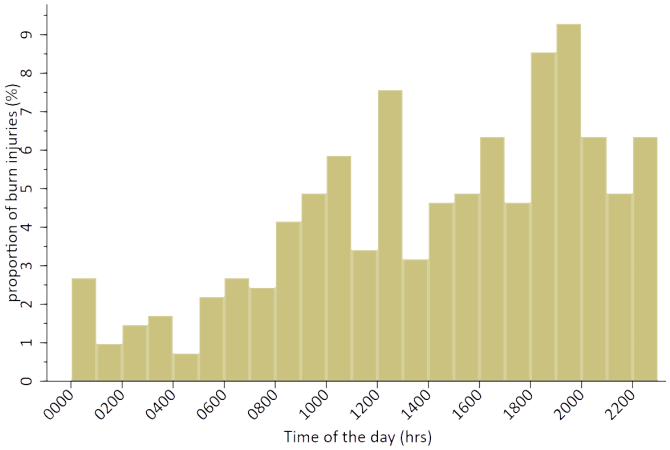

Figure 4: Diurnal variation in reported time of burn incidence (2007-2017)

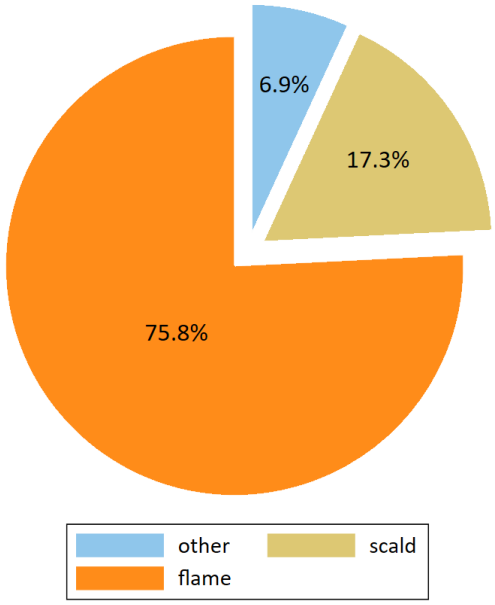

Figure 5: Etiology of burns among adult patients admitted in the QECH burns unit

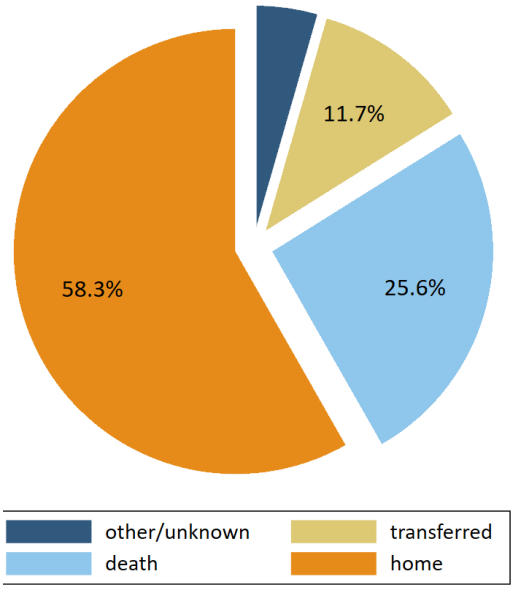

Figure 6: outcomes of adult patients admitted in the QECH burns unit (2007-2017)

anatomical distribution, they affected a third of the patients, and are particularly important due to (I) the possible risk of airway compromise, (II) the psychosocial implications of facial disfigurement, and (III) the limited treatment options for the same[18–20]. Upper limb burns are also very important due to the vital role of the upper limbs in social interaction and the economic consequences of limited physical abilities. Lower limbs are critical to activities of daily living such as walking, sitting or squatting among others.

Although the socioeconomic status of the patients could not be ascertained, informal urban settlements and rural populations are associated with a relatively low socioeconomic status, less costly & substandard infrastructure, and limited access to basic urban services[16,21,22]. The predominance of these patients coupled with predominance of flame burns, presence of statistically significant larger burns, and delayed presentation among rural patients suggests the presence of significant associations between socioeconomic status and major burns in Malawi. Other studies have demonstrated a relationship between residence in an informal settlement or low socioeconomic status, and the risk of burn injury[5,22,23]. In informal settlements and rural areas, cooking is often done over a ground-level fire and kerosene bottle lamps are often used as light sources. These devices, which are often non-ergonomic, lacking innate safety features, and susceptible to environmental influences (e.g. wind) are known risk factors for burn injury especially among people with neuropsychiatric disorders[24]. Thus, given Malawi's 10% overall electrification rate (2% in rural areas where 84% of the population resides) coupled with (I) limited supply of renewable energy and heavy dependence on biomass fuels, (II) predominance of the household sector consumption of final energy (84%) and incidence of burns (80.7%), we postulate that energy supply in Malawi has significant interaction with burn injuries[25].

