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Review Article

Burns in Tanzania: morbidity and mortality, causes and risk factors: a review

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Abstract: Burn injuries in low and middle income countries still remain a significant health problem, even though numbers of burn injuries in high income countries have decreased showing that such events are not “accidents” but are usually preventable. WHO states that the vast majority (over 95%) of fire-related burns occur in low and middle income countries. Burn injuries are a major cause of prolonged hospital stays, disfigurement, disability, and death in Africa Region. Evidence shows that prevention strategies can work. However prevention strategies need to be tailored to the specific environment taking into account local risk factors and available resources. An examination of the patterns and causes of burns should allow site specific recommendations for interventions. This literature review, specific to the United Republic of Tanzania, was conducted by researching PubMed, SafetyLit, and African Journals on Line data bases for primary sources using key words <Tanzania> plus <burns, suicide, homicide, injury mortality, injury morbidity>. Two sets of student data collected as part of Bachelor’s degree final dissertations at Muhimbili University of Health and Allied Sciences were used. In all, twenty two primary sources were found. Risk factors for burn morbidity in Tanzania are: 1/ a young age, especially years 1-3, 2/ home environment, especially around cooking fires, 3/ epilepsy, during seizures, and 4/ perceived inevitability of the incident. It was expected that ground level cooking fires would be found to be a risk factor, but several studies have shown non-significant results about raised cooking fires, types of fuel used, and cooking appliances. Risk factors for burn mortality are: being male, between 20-30 years of age, and being punished for alleged thieving by community mobs. An important factor in reducing burn morbidity, especially in children, is to educate people that burns are preventable in most cases and that most burns occur in the home around cooking fires. Children need to be kept away from fires. Epileptics should be monitored for medication and kept away from cooking fires as well. Community members need to be encouraged to bring wrong doers to the police.

Keywords: Burn injury, burn mortality, burn morbidity, Africa, Tanzania

Introduction

Worldwide, burn injury is a problem. Burns cause intense pain. Long-term morbidity is often a significant problem for burn survivors that create suffering for the individual as well as for family and community.

Annually more than 310,000 people die as a result of fire-related burns [1]. Death by burn injury in low and middle income countries (LMICs) is estimated to be eleven times higher than in high-income countries. Over 95% of fire-related burns occur in LMICs [2] and are among the leading causes of disability-adjusted life years (DALYs) lost in LMICs [1].

World Health Organization (WHO) estimated that 43,000 people die of burns in Africa every year with a rate of 6.1 per 100,000 [2]. Albertyn, Bickler, and Rode [3] state that burn injury is on the increase throughout Africa citing poverty, illiteracy, and movement to urban slums and shanty towns as some of the reasons.

Consequences

Burn injuries lead to multiple short and long term costs to families, communities, and the nation.

The obvious consequences of burns are well known and include pain, infections, scarring,

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wound contractures, amputations, and death, as well as psychological trauma. Hypertrophic scarring for example occurs in almost half of severe burn cases [4]. Keloid formation is relatively more common among people of African descent [5]. In Dodoma, Tanzania from 1983 to 1991 of the 49 children who suffered amputations, 16% of their amputations were due to burns [6]. Burn injuries are a major cause of prolonged hospital stays, disfigurement, disability, and death in Africa Region [7].

Non-visible sequelae also can be long lasting. Main contributors to adverse outcome in severely burned patients are complex fluid and metabolic changes which occur in response to the initial injury. Recent research has found that hyper metabolic and inflammatory alterations can be in a hyper inflammatory state three years post-burn. Pediatric patients in the United States (n=977) with burns over 30% of their total body surface were followed for up to three years and compared to a cohort of non-injured children [8]. The resting energy expenditure, body composition, metabolic markers, cardiac and organ function clearly demonstrated that burns caused profound alterations even several years post-burn - demonstrating marked and prolonged hypermetabolism. Increased hypermetabolism, elevated cortisol, catecholamines, cytokines, and acute phase proteins indicate that burned patients are in a hyperinflammatory state up to three years after the burn injury was sustained. Even though the metabolic alterations after severe burn injury are similar to any major trauma, they are characterized by responses more extreme and sustained [8].

