



Original article

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Descriptive epidemiological study of burn admissions to the Burns Intensive Care Unit of the Komfo Anokye Teaching Hospital, Kumasi-Ghana, 2009–2016

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ABSTRACT

Objective: To determine the trends in burn admissions, and aetiology, severity and mortality of patients admitted to the Burns Intensive Care Unit of the Komfo Anokye Teaching Hospital from May 2009 to April 2016 (7 years).

Methods: Patients' data used in this longitudinal and retrospective study were accessed from the records of the Reconstructive Plastic Surgery and Burns Unit. Processed data were depicted in tables and figures as appropriate. Univariate and multivariate analysis and Pearson's rank correlation were used in comparing relevant groups. Data analysis was conducted using Excel version 2013 and SPSS version 17.0.

Results: A total of 681 patients, with a male to female ratio of 1.1:1.0, were analysed. The average annual incidence was 97.28 with a progressive decline in incidence. Mortality rate was 24.2%. Majority of the patients were children less than 10 years (43.5%) with scalds as the main aetiology in this group. Open flame was the major aetiology of burns (49.9%). Majority of the patients spent less than 10 days on admission (67.1%). Mean total body surface area was 30.54%. There was correlation between TBSA and disposition, total body surface area and aetiology and number of days in the Burns Intensive Care Unit, total body surface area and aetiology, and aetiology and number of days in the Burns Intensive Care Unit.

Conclusions: Children below 10 years were the main victims. There was a shift from scald to open flame burns in this current study. Mean total body surface area and mortality rate have increased. There is urgent need for prevention campaign of flame burn and first aid education on intensive burns.

1. Introduction

Burns is one of the global public health problems with direct negative impact on its victims and their countries at large[1]. It leaves its victims emotionally trauma, deformity, temporarily or permanently disablement, and in worst cases claims their lives. These effects adversely affect the socio economic development of a country by

reducing the efficiency and number of human resources, increasing disease burden, cost of hospital and infrastructure management.

Application of preventive measures still remain the ideal solution to burn injury cases. Nonetheless, accidents are inevitable, and the likelihood and severity of their occurrence can be managed. For this reason, the World Health Organization (WHO), governments, non-governmental organizations and other recognized institutions have put in place policies and measures to help to reduce to the barest minimum of the occurrence of burn accidents as well as provide good health care to its victims. These measures are education of mothers and guardians on how to handle hot liquids, proper use and handling of inflammables, proper wiring in homes and institutions, periodic check of industrial safety measures and media campaign on use of smoke detectors and fire extinguishers.

Despite these efforts, burn morbidity and mortality rates remain high in low and middle income countries, compared to those of high

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The study protocol was performed according to the Helsinki declaration and approved by the Committee on Human Research, Publications and Ethics of the School of Medical Sciences, Kwame Nkrumah University of Science and Technology and the Komfo Anokye Teaching Hospital. Informed written consent was obtained from patients.

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income countries[1,2].

The WHO has indicated the lack of considerable research data as one of the seven major challenges confronting burns management in low and middle income countries. Scientific data research and reporting are, therefore, the keys to overcome this challenge[1].

The WHO further recommended and encouraged that burn centres in low and middle income countries publish periodically data indicating the epidemiology of reported burn cases. This will help to inform policy makers and stakeholders of the outcome of applying management policies and practices in relation to burns and further help to formulate policies that specifically relate to prevailing conditions, improve upon those already formulated, and ensure the enforcement of effective policies that have been ignored.

In accordance with the above recommendations, Ghana, as a low and middle income country, has taken initiatives in publishing epidemiological data on burn cases from some burn centres (particularly the Burns Intensive Care Unit (BICU) of the Komfo Anokye Teaching Hospital) in the country. The incidence of burns in Ghana has mainly been reported by Agbenorku *et al.*[3-11], Brusselaers *et al.*[12] and Negble *et al.*[13]. These works have mostly documented the epidemiology of burn cases in the middle belt of Ghana with the age groups below 10 years and 20–29 years constituting a majority of the burn victims.

This paper provided an update on the current incidence of burns in the middle belt of Ghana through a descriptive analysis of epidemiological data reported at the Komfo Anokye Teaching Hospital from May 2009 to April 2016. Specifically, this paper determined the frequency, pattern and aetiology of burn prevalence and mortalities and measured the degree of burns and mortality rate of burn patients reporting at the BICU of the Komfo Anokye Teaching Hospital over the past 7 years (May 2009–April 2016).

2. Materials and methods

2.1. Study setting

This was longitudinal and retrospective study involving patients admitted to the BICU of Komfo Anokye Teaching Hospital from May 2009 to April 2016. The study was undertaken at the Accident and Emergency Centre of the Komfo Anokye Teaching Hospital with a total ventilated bed capacity of 160. This well-equipped centre was established in 2009, with houses among other units, the Reconstructive Plastic Surgery and Burns Unit. Within the Reconstructive Plastic Surgery and Burns Unit is the BICU specially dedicated to burns patients. It is the main referral centre for the treatment of burns in the middle belt of Ghana.