Epileptic seizures are a common risk factor for burn injury in LMICs where the epilepsy treatment gap is over 75% (5,26). The exact magnitude of the treatment gap in Malawi is not known but it is estimated to be over 95% in Tanzania and Zambia, which are adjacent to Malawi[26]. The epilepsy treatment gap is reported to be twice as high in rural areas when compared to urban areas in LMICs[26]. Lack of treatment increases the risk of burn injury among people with epilepsy. Although the underlying mechanisms for the treatment gap have not been elucidated in our setting, cultural beliefs, limited access to treatment, and stigma have been identified as important factors in other parts of SSA[27,28].

Prolonged hospital stay was found to be associated with the following three factors: etiology of the burn, inadequate fluid resuscitation and timing of surgery for burn injuries. Non-thermal burns, most of which were of electrical etiology, may carry a significant acute risk of death. Survivors of these injuries may have small wounds and few immediately perceptible burn effects, especially in resource-limited settings[29]. Fluid resuscitation is the mainstay of burns management to mitigate the effects of systemic inflammatory response syndrome and avoid multi-organ failure[30]. We previously demonstrated the association between fluid resuscitation and mortality in the QECH burns unit[17]. Thus these results augment previous findings and provide hints for evaluation of the opportunity cost of optimum fluid resuscitation in the QECH burns unit. Although the benefits of early surgery after burn injury have been demonstrated in scientific literature, its utility in resource-limited settings, including Malawi, has also emerged as a significant challenge[31–33]. The association between early surgery and prolonged hospital stay in this study is, therefore, consistent with literature from other resource-

limited settings. Based on the experience of the authors, early excision and grafting was not commonly practised during the study period. Early operations were mostly to debride burn wounds that were clearly full thickness on presentation. After a month of wound bed preparation with dressings and debridement, the patients were then skin grafted. The factors associated with the limited utility of early surgery have been elucidated by other authors and are amenable to health systems strengthening and improvements in social determinants of health[32].

There is a paucity of evidence-based effective burn prevention strategies from Malawi and the rest of Sub-Saharan Africa. The results of this study however suggest potential areas of improvement that might result in lower incidence of severe burns in our setting. Given the wide array of potential gaps identified by this study, inter-sectorial cooperation is a prerequisite for sustainable reductions in burn injuries. Such efforts should include (I) mass education on epilepsy, fire safety (including safe storage of biomass fuels) and acute management of burns, (II) provision of holistic epilepsy & trauma care, (III) enforcement of quality standards in design and construction of appliances and built environments, and (IV) improving access to such appliances.

Limitations and constraints

Our study is the first of its kind in our setting in terms of its scope and size. It therefore provides a base for future studies. The study however has a number of weaknesses due to its dependence on hospital presentation of burn victims, exclusion of patients treated on out-patient basis, and the retrospective study design. These weaknesses include: limited number of variables that could be assessed, incompleteness of the available data, lack of standardized documentation which makes comparison difficult outside certain timelines, missing files, and lack of population based denominators for estimation of incidence proportions. These limitations therefore make it difficult to make certain conclusions and thus the numerical findings of this study should be taken as minimum rates due to inevitable underestimation.

Conclusion

Burns are one type of significant but preventable cause of injury among adults in Malawi. Thus contemporary and relevant epidemiological data on such injuries is needed to develop effective strategies for monitoring and reducing burn incidence and ensure equitable care. With this goal in mind, this paper described the epidemiology of burn injury among adult patients presenting at the QECH burns unit over a 10 year period. The findings of this study suggest the need for special attention and interventions to be tailored to rural and informal urban settlement dwellers, young and middle aged adults, and people living with Epilepsy. There is also a need to improve emergency and primary care services to ensure timely access to adequate pre-hospital care to mitigate progression of burns and mortality.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the College of Medicine Research and Ethics Committee (COMREC reference number P.09/17/2275).