Burn injuries often lead to long hospital stays [9]. In a retrospective analysis of case notes of 149 children with burns who presented to Hlabisa Hospital in KwaZulu Natal, South Africa, 59% (88) were admitted [10]. Of them 22% (19) developed wound infections, 6% (5) developed contractures and 23% (20) required a total of 32 surgical procedures, and one died. Burns were responsible for more pediatric patient days spent in hospital than any other condition except malnutrition. In Ghana, short term complications included infection and septicemia. Eighteen percent of childhood burns led to long-term physical impairment or disability including hypertrophic scarring and keloids, contractures, amputations, and other disfigurements [11].

Burns have a high mortality rate. At Bugando Hospital in Mwanza Tanzania for example, from 1995-1997 while burns were only 2.6% of the injuries that were attended, the case fatality rate which averaged 2.2% for all injury, was 13% for burns (even higher than traumatic amputation at 8.7%) [12].

As well, LMIC hospital care is often plagued by chronic shortage of resources and health care professionals [13]. As in many other LMICs, in Tanzania, facilities to provide continuing care, functional and psychological rehabilitation, do not exist. The victim and their families are left to their own devices to come to terms with sometimes, devastating injuries.

Prevention

In high income countries (HICs) burn injuries and their predisposing factors have been studied. Legislation has increased use of smoke detectors, flame-retardant clothing for children, and water heater modifications [7]. Consequently burn injuries have been much reduced. "There seems to be overwhelming evidence that childhood burns are largely environmentally conditioned and preventable" [14].

However in LMICs, burn injuries still remain a significant health problem. Prevention strategies need to be tailored to the specific environment taking into account local risk factors and available resources [15]. There is little sense in adopting what has worked in HIC's, such as mandating the lowering of the temperature of hot water heaters, in a place such as Dar es Salaam (DSM) where the vast majority of people do not have hot water heaters. Likewise sprinkler systems while effective in HICs will have little impact in most low income countries.

WHO has called for designing and testing of potential interventions [2]. If burn mortality and morbidity are to be decreased with appropriate interventions, country-specific studies need to be tailored to local contexts. An examination of the patterns and causes of burns should allow site specific recommendations for interventions. Therefore the following literature review is specific to one country in East Africa, the United Republic of Tanzania and may serve as a model for other countries. With a goal of informing interventions to decrease burn morbidity

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and mortality, the objectives of this review are to report the current state of knowledge about the causes and risk factors of burn injury in Tanzania.

Methods

This literature review was conducted by researching PubMed, SafetyLit, and African Journals on Line data bases for primary sources using key words <Tanzania> plus <burns, suicide, homicide, injury mortality, injury morbidity>. References of articles were examined for other references and some trauma reports of children from Tanzania were uncovered. When it became clear that epilepsy is an important risk factor, a key word <epilepsy> was added to the searches. The definition for burns was defined as per ICD-9-CD Diagnostic Codes 940-949 [16] which includes injury to the tissue caused by thermal trauma including scalds, flame burns, electrical, chemical, inhalation, contact burns and damage due to radiation and friction.

In addition, two sets of unpublished data collected by supervised Bachelor's students at Muhimbili University of Health and Allied Sciences in DSM were included. Burn morbidity data was collected through in-hospital interviews (27) and case records (55) by Ismail in 2010. Homicide mortality data was collected by Mgalilwa reviewing all physicians' autopsy reports in all mortuaries which received police cases in DSM Region in year 2010. Excluded from this review are articles about 1/ burns without discussion of causes and risk factors e.g. articles that focus on injury sequelae and treatment and 2/ radiation burns e.g. sunburns.

In all, 22 relevant primary source articles were included as shown in **Table 1**. The settings of 18 studies were hospital-based and four were in the community. Most studies were conducted in DSM (15). There were a few sites in other parts of the country: three in Mwanza, two each in Kilimanjaro and Morogoro, and one each in Shinyanga and Dodoma. In addition, the data on occupational hazards of hospital workers were collected nationally at 14 sites: 9 regional hospitals, 3 referral hospitals, and 2 district hospitals.

Nine studies included people of all ages. Children were the focus of 9 articles; adults of

four, including one focusing on the elderly. Most articles were epidemiological reports: on injury in general (8), burns in particular (6), homicide (3), epilepsy (2), suicide (1), and occupational safety (1); a surgical report (1) also contained data useful for this review.