2.2. Data collection and analysis

Data of burn patients within May 2009–April 2016 (the study period) were accessed from the BICU of the Reconstructive Plastic Surgery and Burns Unit from the admission and discharge/death log book. The retrieved information included record of admission, gender, age,

occupation, causes of injury, percentage total body surface area (TBSA) of burns, duration of hospital staying and record of discharge/death. The data were then entered into a computer database using Microsoft Excel version 2013.

The quantitative data were descriptively analysed, summarized and displayed on tables and charts. Parameters analysed included morbidity and mortality among various age groups, aetiology and severity of burns. Univariate (Fisher's exact test) and multivariate analysis including the Pearson's rank correlation were used in comparing relevant groups. Burns severity was analysed using the American burn association grading system for burn severity and disposition of patients. Data analysis was conducted using Excel version 2013 and SPSS version 17.0 (SPSS, Inc., Chicago, USA).

2.3. Ethical clearance

Ethical approval for the study was granted by the Committee on Human Research, Publications and Ethics of the School of Medical Sciences, Kwame Nkrumah University of Science and Technology and the Komfo Anokye Teaching Hospital.

2.4. Exclusion criteria

Re-admitted patients, as well as patients presenting with Stevens-Johnson syndrome were excluded from the study.

2.5. Limitations of the study

Other health facilities in and around the region might have been managed for some burn cases which were not included in this study.

3. Results

3.1. Admissions

A total of 681 burn patients from various regions of the country were admitted from May 2009 to April 2016. Of these patients, 78% were inhabitants of the Ashanti region, and patients from the other nine regions formed 22% of the burn patients (Figure 1).

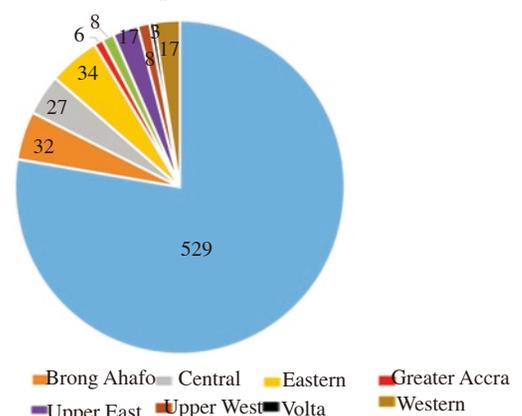


Figure 1. Regional distribution of patients.

Males formed the preponderance of patients admitted (53%) while

females formed 47% of the burn patients, thus indicating a male to female ratio of 1.1:1.0 (Table 1).

Table 1

Total frequency, gender distribution, mortality of the age groups, n (%).

Age group	Frequency	Male	Female	Mortality
0-9	297 (43.5)	151 (22.1)	146 (21.4)	61 (9.0)
10-19	69 (10.1)	27 (4.0)	42 (6.2)	14 (2.1)
20-29	121 (17.7)	71 (10.4)	50 (7.3)	27 (4.0)
30-39	100 (14.7)	60 (8.8)	40 (5.9)	27 (4.0)
40-49	50 (7.3)	29 (4.3)	21 (3.1)	16 (2.3)
50-59	29 (4.3)	20 (2.9)	9 (1.3)	12 (1.8)
60-69	5 (0.7)	0 (0.0)	5 (0.7)	1 (0.1)
70-79	9 (1.3)	3 (0.4)	6 (0.9)	6 (0.8)
80-89	2 (0.3)	1 (0.1)	1 (0.1)	1 (0.1)
Total	681 (100.0)	361 (53.0)	320 (47.0)	165 (24.2)

The age of the burn victims ranged from 0.96 to 88 with a mean of (19.1 ± 17.9) and median of 17. Majority of the patients were below age of 10 (297, 43.5%), followed by age ranged from 20 to 39 (221, 32.4%). The age ≥ 60 years recorded the least burn cases (16) with female predominance (12) (Table 1). Age ranged from 10 to 19 also showed female predominance.

With regards to employment status, the bulk (47%) of the patients were children (< 15 years) of which 67% were toddlers (≥ 3 years) and the rest were pupils (6-15). About 41% were employed, while 12% were unemployed. Blue collar (manual) workers, including drivers and their mates, cooks, farmers, electricians, fuel station attendants and others formed majority (90%) of the employed population while only 10% were formed by white collar jobs (nursing, teaching, counselling, etc.) (Figure 2).

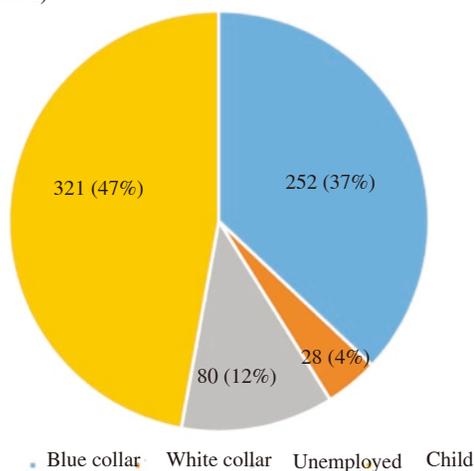


Figure 2. Employment status of patients, n (%).