Consent for publication

Not applicable

Availability of data and materials

The study data will be made available upon request to the authors subject to additional approvals from the College of Medicine Research Ethics Committee (COMREC) and the Queen Elizabeth Central Hospital.

Funding

This research received no specific grant from any funding agency in public, commercial or not-for-profit sectors.

Competing interests

The authors declare that they have no competing interests.

Author contributions

Conceptualization: SK, DM & TC; Data curation: SK; Formal Analysis: SK & DM; Writing-original draft preparation: SK & DM; Writing-Review & Editing: SK, DM, & TC. All authors read and approved the final manuscript.

Acknowledgements

The authors wish to acknowledge the QECH management and HMIS office for providing access to the study data. We also thank Dr Geoffrey Manda for his role in the conceptualisation of the BEAM project that led to this publication.

References

1. World Health Organization (WHO). A WHO plan for burn prevention and care. Geneva: World Health Organization [Internet]. 2008;3. Available from: https://apps.who.int/iris/handle/10665/ 97852

2. Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC, et al. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. Injury Prevention. 2016 Feb;22(1):3–18. https://doi.org/10.1136/injuryprev-2015-041616

3. Rybarczyk MM, Schafer JM, Elm CM, Sarvepalli S, Vaswani PA, Balhara KS, et al. Prevention of burn injuries in low- and middle-income countries: A systematic review. Burns. 2016 Sep;42(6):1183–92. https://doi.org/10.1016/j.burns.2016.04.014

4. Murray CJL, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet. 2012 Dec;380(9859):2197–223. https://doi.org/ 10.1016/S0140-6736(12)61689-4

5. Peck MD. Epidemiology of burns throughout the world. Part I: Distribution and risk factors. Burns. 2011 Nov;37(7):1087–100. https://doi.org/10.1016/j.burns.2011.06.005

6. Allorto NL, Wall S, Clarke DL. Quantifying capacity for burn care in South Africa. Burns Open. 2018 Oct;2(4):188–92. https://doi.org/10.1016/j.burnso.2018.07.002

7. Stokes MAR, Johnson WD. Burns in the Third World: an unmet need. Ann Burns Fire Disasters. 2017 Dec 31;30(4):243–6. PMID: 29983673

8. Rybarczyk MM, Schafer JM, Elm CM, Sarvepalli S, Vaswani PA, Balhara KS, et al. A systematic review of burn injuries in low- and middle-income countries: Epidemiology in the WHO-defined African Region. African Journal of Emergency Medicine. 2017 Mar;7(1):30–7. https://doi.org/ 10.1016/j.afjem.2017.01.006

9. Nthumba PM. Burns in sub-Saharan Africa: A review. Burns. 2016 Mar;42(2):258–66. https://doi.org/10.1016/j.burns.2015.04.006

10. Samuel J, Campbell E, Mjuweni S, Muyco A, Cairns B, Charles A. The Epidemiology, Management, Outcomes and Areas for Improvement of Burn Care in Central Malawi: An Observational Study. Journal of International Medical Research. 2011 Jun;39(3):873–9. https://doi.org/10.1177/147323001103900321

11. Kiser MM, Samuel JC, Mclean SE, Muyco AP, Cairns BA, Charles AG. Epidemiology of pediatric injury in Malawi: Burden of disease and implications for prevention. International Journal of Surgery. 2012;10(10):611–7. https://doi.org/10.1016/j.ijsu.2012.10.004

12. Bane M, Kaima R, Mapala S, Cairns B, Charles A. Qualitative evaluation of paediatric burn injury in Malawi: assessing opportunities for injury prevention. Trop Doct. 2016 Jul;46(3):165–7. https://doi.org/10.1177/0049475515612304

13. Harris L, Fioratou E, Broadis E. Paediatric burns in Blantyre, Malawi: A follow up study. International Journal of Surgery. 2015 Nov;23:S95. https://doi.org/10.1016/j.ijsu.2015.07.437

14. Broadis E, Chokotho T, Borgstein E. Paediatric burn and scald management in a low resource setting: A reference guide and review. African Journal of Emergency Medicine. 2017;7:S27–31. https://doi.org/10.1016/j.afjem.2017.06.004

15. Department of Climate Change and Meteorological Services. Climate of Malawi [Internet]. [cited 2019 Apr 24]. Available from: https://www.metmalawi.com/climate/climate.php

16. united nations Human Settlements Programme. Malawi: Blantyre urban profile. UN-HABITAT; 2011.

