

Trends in Gender Specific Mortality Differences Post Burn Injury; Evidence from Burns Care Centre, Pakistan Institute of Medical Sciences, Pakistan

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ABSTRACT

Objective: To evaluate the effect of gender following burn injury on mortality outcomes.

Methodology: This retrospective cohort study was conducted at Burn Care Centre, PIMS, Pakistan. Secondary data was collected and reviewed via HMIS database. Annual mortality patterns observed from 2019-2023 across multiple age groups revealed differences in gender for several confounding variables.

Results: Mortality rate stated in females was (13.17%) compared to males (12.76%). No significant difference was observed across various age intervals when viewed heterosexually. Similarly, although flames showed higher mortality among females and males had greater mortality as a result of scald, electric & cylinder burns, the data proved to be statistically insignificant. Total burn surface area (TBSA) was reported to be insignificantly higher among males of childhood & reproductive ages and females of old age. Length of stay (LOS) also displayed analogous patterns in mortality irrespective of age except for a rise in mortality among women of childbearing age in comparison to post-pubertal males (10.3 vs 6.7).

Conclusion: Our study depicted trends in post-burn mortality across reproductive age group, emphasizing gender disposition. Females are at greater risk of mortality particularly among those with prolonged hospitalization. Rest of the confounding factors i.e. TBSA, degree and mechanism of burn injuries did not show significant fluctuations with respect to mortality in both genders on statistical grounds.

*Abbreviations: TBSA, Total Burn Surface Area; LOS, Length of Stay; HMIS, Hospital Management Information System; PIMS, Pakistan Institute of Medical Sciences

Keywords: Burn Type; Burn injury; Gender Differences; Length of Stay; Mortality; Total Burn Surface Area.

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^{1,2}Conception; Literature research; manuscript design and drafting; ^{3,4}Critical analysis and manuscript review; ^{5,6,7}Data analysis; Manuscript Editing.

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Introduction

WHO Burn records analyzed last year documented incidence of 180,000 injuries per annum. Over the years, various risk factors leading to frequent morbidity and mortality were identified. With respect to age, children are more prone to death while higher survival rate has been observed in

upper extreme of age.¹ Disparities have been noticed in mortality among reproductive age group (15-49 years), for which possible explanation lies in difference in accordance with gender. In contrast to non-thermal trauma, gender has become independent risk factor in prognosis of mortality following burn injury.

According to Gerald McGwin Jr et al, females have higher mortality rate across 20-34 years of age [while others have shown significantly rising case fatality rate among 30-59 yr. age group].^{2,6} A relatively non-significant rise in mortality was depicted in males in age interval of 35-49 years.³ Although males have shown higher incidence of case fatality up to 15 years of age, likewise, ambiguous reports on influence of gender in older age intervals >60 yrs. have been reviewed, reproductive age group show wider spectrum of gender differences leading to mortality subsequent to burn injury.² Multifactorial etiology underlies the observed sex difference. Some studies relate higher estrogen hormone levels to better immune response generated in females thereby establishing a protective role against sepsis which is a major secondary cause of death, indicating higher survival rate in women.^{2,5} This is consistent with immunosuppressive effects of testosterone observed in post-pubertal males. However, another report has shown increased incidence of mortality in females of child-bearing age, describing flame burns, which have the highest overall case fatality rate among several mechanisms of burn injury, by open fire cooking and low-quality stoves as the main environmental hazard.² On the other hand, males seem to have a higher morbidity rate following burn trauma, particularly among those aged 20-39 years.⁴ In the light of discrepancies found in mortality following burn insult with respect to gender in multiple spectrums of age, our study aims to evaluate trends occurring in age-specific mortality rate (15-49 years) at BCC, PIMS in Islamic Republic of Pakistan.

Methodology

It is a single-center, retrospective cohort study conducted at the Burn Care Centre, Pakistan Institute of Medical Sciences (PIMS), a tertiary care teaching hospital in Islamabad. It is affiliated with

Shaheed Zulfiqar Ali Bhutto Medical University (SZABMU). Our study includes patients of all ages and genders who suffered from burn injuries as the leading cause of death. In this research we analyzed data collected over a 5-year period by retrospectively reviewing Hospital management information system (HMIS) database. 3065 patients were admitted to BCC and out of them 397 died. Mortality rate was compared between the two genders (male and female) to study influence of sex on burn outcome. Data regarding age, gender, Total burn surface area (TBSA), type of burn, and length of stay (LOS) i.e., duration from time of admission to time of death was collected for each patient from HMIS file

For assessment of mortality rate for both genders, 3 age categories were considered: 0-14(children), 15-49(reproductive age) and 50 and above(elderly). TBSA was calculated using "rule of nine". TBSA was categorized into following groups :0-10%, 11-20%, 21-40%, 41-60%, 61%+. Burn etiology was split into following categories: flame, scald, electric burn, cylinder, contact, chemical, flash and others (explosive etc.). Length of stay was divided into 3 categories: 1 week, 1 month and >1 month.