Injuries are traditionally grouped as to those that cause illness/disability, or death and according to two broad categories: intentional and unintentional. Therefore this review of burn injury in Tanzania is divided into two sections - morbidity and mortality; each section is divided by child and adult, and then by unintentional and intentional injury.

Results

Morbidity

Children

Childhood burn injury is not uncommon. In DSM for example a 1.73% per month incident rate was found for children 0-18 years [28].

Unintentional

A 1971-1974 study based on admissions to Muhimbili National Hospital (MNH) in DSM found that of the 589 cases of childhood accidents, 25% were burn injuries [17]. Most were due to accidental falls into fires and scalds from boiling water. This has been confirmed in subsequent years. Most burns suffered by children are scalds and flames.

Most childhood burns occur in the home environment [17]. In northwest Tanzania for example, it was found that 90.6% of burned children ten and under who reported to the regional hospital, acquired the burns at home, in the kitchen, bathroom, sitting room and near outdoors [9]. Likewise a community study in DSM found that 88% of children 18 and under suffered their burn injury at home [28].

According to Mbembati, Museru, and Leshabari more than 90% of children's burn injuries were related to cooking: 39% were related to hot water, 31% to hot food, 14% due to open flame and 9% due to cooking oil [21]. A child may fall into a fire, or more likely tip a pot of boiling liquid onto him or herself [22]. Justin-Temu and colleagues also found that about 90% of children's burn injuries were related to cooking; the

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Table 1. Primary Source Data collected in TZ about Burn Morbidity and Mortality, by date of data collection

Site Dates of data collection	Author, Date of Publication	n burns (Population)	Setting	Age group years	Burns as proportion of all injuries
MORBIDITY					
DSM 1971-1974	Sarungi, Kaduri, 1980	259 (1037 injuries)	Muhimbili National Hospital (MNH)	0-15	25
DSM 1974	Kimati, 1976	144 (589 injuries)	MNH	<7	24
Dodoma 1983-1991	Loro, Franceschi, Dal Lago, 1994	9 (56 amputations)	Dodoma Regional Hospital	0-18	n.a.
DSM 1988-1992	Sayi, Mlay, Shija, 1994	10 (13 esophageal strictures)	MNH	<6	n.a.
DSM 1994 - 1996	Mbanga, Mwafongo, 1998	330 (n.a.)	MNH	All	n.a.
Mwanza 1995-1997	Rutta, Mutasingwa, Ngallaba, Berege, 2001	80 (3340 injuries)	Bugando Medical Center	All	2.4
DSM May-Nov 1999	Mbembati, Museru, Leshabari, 2002	253 (2010 injuries)	Muhimbili Orthopedic Institute (MOI) + 3 District Hospitals	< 18	12.5
DSM May-Nov 1999	Leshabari, Museru, Mbembati, 2003	237 (1778 injuries)	MNH, MOI + 3 District Hospitals	< 18	13.3
DSM Feb-Mar 2004	Justin-Temu, Rimoy, Premji, Matem, 2008	204 (n.a.)	3 District Hospitals	< 5	n.a.
Tanzania 2006	Manyele, Ngonyani, Eliakimu, 2008	45 (430 health-workers)	14 hospitals	adults	n.a.
Mwanza 2008-2010	Chalya, Mabula, Dass, et al., 2011	342	Bugando Medical Center	≤ 10	n.a.
Mwanza 2008-2010	Chalya, Gilyoma, Dass, et al., 2011	9 burns (312 trauma cases)	Bugando Medical Center ICU	All	2.9
Kilimanjaro 2009	Mushi, Hunter, Mtuya, Mshana, Aris, Walker, 2011	17 (41 people with epilepsy)	Community	15-60	n.a.
DSM 8-22 July 2009	Roman, Lewis, Kigwangalla, Wilson 2011	68 (416 injuries)	1928 Households with 3927 children	≤ 18	16
DSM Nov 2009-Jan 2010	Ismail, 2010*	82 (n.a.)	MNH	>18	n.a.
Shinyanga Mar-Sept 2010	Challya, Mabula, Ngayomela et al., 2012	4 (94 injuries)	Regional Hospital	≥ 60	4.3
MORTALITY					
Morogoro 1959-1990	Jilek-Aall, Rwiza, 1992	6 (110 people with epilepsy)	Outpatient clinic	All	n.a.
DSM Hai Morogoro, 1992-1998	Moshiro et al., 2000	10 (246)	64,756	All	2.5
		32 (701)	146,359		4.6
		21 (531) injuries	103,053 people in households		4.0
DSM 2000-2004	Ng'walali, Kitinya, 2006	601 (1249 mob homicides)	DSM region	All	n.a.
DSM 2005	Mgaya et al. 2008	1 (65 suicides)	DSM Region	All	n.a.
DSM 2005	Outwater et al., 2008	50 (367 homicides)	MNH + 3 District Hospitals	All	n.a.
DSM 2010	Mgalilwa, 2011*	54 (310 homicides)	MNH + 3 District Hospitals	≥ 1 year	n.a.