Although the burns incidence increased from 78 in 2009 to 137 in 2010, subsequent years recorded a gradual decrease in reported cases, resulting in an overall marked reduction in burns incidence over the years (Figure 3).

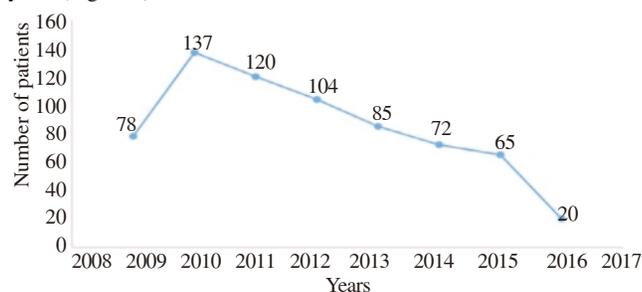


Figure 3. Trend in burns admission over the years.

3.2. Aetiology of burns

For the period under review, the causes of reported burn injuries were scalds, open flame, electricity and chemicals. The frequency of aetiology and corresponding sex distributions were indicated in Figure 4.

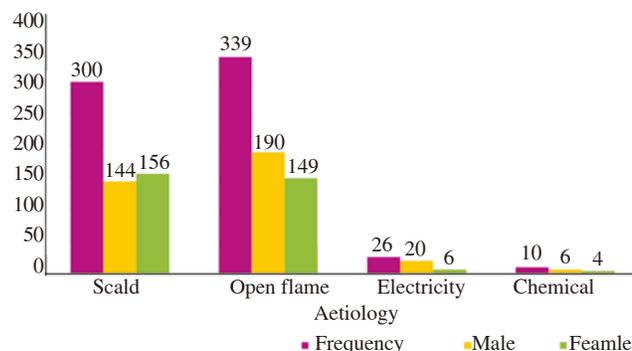


Figure 4. Frequency of aetiology and sex distribution.

There was male predominance in various aetiologies except for scald burns. Open flame was the major aetiology of burns. It presented practically half (49.9%) of the burns cases. It was the major cause of burns in all age groups except for paediatrics (0-10 years) who were recorded the highest aetiology as scalds. The population most affected by open flame burns were within the age group of 20-40 years (Table 2).

Table 2

Frequency, mortality rate of the aetiologies of burn per age group.

Age range	Aetiology	Frequency	Mortality	Mortality rate (%)
0-9	Scald	237	43	6.3
	Open flame	58	18	2.6
	Electricity	1	0	0.0
	Chemical	1	0	0.0
10-19	Scald	17	2	0.3
	Open flame	44	11	1.6
	Electricity	3	1	0.1
20-29	Scald	24	2	0.3
	Open flame	86	24	3.5
	Electricity	9	1	0.1
30-39	Scald	14	2	0.3
	Open flame	75	25	3.7
	Electricity	9	0	0.0
40-49	Scald	6	1	0.1
	Open flame	41	14	2.1
	Electricity	3	1	0.1
50-59	Scald	4	0	0.0
	Open flame	23	10	1.5
	Electricity	1	1	0.1
≥ 60	Scald	1	1	0.1
	Open flame	13	8	1.2
	Electricity	0	0	0.0
Total	Chemical	0	0	0.0
	Frequency	681	165	24.2

Electrical and chemical burns were recorded at relatively very low incidence of 26 and 10, respectively (Figure 4) and were not reported in all the years. Of the 26 electrical burn patients, 18

(69.2%) of them were within age of 20–40 years (Table 2).

Open flame burns, electrical and chemical burns did not show any defined pattern in burns incidence. However, scald burns followed a markedly reducing burns incidence trend, recording an incidence of 4 in 2016 as against 41 in 2009. Nonetheless, there was an increase in scald burns from 2009 to 2010 (Figure 5).

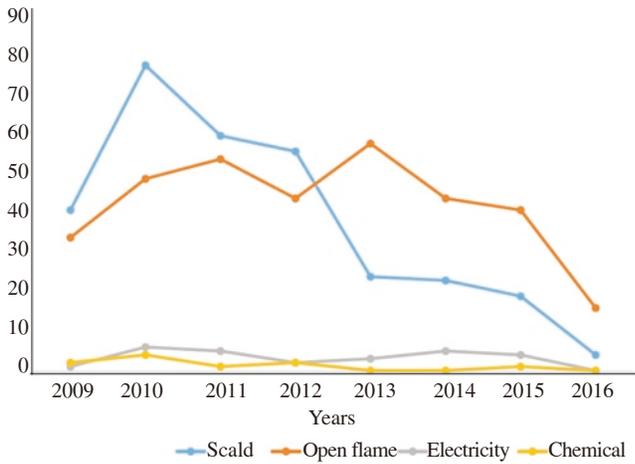


Figure 5. Trends in burn aetiologies over the years.