Data was analyzed using IBM Statistical package for the Social Sciences (SPSS) Version 25 software. Mann-Whitney U test and independent sample median test was used to find significant gender difference in length of stay and TBSA. Correlation of gender with burn type and age was evaluated using Pearson Chi-square test with p value <0.05 considered significant.

This study was approved by the ethical review board of Shaheed Zulfiqar Ali Bhutto Medical University. Informed consent of patient was not required as it is a retrospective analysis. Hospital record data was restricted to researchers only to keep patient's data confidential. This study was conducted in accordance with principles of the World Medical Association Declaration of Helsinki 2013.

Results

From 2019-2023, 3065 patients were admitted to Burns Care Centre; 1653 were males (54%) and 1412 (46%) were females. Table 1 shows information on patient demographics, injury characteristics and length of stay. Children accounted for largest proportion of burn victims in both males and females. Injury etiology differed in both genders. Males were more likely to experience scald, cylinder and electric injuries, whereas female reported a greater proportion of flame related injuries. Most patients stayed for up to 7 days ($n=1663, 54.25\%$), followed by up to one month ($n=1160, 37.84\%$), and finally > 1 month ($n=239, 7.79\%$). During this time 397 people died giving us an overall mortality rate of 12.95%. Females reported higher mortality rate as compared to males (13.17% vs 12.76%). An analysis of mortality risk across different age group as shown in table 2 revealed that female children (0-14 age group) and males in reproductive age (15-49 age) had a slightly higher mortality risk compared to their counterparts. However, these differences were not statistically significant with p values 0.468 and 0.83 respectively. Similarly, although male elderly (50+ age group) had a greater mortality risk than females (35.8% vs 31.1%) but it also failed to be statistically significant ($p=0.503$). Flame and scald burn resulted in highest number of mortalities across both genders with a higher number observed in female children. However statistically no significant association was found between gender and type of injury with p value of 0.988 for children, 0.137 for individuals of reproductive age group and 0.114 for the elderly. The results as indicated in table 3 shows that burn type affected both males and females equally across all age groups.

Table 4 shows that TBSA varied between males and females. Male children and males in reproductive age group exhibited higher TBSA as compared to females, but the differences were not statistically significant with p values 0.069 and 0.750 respectively. Similarly, elderly females reported

higher mean TBSA as compared to their male counterparts (71% vs 64%) but it also was also not statistically significant ($p=0.519$)

Table I: Patient demographics, injury etiology, and length of stay

Category	Male (n=1653)	Female (n=1412)	Total
Mean age	14.79	15.26	
Flame	503	537	1040
Scald	596	529	1125
Cylinder	16	9	25
Electric	184	39	223
Flash	17	0	17
Chemical	5	1	6
Contact	5	4	9
Others	20	13	35

Note: Injury type data excludes 585 unknown cases

Table II: Age-wise mortality distribution among males and females

Age Group	Male (Total)	Male (Dead)	Male (%)	Female (Total)	Female (Dead)	Female (%)
0-14	1053	96	9.1	933	100	10.7
15-49	505	81	16.0	386	57	14.8
50+	95	34	35.8	93	29	31.1
Overall	1653	211	12.7	1412	186	13.2

Note: 10 patients with other causes (flash, chemical, contact, etc.) not included in the table.

Table III. Gender-based comparison of mean total burn surface area (TBSA) across different age groups

Age Group	Male TBSA (%)	Female TBSA (%)
0-14	58.8	56
15-49	76	69.3
50+	64	71

Among non survivors LOS varied between males and females. Female children and male elderly reported longer length of stays compared to their counterparts as depicted in table 5 but this trend did not achieve statistical significance with p values 0.5510 and 0.107 respectively. Notably, females in reproductive age group reported longer length of stay (10.3 vs 6.7) and it proved to be statistically significant ($p=0.002$)

Discussion

As stated by the World Health Organization, "Gender refers to the characteristics of women, men, girls and boys that are socially constructed. Gender is hierarchical and produces inequalities that interact with other social inequalities. Sex generally refers to a set of biological attributes that are associated with physical and physiological features (e.g., chromosomal genotype, hormonal levels, internal and external anatomy)".⁷

Astute evaluation of data disclosed that as compared to adults and older individuals, children had significantly higher number of casualties. Of 3065 deaths, 1985 reportedly belong to 0-14 age group. Duke et al. conducted a study to evaluate the risk of mortality after burn injury among children and it was reported that 46.4% children often suffer minor burns and carry high risk for mortality. Among pediatric burn patients who received severe burn injury demonstrated metabolic and inflammatory changes that last for at least 3 years after injury.⁸ TBSA and inhalation injury reported to be important predictors of mortality in childhood burn injury.⁹