*These data were collected as part of dissertation research conducted by students of Bachelor's of Science of Nursing at School of Nursing, Muhimbili University of Health and Allied Sciences.

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remaining injuries were a result of lighting: candles and small lanterns (*kibatari*) [23].

Less common are chemical burns. For example it was found at the Pediatric Surgical Unit at MNH, between 1988 and 1992, ten pediatric patients were admitted with esophageal obstruction. Their corrosive strictures were caused by chemical burns from ingesting hair-plaiting chemicals (5), caustic soda (4), and kerosene (1) [19]. Six died.

At the community level, 25% of burns were caused by hot objects [28]. The objects that caused these contact burns are not stated. There are no cases of contact burn victims in the hospital based studies, suggesting that contact burn wounds may be milder or smaller.

Intentional

In Mwanza it was found that 2.9% (10) of childhood burns were intentional, "mainly due to child abuse" [9]. Similarly in DSM, 2.5% (5) of 204 under-fives who sustained burns were intentionally injured. Four of the five intentional wounds were caused by men using these children as punishment or revenge in matrimonial conflicts [23]. In one case, a mother believed that burning the right leg of her son would bring her success in business.

Adult

Non-intentional

Of 312 trauma patients admitted to the Bugando Medical Centre Intensive Care Unit (ICU) in Mwanza, 2.9% (9) were admitted due to burn injury [25]. Of 94 geriatric patients, at the Shinyanga Regional Hospital Emergency Department, 4.2% (4) were caused by burns; all of these victims were male [26].

Unlike children, most adult burns are caused by flame, followed by scalding and electricity. Ismail (see **Table 1**) found that about 66% of adult burned patients on the MNH wards were caused by flames (including petrol, kerosene/gas, candles, and falling into the fire), 21% caused by scalds and 13% were caused by electricity. About one-half were cooking accidents. Of this population of adult burn patients, 40% of the injuries occurred in the kitchen, 15% in the bedroom, 23% in the workplace, and 20% in the street. Females were more

often burned while at home; males were more often burned at work and on the street.

A study of occupational health hazards in 14 Tanzanian hospitals revealed that needle stick injuries (52.9%), blood splashes (21.7%), and chemical burns (10.6%) were the leading causes of accidents [24]. Most hazardous activities were carried out by nurses and attendants. Chemicals, mainly antiseptics and disinfectants, caused skin burns during handling and usage. It was not ascertained exactly which chemicals were causing the irritation. But Class I chemicals including glutaraldehydes, chlorhexidine gluconate, and chlorine (which are known to be toxic in high doses or in enclosed spaces), were shown to be routinely used as cleaning agents throughout Tanzania.

Intentional

Para-suicide: In a study of 272 parasuicides admitted to MNH in 1991-1993, none of them had attempted to take their life by fire [34]. At the same referral hospital, MNH, 1994-1996, of 330 adult burn patients, only one was an attempted suicide [20]. Ismail found that at MNH in 2010 of 82 burn patients admitted, one was an attempted suicide.

Attempted homicide: At MNH between the years 1994 and 1996, it was found that eight patients (2.4%) were burned as a result of community mob violence punishment for alleged stealing; another 3 cases (> 1%) were the result of assaults [20]. In 2010, Ismail found that of 82 burn patients, one was severe punishment of a suspected thief. In Shinyanga where many elderly women were injured by assault, none were burned [26].