3.3. Mortality and mortality rate

Of the 681 patients, 165 died, indicating a mortality rate of 24.2%. Of those who died, males formed 53.3% while females formed 47.7% indicating a male to female ratio of 1.1:1.0 as shown in Table 3.

Table 3 Gender distribution of the total frequency, mortality and mortality rate.

Gender	Total frequency	Mortality	Mortality rate (%)
Male	361	88	24.4
Female	320	77	24.1
Total	681	165	24.2

As observed in Figure 6, there was no defined trend in mortality and mortality rate. Mortalities increased from 2009 and peaked in 2012, and then it decreased in 2016. Interestingly, the peaks in mortality rate occurred in the year 2013 and 2016.

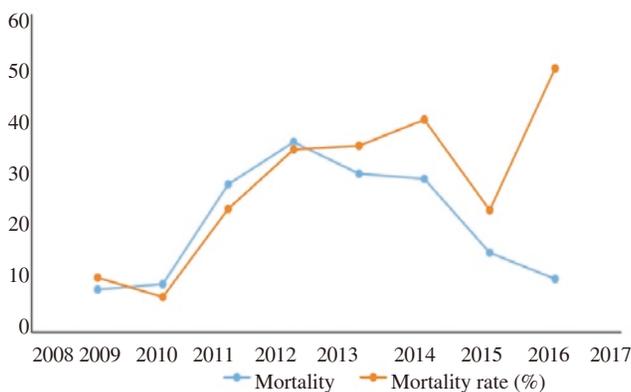


Figure 6. Trends in mortality and mortality rate over the years.

Open flame caused more than half of the total deaths recorded (n

= 110, 66.7%) with the highest mortality rate of 33.3% as shown in Table 4. Scald burns followed with fewer mortalities ($n = 50$) represented 30.3% of total deaths. Electrical and chemical burns claimed 5 lives. Scalds was the major cause of death in paediatrics while open flame was the major cause of deaths in all the other age groups, especially age of 20–40. Half of the aged burn victims died (Table 2).

Table 4 Total frequency and mortality rate of the individual aetiologies.

Aetiology	Total frequency	Mortality	Mortality rate
Scald	305	50	30.3 (16.4)
Open flame	340	110	66.7 (32.4)
Electricity	26	4	2.4 (15.4)
Chemical	10	1	0.6 (10.0)

3.4. Severity of burns

Most of the patients had major burns (Table 5). Table 6 clearly reveals a direct proportionality increase in percentage mortality as the TBSA burnt increased. Most of the patients recorded a TBSA of 11%–30%. High mortality was associated with burnt surface areas greater than 50%. The outcome of patients with TBSA \leq 50% was favourable. However, TBSA \leq 10 produced the best outcome. Average TBSA was 30.54%.

Table 5 Severity of burns (with reference to American burn association grading system).

Patient criteria	Severity of burns (%)		
	Minor	Moderate	Major
Young	10	51	236
Adult	45	68	236
Old	2	0	33
Total	57	119	505

Table 6 TBSA and outcome (%).

TBSA	Outcome		
	Lived	Died	Total
\leq 10	105 (92.9)	8 (7.1)	113
11–20	148 (92.5)	12 (7.5)	160
21–30	119 (86.2)	19 (13.8)	138
31–40	71 (71.0)	29 (29.0)	100
41–50	36 (61.0)	23 (39.0)	59
51–60	15 (40.5)	22 (59.5)	37
61–70	8 (36.4)	14 (63.6)	22
71–80	7 (29.2)	17 (70.8)	24
81–90	3 (25.0)	9 (75.0)	12
91–100	4 (25.0)	12 (75.0)	16

3.5. Duration of admission

Table 7 shows that majority (67.1%) of the patients spent not more than 10 days on admission in the BICU. Only 4.9% ($n = 34$) of the patients spent more than a month on admission. However, most (66.7%) of the patients' death occurred in the first 10 days of admission.

Table 7

Duration of admission.

Number of days	Total frequency	Died (%)
≤ 10	457 (67.1)	110 (24.1)
11–20	152 (22.3)	38 (25.0)
21–30	38 (5.6)	9 (23.7)
31–40	22 (3.2)	6 (27.3)
41–50	5 (0.7)	0 (0.0)
51–60	5 (0.7)	1 (20.0)
> 60	2 (0.3)	1 (50.0)

3.6. Univariate analysis

The univariate analysis (Fisher's exact test) was used in calculating the odds ratio, the odds for the number of days at intensive care unit (ICU), and gender (female) as a risk factor for death was statistically insignificant with odds ratios of 1.046 and 1.017, respectively. The odds for 'age' as risk factor was 57% with the true population effect between 83% and 39%. This result was statistically significant at $P = 0.0043$. TBSA also recorded statistically significant ($P < 0.0001$) odds at 95% with the true population effect between 15% and 6% as shown in Table 8.

Table 8

Univariate analysis for risk factors for death in BICU of Komfo Anokye Teaching Hospital.