17. Kasenda S, Mategula D, Manda GE, Chokotho TK. Risk factors for mortality among hospitalised adult burn patients at a Malawian tertiary hospital burns unit. EAST and CENTRAL AFRICAN Journal of Surgery. 2019;24(2):9.

18. Sahni V. Psychological Impact of Facial Trauma. Cranial Maxillofac Trauma Reconstruction. 2018 Mar;11(01):015–20. https://doi.org/10.1055/s-0037-1603464

19. Gibson JohnAG, Ackling E, Bisson JI, Dobbs TD, Whitaker IS. The association of affective disorders and facial scarring: Systematic review and meta-analysis. Journal of Affective Disorders. 2018 Oct;239:1–10. https://doi.org/10.1016/j.jad.2018.06.013

20. Rumsey N. Psychosocial adjustment to skin conditions resulting in visible difference (disfigurement): What do we know? Why don't we know more? How shall we move forward? International Journal of Women's Dermatology. 2018 Mar;4(1):2–7. https://doi.org/10.1016/j.ijwd.2017.09.005

21. Heng JS, Atkins J, Clancy O, Takata M, Dunn KW, Jones I, et al. Geographical analysis of socioeconomic factors in risk of domestic burn injury in London 2007–2013. Burns. 2015 May;41(3):437–45. https://doi.org/10.1016/j.burns.2014.12.001

22. Edelman LS. Social and economic factors associated with the risk of burn injury. Burns. 2007 Dec;33(8):958–65. https://doi.org/10.1016/j.burns.2007.05.002

23. Peck MD, Kruger GE, van der Merwe AE, Godakumbura W, Ahuja RB. Burns and fires from non-electric domestic appliances in low and middle income countries. Burns. 2008 May;34(3):303–11. https://doi.org/10.1016/j.burns.2007.08.014

24. Peck M, Molnar J, Swart D. A global plan for burn prevention and care. Bulletin of the World Health Organization. 2009 Oct 1;87(10):802–3. https://doi.org/10.2471/BLT.08.059733

25. Taulo JL, Gondwe KJ, Sebitosi AB. Energy supply in Malawi: Options and issues. Journal of Energy in Southern Africa. 2017 Apr 13;26(2):19. https://doi.org/10.17159/2413-3051/2015/v26i2a2192

26. Meyer A-C, Dua T, Ma J, Saxena S, Birbeck G. Global disparities in the epilepsy treatment gap: a systematic review. Bulletin of the World Health Organization. 2010 Apr 1;88(4):260–6. https://doi.org/10.2471/BLT.09.064147

27. Chin JH. Epilepsy treatment in sub-Saharan Africa: closing the gap. Afr Health Sci. 2012 Jun;12(2):186–92. https://doi.org/10.4314/ahs.v12i2.17

28. Davé DR, Nagarjan N, Canner JK, Kushner AL, Stewart BT. Rethinking burns for low & middle-income countries: Differing patterns of burn epidemiology, care seeking behavior, and outcomes across four countries. Burns. 2018 Aug;44(5):1228–34. https://doi.org/10.1016/j.burns.2018.01.015

29. Wesner ML, Hickie J. Long-term sequelae of electrical injury. Can Fam Physician. 2013 Sep;59(9):935–9. PMID: 24029506

30. Chan J, Ghosh S. Fluid Resuscitation in Burns: An Update. Hong Kong Journal of Emergency Medicine. 2009 Jan 1;16(1):51–62. https://doi.org/10.1177/102490790901600112

31. Atiyeh B, Masellis A, Conte C. Optimizing Burn Treatment in Developing Low- and Middle-Income Countries with Limited Health Care Resources (Part 1). Ann Burns Fire Disasters. 2009 Sep 30;22(3):121–5.

32. Gallaher JR, Mjuweni S, Shah M, Cairns BA, Charles AG. Timing of early excision and grafting following burn in sub-Saharan Africa. Burns. 2015 Sep;41(6):1353–9. https://doi.org/ 10.1016/j.burns.2015.02.011

33. Miroshnychenko A, Kim K, Rochwerg B, Voineskos S. Comparison of early surgical intervention to delayed surgical intervention for treatment of thermal burns in adults: A systematic review and meta-analysis. Burns Open. 2021 Apr;5(2):67–77. https://doi.org/10.1016/j.burnso.2021.02.003