Mortality

Children

Moshiro and colleagues did not separate unintentional and intentional injury, although it was found that the commonest cause of injury death among children under five years in DSM were burns, transport accidents and drowning – each which was estimated to occur at 7 per 100,000 population per year in 1992-1998, for girls [30]. The mortality rate for boys under five due to burns in DSM was 17 per 100,000; this age group in the rural districts of Morogoro and Hai had generally lower rates of burn mortality

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and higher rates of drowning and animal attack (mostly snakes) and in Morogoro, transport accidents.

Intentional

In DSM in 2005, four children died in a fire in their room with an adult female in an undetermined incident that was possibly politically motivated [33]; other than this incident no child died through intentional burns in 2005 [33]. Likewise Mgalilwa reported in his dissertation that no children in DSM died from intentional burns in 2010.

Adults

Burn mortality rates for females aged 15-59 were the same in DSM, Hai and Morogoro (1.7-1.8 per 100,000) and likewise for males (2.5-2.6 per 100,000) [30]. There were no burns reported from the DSM sample for males and females older than 60 years. However in Hai and Morogoro the rates were 2.8 per 100,000 and 23 per 100,000 respectively for females; and 8.5 per 100,000 and 16.1 per 100,000 for males over 60 years. Falls, alcohol poisoning, suicide, and transport accidents were all more serious causes of injury mortality than burns in this elderly age group in Hai. In Morogoro animal attack (mostly snakes) and transport accidents appear to be more frequent causes of loss of life in the elderly, than fire.

Intentional

Suicide: Burns are not a common suicide method. Of 100 consecutive suicides at MNH mortuary for example, in 2000 and 2001, none were by fire [34]. In 2005 in DSM, it was found that of 65 suicides only one used fire, an elderly physically ill woman who doused herself with kerosene [32].

Homicide: Burns were the primary cause of death for 13.3% (n=45) of all adult homicide victims in DSM [33]; only one was female. Similarly in 2010, 17.4% (54) people died of homicidal burns; all were adult males. Intentional burn mortality in DSM in 2005 and 2010 was almost always a result of mob violence. Most of the victims were, unemployed males between the ages of 20 and 35 who were killed as alleged thieves [33].

Risk factors for burns in Tanzania

Some variables appear to be risk factors but may not be.

Sex

Many studies in Tanzania found that boys are slightly more likely to be burned than girls. Challya and colleagues, examined significance levels, and found that among 342 children burn victims (58% males and 42% females) in north-west Tanzania; this tendency was not significant in univariate or multivariate analysis [9]. Likewise child burn injury in Dar es Salaam was not significantly different by sex ($p = 0.404$) [28].

However as described above, for intentional adult burns, males are at much higher risk of being burned than females [33] which was confirmed by Mgalilwa's review of 2010 post-mortem reports.

Socioeconomic status

Many studies note that burn patients are often from low socioeconomic group, coming from homes where people live in crowded conditions; a family including young children sleeping, living, and cooking in one room is common in many urban areas in Tanzania [17, 20-23]. However since most people in DSM live under similar circumstances, it is not clear whether or not socio-economic status per se leads to increased risk for burns. Roman et al. found no significant differences among caregiver level of education ($p = 0.542$) or caregiver occupation ($p = 0.343$) [28]. Likewise, location of residence (urban, mixed, or rural wards) was not significantly associated with burn events ($p = 0.394$) or was the ability of caregivers' ability to meet daily needs ($p = 0.815$).

Data based risk factors for burn morbidity include:

Young age: In the 1970's Sarungi and Kaduri found that the age group most susceptible to burns was the 1-3 year age group [17]. Thirty years later, Challya et al. [9] found that of children ten years and under, 45.9% of the cases were less than three years old; the mode of this sample of 342 burned children was 2 years. Mbanga and Mwafongo found that 50% of all burn injuries admitted to MNH were under five

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years old [20]. As can be seen in **Table 1**, burns as a percentage of all injuries decreases steadily through childhood into adulthood and into old age.

Setting: Most burn injuries occur at home and are centered around cooking accidents.

Epilepsy: In MNH in DSM, Kimati noted that “some “ burn victims had epilepsy [18]. In the years 1994-1996, of the 330 burn admissions to MNH, 12 (3.6%) had experienced an uncontrolled epileptic seizure and fallen into the fire [20]. In 2010 Ismail found that 11% of severe adult burn morbidity at MNH was a result of uncontrolled epileptic seizures. In northwest Tanzania epilepsy was found to be the most commonly stated pre-existing condition to burn injury, reported by three of 342 burn patients [25].