Variable	Univariate		
	OR	95% CI	P
Days at ICU (No.)	1.04600	0.67600–1.62000	0.9120
Gender (female)	1.01700	0.71590–1.44600	0.9289
Age (years)	0.56510	0.38680–0.82560	0.0043
TBSA (%)	0.09499	0.06033–0.14960	< 0.0001

OR: Odds ratio; CI: Confidence interval.

3.7. Multivariate analysis

The multivariate analysis (using binomial logistic regression) significantly showed TBSA as a risk factor for death in burn patients at $P < 0.0001$ with an odds ratio of 1.055 with a true population effect between 1.044 and 1.066 at a 95% confidence interval (Table 9). Age, the number of days in ICU and sex were not statistically significant at the 0.05 significance level. Age had an odds ratio of 1.004 with a true population effect between 0.993. Sex also had an odds ratio of 1.189 with a true population effect between 0.971 and 1.011 while the number of days in ICU showed an odds ratio of 0.991 with a true population effect between 0.971 and 1.011 at 95% confidence interval.

Table 9

Multivariate analysis of risk factors for death in burn patients in BICU of Komfo Anokye Teaching Hospital.

Variable	OR	95% CI		P
		Lower	Upper	
Age	1.004	0.993	1.016	0.479
Days in ICU	0.991	0.971	1.011	0.362
Sex	1.189	0.800	1.765	0.392
TBSA	1.055	1.044	1.066	0.000

OR: Odds ratio; CI: Confidence interval.

3.8. Pearson's correlation analysis

Pearson's correlation analysis was used for TBSA/outcome, TBSA/the number of days in ICU, TBSA/aetiology and aetiology/number of days in ICU.

There was a positive correlation between TBSA and outcome ($P = 0.487$) as well as TBSA and duration of stay in ICU ($P = 0.129$). A negative correlation was rather recorded for TBSA/aetiology ($P = -0.267$) and aetiology/the number of days in ICU ($P = -0.179$). Correlation was significant at the 0.01 level (2-tailed) as shown in Tables 10–13.

Table 10

Correlation of TBSA and admission outcome.

Variable	TBSA	Admission outcome
TBSA	Pearson correlation	1
	Significant (2-tailed)	0.487**
	N	681
Disposition	Pearson correlation	0.487**
	Significant (2-tailed)	0.000
	N	681

**: Correlation is significant at the 0.01 level (2-tailed).

Table 11

Correlation of TBSA and the number of days in ICU.

Variable	TBSA	Number of days in ICU
TBSA	Pearson correlation	1
	Significant (2-tailed)	0.129**
	N	681
Days in ICU	Pearson correlation	0.129**
	Significant (2-tailed)	0.001
	N	681

**: Correlation is significant at the 0.01 level (2-tailed).

Table 12

Correlation of TBSA and aetiology.

Variable	TBSA	Aetiology
TBSA	Pearson correlation	1
	Significant (2-tailed)	-0.267**
	N	681
Aetiology	Pearson correlation	-0.267**
	Significant (2-tailed)	0.000
	N	681

**: Correlation is significant at the 0.01 level (2-tailed).

Table 13

Correlation of aetiology and number of days in ICU.

Variable	Aetiology	Number of days in ICU
Aetiology	Pearson correlation	1
	Significant (2-tailed)	-0.179**
	N	681
Days in ICU	Pearson correlation	-0.179**
	Significant (2-tailed)	0.000
	N	681

**: Correlation is significant at the 0.01 level (2-tailed).

4. Discussion

4.1. Admissions

The average annual burn admissions in this study (97.28) indicates a remarkable reduction relative to the previous studies (182)[6]. Many other studies have reported similar results, with reduction in

burns morbidity[14-17]. This trend could be attributed to the increase in burn awareness through prevention campaigns. Improved data collection, effective research and the implementation of policies that tackle proven prevailing conditions of burn injuries have also contributed significantly.

This study revealed a preponderance (43.5%) of burns in children under 10 years, followed by age of 20–39 years (32.4%). This is a trend characteristic of low and middle income countries[18]. A review study by Forjuoh[2] and studies by other researchers reported high burn prevalence in children aged 10 years and below[19-21]. This result can be attributed to parental or guardian negligence and under developed cognitive function of children who are especially below 5 years[22]. The high prevalence in age of 20–39 could also be as a result of lack of poor adherence to safety regulations and work inexperience. Such a high incidence of burns within this age group is very devastating to both families and the country, as this group forms part of the most economically active population[23]. Majority of Ghanaians are manual workers. High burns incidence in this group has a deleterious effect on economy of the country. Education on occupational hazards and safety is highly recommended.

Overall, males were the major burn victims with 53% dominance in this study (ratio of male to female: 1.1:1). Nthumba[24] realized approximately the same ration in his review of burns in 14 countries in sub-Saharan Africa (1.2:1) as well as studies by Gupta *et al.*[25], thus indicating that males are at a higher risk of being victims of burn accidents than females. Studies by Outwater *et al.*, Queiroz *et al.*, Hwee *et al.*[26-28] and Brusselaers *et al.*[21] have also indicated a male predominance among burn patients across the world. De Roche *et al.* posited that this trend is as a result of the high burn risk occupation men often involved in[29]. In contrast to this result, Brusselares *et al.* reported that separate studies from Austria and Turkey reported only one third of the burn victims as men, and this dissimilarity was, however, not discussed[21].

There was, however, a female dominance for age ranges 10–19 years and 60–80 years. Female dominance in the stated age groups owes to the active involvement of females in these age ranges in cooking and other domestic activities with high burn risk[26]. Brusselares *et al.* attributed female dominance in the aged (≥ 60 years) to long life expectancy in the female gender[21].

4.2. Aetiology

Considering the aetiology, open flame burns was the most frequent among adults while scalds was the most frequent among children. This result is consistent with reviews by other authors[19,21,30]. Also, females, rather than males were the most affected by scald burns. This result is similar to a review by Brusselares *et al.* in Europe[21]. The role of females in performing domestic activities especially cooking, could partly be the reason for this observation. Children (often toddlers) with under developed cognitive ability often find themselves with their mothers in the kitchen while cooking, and

accidentally hurt themselves with hot liquids. Adults, on the other hand, are often found at work places and on the streets where open flame burns usually occur.

In the previous epidemiological studies for BICU of Komfo Anokye Teaching Hospital[6], scald was the major cause of burns. Remarkably, the current study has recorded a drastic reduction in scald burns, from 47 in 2009 to 4 in 2016. The rise in scald-related burns from 47 in 2010 to 78 in 2009 is most likely due to the increased number of months. The number of months from which cases were studied in 2009 was 8 months (May to December) while that for 2010 was 12 months. Nonetheless, the overall result is very commendable and reflects the effectiveness of the urgent positive response of government and policy makers to earlier recommendations. Similar observation was made for South Africa by Nthumba in his review where he stated that South Africa is now benefitting from the response of government and civil society to research recommendations proposed by their burns society[24].

Nthumba's review for sub-Saharan Africa indicated an equal percentage (45%) of scald and open flame burns for West African countries, including Ghana[24]. Interestingly, this study highlighted open flame as the major aetiology of burns accounting for close to 50% (49.7%) of recorded burn cases, thus evincing a shift in aetiology from scald. This is in contrast with many other burn studies as scald remains the major aetiology[30].

Open flame as the major aetiology in this study is consistent with Oladele and Olabanji's review in Nigeria and a few others[19,23,27]. The shift in aetiology can be attributed to the increasing fire outbreaks in Ghana which was reported by Addai *et al.* particularly in the middle belt of the country[31]. The main cause of the open flame burn is petrol and gas explosions. These explosions caused about 43% of open flame burns. It is thus, very important that the various stakeholders adhere to safety measures in order to mitigate these absolutely preventable accidents. Electricity and chemicals were less frequent in causing burns. Oladele and Olabanji are of the view that the less frequencies recorded for electrical burns may be because they are under reported since many patients with severe electrical burns who die are usually simply reported as cases of electrocution, without any documentation regarding to the electrical burn component of their injury[19].

The shift from scald burns to open flame burns is a cause for alarm because flame burns unlike scalds often claims the lives of most of its victims[24]. The population most affected by this aetiology are men within the age group of 20–30 years, who form part of the economically active population in most countries[23]. The analysed data indicated 56% of flame burn victims were men, and people aged at 20–40 years (43.9%) were the most affected by flame burns. Young men in this age group often work at fuel stations as fuel dispensers (petrol and gas) and car wash attendants with insufficient work hazardous awareness and inexperience, and these could partly be the reasons for this observation.

The shift from scald to flame burns calls for immediate attention.

In attempt to curb the menace of open flame, prevention campaigns for the other aetiologies (chemicals, electricity and scalds) should not be excluded. Urgent response to this situation will drastically reduce burns incidence and mortality.

4.3. Mortality

4.3.1. Mortality and mortality rate

The reduction in burn prevalence was expected to draw parallel with mortality and hence a reduced mortality rate. Unfortunately, the decreasing burn injury cases with increasing deaths resulted in an increased mortality rate of 24.2% as compared to 13.1% for the previous studies. This result is in contrast with the review by Brusselares *et al.* in Europe[21], Smolle *et al.*[32] for the world and studies by Hwee *et al.* in Singapore where a decreased mortality rate was recorded[28]. The increased mortality can primarily be attributed to the shift in burn aetiology from scalds to open flame, as discussed above.

4.3.2. Risk factors of mortality

Mortality is associated with gender, age, aetiology, percentage of TBSA and complications of burns such as septicaemia, respiratory failure, *etc.*[27,33].

We found that the death toll in men is slightly greater than in women in a ratio of 1.1:1.0. We can attribute this result to the kind of work that men are engaged in. Most men than women, are engaged in high burn risk jobs like petroleum works, driving, farming, *etc.*

Mortality rate in the other age groups were lower than that in the aged. The high mortality rate within the aged can be attributed to their very low incidence and high mortality.