Almost all articles on epilepsy describe the common presence of burns [e.g. 29]. In a qualitative study conducted in Hai, Kilimanjaro, of 41 people with epilepsy, the majority had experienced burns and 41% (11 females, 6 males) had experienced severe burns because of seizures [27]. Fear of being injured during a seizure limited their participation in domestic activities such as cooking. A thirty year follow-up of 164 epileptic patients in rural Mahenge found that of 67.1% of patients who had died, 5.5% had died of burn injuries (4 females, 2 males) [29].

Perceived inevitability: Most parents were fatalistic, believing the injury their child sustained was unavoidable and outside their control [21, 22]. Prevention was beyond their control because it was God’s wish (54%), it is difficult to control children (36%) and other reasons (11%) [22]. For burns in particular, 57% of the caregivers indicated the injury was not preventable. Thirty seven percent of the parents who did not believe the injury was preventable, perceived risk taking at household level to be low even though most of these injuries took place at home.

Risk factors for adult burn mortality are being male, between 20-30 years of age, and captured as a petty thief [33].

Gaps in the literature about burns in Tanzania

There is no data from many areas of Tanzania, most notably Zanzibar. There is a large knowl-

edge gap around occupational burn mortality. For example, Ismail’s dissertation data reveals that 13% of adult burn patients admitted to the hospital had suffered electrical incidents but it is not clear how the injuries were sustained. Chemical burns from cleaning fluids were sustained by nurses and attendants, but the type of cleaning fluid was not specified [24].

An important qualitative and quantitative gap surrounds the specifics of the cooking fires that led to the burns. There is a complete lack of experimental studies including any sort of intervention.

Discussion

In Tanzania the body of literature is balanced between children, adults, and all ages unlike many other African countries where the preponderance of burns research is about children [14].

Child morbidity

Many children suffer burns. A community based study in a rural area of Zimbabwe found that of 196 children, 25.5% of them had sustained an injury in the previous two weeks; of the injured, 16.3% had been burned by fire and 4.7% by scalds [36]. In another community based study, in rural South Africa, data were obtained from 324 families with 502 children under five years of age. Thirty nine (7.7%) children were reported to have suffered burns in the previous six months [37].

In young children, the level of motor development does not match the child’s cognitive and intellectual development; injuries thus occur easily.

In Tanzania and in other places in Africa, child injury accidents usually occurred at home, around cooking fires [7, 14, 21, 37, 38]. The cooking fires, which are at ground level, burning solid fuels including charcoal and firewood are used inside by an estimated three billion people around the world. Besides creating a risk factor for toddler burns, these fires are considered by World Health Organization to be the top environmental killer in that two million people a year are estimated to die prematurely from illness (such as pneumonia, chronic obstructive pulmonary disease and lung cancer) attributable to the indoor air pollution they cause.

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Table 2. Causes of burn injury of children in Africa, by country and age group

Place	Author, Year of publication	N burns	Age (yrs)	Scald % (n)	Flame % (n)	Electric % (n)	Contact % (n)	Chemical % (n)	Not stated Other
Ghana									
Ashanti	Forjuoh, Guyer, Smith 1995	550	0-5	45 (290)	19 (26)	0	33 (217)	0	3 (17)
Nigeria									
Port Harcourt	Datubo-Brown, Kejeh, 1989	43	0-5	86 (37)	14 (6)	0	0	0	0
Ibadan	Ofodile, Norris, Gar-nes, 1979	23	<15	78.3 (18)	8.7 (2)	4.3 (1)	8.7 (2)	0	0
Imo State	Okoro, Igwe, Ukachukwu, 2009	53	<15	64.1 (34)	26.4 (14)	3.8 (2)	5.7 (3)	0	0
Zaria	Kalayi, 2001	135	<15	54.8 (74)	43.7 (59)	0	0	0	1.5 (2)
	Mabogunje, Khwaja, Lawri, 1987	429	<15	41 (175)	59 (254)	0	0	0	0
Tanzania									
DSM	Mbembati, Museru, Leshabari, 2002	251	<5	76 (190)	16 (41)	0	0	0	8 (20)
DSM	Justin-Temu, 2008	204	<5	78 (160)	22 (44)	0	0	0	0
DSM	Kimati, 1976	144	<7	Most	-	-	-	-	-
Mwanza	Chalya et al. 2011	342	≤10	56 (192)	40.4 (138)	0.9 (3)	1.2 (4)	1.5 (5)	0
DSM	Roman, Lewis, Kig-wangalla Wilson, 2011	68	≤18	34 (23)	37 (25)	3 (2)	25 (17)	-	1 (1)