4.3.3. Mortality and aetiology

Although there has been a shift in major aetiology from scalds to open flame, scald burns continue to be the major cause of burn deaths in children under age of 10, accounting for 79.7% of paediatric mortalities. However, we recorded a higher mortality rate for open flame burns (31%) in paediatrics as compared to scalds (18.1%). Though the current burn admissions are lesser than those recorded in the previous studies[6], paediatric burns remain a huge problem in burns management in Ghana and calls for more attention than given. The primary aim is to achieve no burn injuries since burn injuries are preventable.

Open flame burns claimed a lot of lives accounting for 66.6% of the total number of deaths recorded. The severity of burn caused, late presentation of burns to the hospital and ignorance of the public on first aid measures to be applied in the event of flame burn injuries could account for this result. Oladele and Olabanji recommended the regionalization of burn care centres to enable burn victims report early to burn units to reduce burn mortalities[19]. Obviously this is dependent on the region's size and population size among other factors. This study also recommend an immediate intensive public

education on first aid administered to burn victims, especially for flame burn victims.

4.4. Severity of burns

It was observed from Table 5 that most (505, 74.2%) of the burn victims were reported with major burn cases. This clearly shows that most of the burn cases are life threatening and thus making burns a disease burden to the region.

4.4.1. Mortality and TBSA

An average TBSA of 30.54% was recorded. Increasing mortality rate was also observed for patients with TBSA ≥ 50 , and this percentage is greater than what Nthumba reported for sub-Saharan Africa ($> 31\%$). This shows an improvement in burn care at BICU relative to other sub-Saharan countries. However, the current mean TBSA is greater than that was reported for the previous studies (24.7%)[6]. This result can be attributed to the shift in aetiology as flame burns tend to cause severe burns rather than scald burns. Half (50.13%) of the patients who recorded TBSA $> 50\%$ were all victims of open flame burns. This suggests a correlation between cause of burns, extent of burns (TBSA) and mortality as indicated in the univariate and multivariate analysis. This further confirms the reason for recording high number of deaths in the current study though burns incidence decreased. As expected, the area burnt increased, and the outcome was worsened. Only 4 out of the 16 patients with TBSA between 90%–100% survived. It is, therefore, prudent to find novel and improved burn therapy and surgical techniques in order to reduce mortalities.

4.4.2. Mortality and duration of staying at BICU

Majority of the patients spent less than two weeks in the BICU. The number of days patients spent at BICU might be elusive because our results showed that most (66.7%) of our patients died within the first 10 days of admission. Improved pre-hospital service and emergency burn care techniques are, therefore, highly recommended.

Burns incidence has reduced drastically over the years, but there has been a shift in aetiology of burns from scalds to open flame which has led to an increase in the average TBSA burnt and mortality rate. Paediatrics continue to record high burns incidence. These findings are very necessary for the government and the civil society in making effective policies to address the incidence of burns especially flame-related burns. Flame burns prevention campaign is urgently recommended in order to drastically reduce its incidence, without neglecting prevention campaign for the other aetiologies, especially scald burns. Burns first aid education and parental monitoring are also recommended for the general public.

Conflict of interest statement

The authors report no conflict of interest.