“Improved stoves” using less biofuel were easily accepted by people in Kenya. The increased combustion of biomass in the improved stoves led to a significant decrease of indoor pollutants, and the accompanying acute respiratory infections and conjunctivitis in women and children in households that use them were significantly reduced over those households using the traditional three stones [39]. It is not clear from the research report exactly what the improved stove was. However it seems it must be enclosed to increase combustion which would also decrease flame access.

Increased use of solar power will decrease burn injuries due to lighting (candles, kerosene lanterns, electricity), and heating water (electricity, firewood, charcoal). But solar cannot, as yet, help a great deal with cooking injuries.

Age

In most settings the majority of burn injuries are suffered by children below five years of age [7, 38, 40]. Childhood burn cases accounted

for between 25 and 68 percent of all burns observed in community-based studies conducted in Africa between 1980-2003 [7]. According to Forjuoh’s review of burns of children in Africa children from birth to four years comprised about one-third of all burns [14]. The number of burn injuries and proportion of all injuries amongst children decreases with age as shown in **Table 2**. Types of burns, almost everywhere, vary according to age group. For instance, scalds from hot liquids are found most frequently in toddlers, whereas flame burns are most frequently seen in older children.

Child intentional

There is a small amount in the peer review literature about intentional burn injury of children in Africa. The injuries sustained through intentional burning are generally found to be more severe than unintentionally caused burns. In 1974, in Ibadan, Nigeria, a review of 23 pediatric burn admissions revealed 9 (39%) cases of child abuse – the majority of which were scalds caused by immersion in a hot tub of water or

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throwing hot water on the child; two were burned by fire and one on the buttocks when placed on a hot car bonnet [43]. In Ghana it was found that 5.4% of burn cases were intentional [41]. In southeastern Nigeria 7.5% of child burn patients had been intentionally burned in an effort to treat convulsions [38]. This is different than findings in Tanzania where less than 3% of childhood burns were intentional and were inflicted in response to marital conflict, and once for witchcraft.

Adult

Less research has been published about adult burn morbidity in Africa, than for children. Unlike children, more adult burns are caused by flame, followed by scalding and electrical.

There does not seem to be a disparity between the sexes in terms of burn incidence overall, although there is a reversal of susceptibility. There are different gender ratios in different age groups. Some studies showed that males are more often burned as toddlers, while women are more often burned as adults. This is attributed to the higher exploratory activities of boys who then spend more and more time outside as they grow older (where the likelihood for burn injury is less), and the more domestic activities of girls as they become women.

Non-intentional injury

As in Tanzania only a few studies in Africa were occupation specific. For example in Kaduna Nigeria, of 330 welders, it was learned that 14% had experienced burns in the past year [46].

Although a small proportion of burn victims have epilepsy, many epileptic people are victims of burns. In most cases people with epilepsy sustained burn injury during epileptic seizure [9]. In Nigeria in the 1970's, 10% of 245 adult burn hospital admissions, had epilepsy [47]. In Kenya 3.6% of 109 consecutive burn patients admitted into Kenyatta National Hospital had been burned as a result of loss control due to epileptic seizures [48], fewer than the 11% that Ismail found on the MNH adult wards in 2010.

Intentional

Suicide: Burns are not usually a common method of trying to commit suicide in Africa. However

in Zimbabwe between 1995-1998, 47 patients (most of whom were young women in troubled relationships) were admitted to the Harare Burns Unit in a four year period for attempted suicide; all had doused themselves with paraffin/kerosene (46) or petrol (1) [49]. The wounds of the para-suicides were more severe than those with non-intentionally caused burns. The mortality rate was 68% (32 died). At that same hospital in 1998, of all attempted suicides (including those which were successful), 11% were burns. It was noted that this high occurrence of suicidal burns was not observed in other parts of Zimbabwe.