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References

- [1] World Health Organization. A WHO plan for burn prevention and care. Geneva: World Health Organization; 2008.
- [2] Forjuoh SN. Burns in low- and middle-income countries: a review of available literature on descriptive epidemiology, risk factors, treatment, and prevention. *Burns* 2006; **32**(5): 529-37.
- [3] Agbenorku P, Akpaloo J, Farhat BF, Hoyte-Williams PE, Yorke J, Agbenorku M, et al. Burn disasters in the middle belt of Ghana from 2007 to 2008 and their consequences. *Burns* 2010; **36**(8): 1309-15.
- [4] Agbenorku P, Akpaloo J, Yalley D, Appiah A. A new era in the management of burns trauma in Kumasi, Ghana. *Ann Burns Fire Disasters* 2010; **23**(2): 59-66.
- [5] Agbenorku P, Agbenorku M. Experience in the management of axillary post-burn scar contractures. *Niger J Plast Surg* 2010; doi: 10.4314/njpsur.v6i2.63646.
- [6] Agbenorku P, Edusei A, Ankomah J. Epidemiological study of burns in Komfo Anokye Teaching Hospital, 2006-2009. *Burns* 2011; **37**(7): 1259-64.
- [7] Agbenorku P, Fugar S, Akpaloo J, Hoyte-Williams PE, Alhassan Z, Agyei F. Management of severe burn injuries with topical heparin: the first evidence-based study in Ghana. *Int J Burns Trauma* 2013; **3**(1): 30-6.
- [8] Agbenorku P. Burns functional disabilities among burn survivors: a study in Komfo Anokye Teaching Hospital, Ghana. *Int J Burns Trauma* 2013; **3**(2): 78-86.
- [9] Agbenorku P, Agbenorku M, Fiifi-Yankson PK. Pediatric burns mortality risk factors in a developing country's tertiary burns intensive care unit. *Int J Burns Trauma* 2013; **3**(3): 151-8.
- [10] Agbenorku P. Modernized standards in burns management: A comparative study in Komfo Anokye Teaching Hospital, Kumasi, Ghana. *Burns* 2013; **39**(5): 990-6.
- [11] Agbenorku P. Early childhood severe scalds in a developing country: a 3-year retrospective study. *Burns Trauma* 2015; **1**(3): 122-7.
- [12] Brusselaers N, Agbenorku P, Hoyte-Williams PE. Assessment of mortality prediction models in a Ghanaian burn population. *Burns* 2013; **39**(5): 997-1003.
- [13] Negble M, Agbenorku P, Ampomah EA, Hoyte-Williams PE. Nursing severe burn injury patients: emotional impact on nurses. *Int J Med Med Sci* 2014; **47**(1): 1430-3.
- [14] Laitakari E, Koljonen V, Rintala R, Pyörälä S, Gissler M. Incidence and risk factors of burn injuries among infants, Finland 1990–2010. *J Pediatr Surg* 2015; **50**(4): 608-12.
- [15] Stylianou N, Buchan I, Dunn KW. A review of the international Burn Injury Database (iBID) for England and Wales: descriptive analysis of burn injuries 2003–2011. *BMJ Open* 2015; **5**(2): e006184.
- [16] Zayakova Y, Vajarov I, Stanev A, Nenkova N, Hristov H. Epidemiological analysis of burn patients in East Bulgaria. *Burns* 2014; **40**(4): 683-8.
- [17] Harats M, Peleg K, Givon A, Kornhaber R, Goder M, Jaeger M, et al. Burns in Israel, comparative study: demographic, etiologic and clinical trends 1997-2003 vs. 2004-2010. *Burns* 2016; **42**(3): 500-7.
- [18] 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; **22**(3): 121-5.
- [19] Oladele AO, Olabanji JK. Burns in Nigeria: a review. *Ann Burns Fire Disasters* 2010; **23**(3): 120-7.
- [20] Othman N, Kendrick D. Epidemiology of burn injuries in the East Mediterranean Region: a systematic review. *BMC Public Health* 2010; **10**: 83.
- [21] Brusselaers N, Monstrey S, Vogelaers D, Hoste E, Blot S. Severe burn injury in Europe: a systematic review of the incidence, etiology, morbidity, and mortality. *Crit Care* 2010; **14**(5): R188.
- [22] Sözen İ, Güldoğan CE, Yastı AÇ. Etiology of childhood burns and parental awareness in Turkey. *Ulus Cerrahi Derg* 2015; **32**(3): 168-72.
- [23] Ortiz-Prado E, Armijos L, Iturralde AL. A population-based study of the epidemiology of acute adult burns in Ecuador from 2005 to 2014. *Burns* 2015; **41**(3): 582-9.
- [24] Nthumba PM. Burns in sub-Saharan Africa: a review. *Burns* 2016; **42**(2): 258-66.
- [25] Gupta AK, Uppal S, Garg R, Gupta A, Pal R. A clinico-epidemiologic study of 892 patients with burn injuries at a tertiary care hospital in Punjab, India. *J Emerg Trauma Shock* 2011; **4**(1): 7-11.
- [26] Outwater AH, Ismail H, Mgalilwa L, Justin Temu M, Mbembati NA. Burns in Tanzania: morbidity and mortality, causes and risk factors: a review. *Int J Burns Trauma* 2013; **3**: 18-29.
- [27] Queiroz LF, Anami EH, Zampar EF, Tanita MT, Cardoso LT, Grion CM. Epidemiology and outcome analysis of burn patients admitted to an Intensive Care Unit in a University Hospital. *Burns* 2016; **42**(3): 655-62.
- [28] Hwee J, Song C, Tan KC, Tan BK, Chong SJ. The trends of burns epidemiology in a tropical regional burns centre. *Burns* 2016; **42**(3): 682-6.
- [29] de Roche R, Lüscher NJ, Debrunner HU, Fischer R. Epidemiological data and costs of burn injuries in workers in Switzerland: an argument for immediate treatment in burn centres. *Burns* 1994; **20**(1): 58-60.
- [30] Aksoy N, Arli S, Yigit O. A retrospective analysis of the burn injury patients records in the Emergency Department, an epidemiologic study. *Emerg (Tehran)* 2014; **2**(3): 115-20.
- [31] Addai EK, Tulashie SK, Annan JS, Yeboah I. Trend of fire outbreaks in Ghana and ways to prevent these incidents. *Saf Health Work* 2016; **7**: 284-92.
- [32] Smolle C, Cambiaso-Daniel J, Forbes AA, Wurzer P, Hundeshagen G, Branski LK, et al. Recent trends in burn epidemiology worldwide: a systematic review. *Burns* 2016; doi: 10.1016/j.burns.2016.08.013.
- [33] Bang RL, Sharma PN, Sanyal SC, Al Najjadah I. Septicaemia after burn injury: a comparative study. *Burns* 2002; **28**(8): 746-51.