Burns are an unusual method of committing suicide in Tanzania or in other parts of Africa. For example in Ife-Ife Nigeria, of 65 suicides recorded between 1979 and 1988 only one was a burn - a person who electrocuted himself [50]. Two percent of suicides in six South African cities were caused by burns in 1996-2001, mostly among Indians [51].

Likewise burns are not usually a common method of homicide. In a review of the literature of Africa Region, it was found that cause of homicide death was never over 5% due to burns [52]. However in DSM it appears that a much larger proportion of homicide victims die as a result of fire, which is almost always associated with mob violence.

Risk factors

Burns occur mainly in the home and workplace. Most burn injuries, particularly among children and women, occur in the domestic environment. The kitchen is the most common site where children upset receptacles containing hot liquids and where women are injured by hot cooking oil or by stove explosions. Employees are at risk from burns in the workplace although this has been inadequately explored.

Epidemiological studies have identified important sociodemographic factors that may increase the risk of child burn injuries. In Ghana a case control study searching for risk factors was conducted in 1992 [14]. The cases were 610 children with a visible burn scar who were matched to controls by age, sex, and area of residence without a history of burns. Risk factors for childhood burns were ascertained to be: sibling death from a burn, history of burn in a sibling, existing impairment of the child, and

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storage of flammable substances in the home. In that same study, mother's education, whether the father was employed, or whether the mother spent many hours away from home were not risk factors.

A community based study, in rural South Africa revealed risk factors including child age between 2-4 years of age, being male, the presence of fewer than five adults in the home during the day, and increased duration that the children spent within 1.5 meters of fires [37]. Income, maternal education, monthly income, housing quality, size of kitchen, number of children less than four, birth order, duration of burning were not significant risk factors.

Ground-level cooking fires (charcoal, kerosene, firewood) are much discussed as creating an environment conducive to burn injury. On ground cooking appears to be dangerous but has many appealing qualities including: no required infrastructure or resources, portability, and flexibility in terms of siting, and materials used.

In Uganda, an association was expected to be found between the presence of a raised cooking area with the incidence of under-five burn injury; however they found no effect (OR=1.38, 95% CI=0.68- 2.83) [53]. Stratified analysis was undertaken with the following variables: number of under-fives in the household, size of the dwelling, type of dwelling and whether cooking area was separate from sleeping area. None of these variables confounded the relationship between raised cooking areas and burn incidence.

Barnes and Moiloa found that fuels burned and cooking appliances were not significantly associated with burns [37]. The significant risk factor was the amount of time a child spent within 1.5 meters of a fire and if there were fewer than 5 adults around during the day.

A key factor in reducing the morbidity and mortality associated with burn injuries is to emphasize the concept that such events are not "accidents"; they are preventable in most cases [15]. A campaign to educate people that burns can be prevented will be important in Tanzania, where many people accept a burn injury as an uncontrollable and unpredictable event.

Community education about burns prevention specifically for children under five, should be targeted at the household level, to heads of household, especially if infrastructure costs may be incurred, and child caregivers.

Groups in need of special targeted care intervention are epileptics and health care workers including nurses and attendants. Epileptics and their families need special care in terms of education and medication. Workers should be protected from workplace burns by the management of the institution; for example chemical burns of nurses and attendants could be dramatically reduced by providing non-toxic cleaning chemicals.

Conclusion

The data show stability over the years. The health issues in Tanzania are clear. Toddlers are most at risk. More than 90% of their burns occur around cooking fires.

The need to educate people about fire-safety in the home environment has been suggested for many years [20, 22]. The immediate focus of prevention efforts should be preventing toddlers' scalds and flame burns. The message is fairly clear: "Burns can be prevented. Keep your child at least 1.5 meters away from all cooking fires." An evaluation of the feasibility of safe play areas for children or more centralized cooking fires would be useful.

The way forward in terms of cooking stove design is not clear. Although logically stove design appears an important element, studies are showing that it is not. However a multi-disciplinary case control study conducted by engineers, architects, and health workers using qualitative and quantitative research techniques, comparing similar settings in which burns did and did not occur, may provide additional insight about household design or fire placement.

Increased opportunities for employment for young men and community education will decrease burn homicides by community mobs.

Most burn injuries are preventable and Tanzania appears to be no exception.

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