Previous published reports explaining gender dimorphism have either reported high male or female mortality or no influence of gender and the studies that have supported the idea of mortality related to gender have reported it to be significant in reproductive age group. Of the total world population, 1.2 billion belongs to adolescent and most of them are from middle- and low-income countries, and of this, 1.2 million die each year due to lack of prioritization of adolescent health.¹⁰ There is preponderance of evidence that suggests that gender is a risk factor that does affect the chances of survival after sustaining a burn injury. Potential causes behind the gender biasness are attributed to be biological and environmental. Epigenetic mechanisms do get altered by environmental factors like traumatic experiences, chemical and nutrition and show variability in expression of disease between males and females as for instance Hepatitis

B virus has female to male ratio of 1:3.8.¹¹ Females tend to have greater risk of mortality after thermal injury while males have greater risk of mortality after non-thermal injury.¹² O Keefe et al. reported increased mortality in females as compared to males in age group 30-59 years excluding the effect of confounding variables like complications, burn size, depth and inhalation injury.⁶ This difference could be attributed to difference in immune response after injury. Researches have reported that males and females express sexual dimorphism and have change in cell-mediated and humoral immunity after burn injury. As for instance, levels of estrogen during menstrual cycle potentiate immune response while levels of estrogen during pregnancy attenuate immune response.¹³ An experiment conducted on male and female mice given 15% TBSA reported suppressed delayed type hypersensitivity (DHT) and splenocyte proliferative response.¹⁴ IL-6 levels were elevated in males at day 1 and in females at day 10.¹⁴ IL-6 is basically involved in suppression of immune response by suppressing splenocyte proliferation. Male and female hormones i.e., testosterone and estrogen respectively could be the underlying principle behind discrepancy in mortality. As gender disparity is mostly observed in reproductive age by most of studies indicate that influence of sex hormones could be a strong possible explanation for this behavior as there's difference in hormonal levels of pre-menopausal and post-menopausal females from that of reproductive age. As no such disparity is reported in younger and older age group. Trauma hemorrhage is characterized by multi organ dysfunction syndrome (MODS) and death.¹⁵ Females after trauma have better immune response and suffer less from complications like MODS, sepsis and death. While males on the other hand demonstrate suppression of immune response following trauma.¹⁵

While this response is opposite in case of burn injury. Females exhibit altered immune response in case of burn injury. A study result demonstrated

that males who received estrogen treatment after trauma hemorrhage decreased production of Kupffer cells, Tumor necrosis factor alpha and IL-6 2 hour after injury.¹⁶ Another study also demonstrated gender discrepancy regarding mortality after burn injury in the age group of 20-34 years old.³ These results were not perplexed by factors like age, race, comorbidity, injury type, TBSA and inhalation injury.³

Skin serves as barrier against infections as it constitutes of first line of defence of our body. Cause of death, mostly reported in hospitals, of burn injury is sepsis. Mortality resulting from sepsis remains high, 15% in individuals with sepsis to 40-50% in persons with septic shock and multi organ dysfunction.¹⁷ A study conducted in Karachi evaluated the role of gender dimorphism and published results favouring higher mortality in males after sepsis while females had better immune response. Plausible justification was attributed to be higher levels of IL-6 in males. Also owing to fact that males possess significant preference when they are sicker and to nature of patients in ICU.¹⁷

Where volumes of research indicate gender discrepancy in mortality after burn injury, Ederer et al. manifested no such confliction and did not support the idea of female mortality more than males.¹² As our study is being conducted in a lower- and middle-income class country, there are also other characteristics that affect female survival more than males. As reported by Mehta et al, that ratio of females undergoing surgical treatment is less than males also females have more in-hospital deaths than males and this was not reported in high income countries.¹⁸ Females also tend to have augmented odds for different burn etiologies, burn size, inhalation injury, and burn injury of upper and lower extremities.¹⁸ Lam et al. after concluding remarks from various studies reported no gender discrepancy in burn patients but longer stay and surgical preponderance in males.¹⁰

In addition to immune response, geographics of our study also support the idea of domestic violence and

household accidents resulting in fire burns. A study of similar locality reported higher odds of intentional burns among females than males cause attributed to be kitchen accidents, domestic violence and self-immolation.¹⁹ Karimi et al in their study supported gender discrepancy by differences in body fat distribution. Females have peripheral while males have central distribution also body fat distribution and hormone related receptors are pivotal indicators of fat metabolism and related morbidity and mortality.²⁰

Type of burn and TBSA as a separate indicator influence mortality rate as flame burns have higher mortality than electric, scalds and other type of burns and larger the TBSA higher the mortality rate.²¹ Our study demonstrated no statistically significant difference between males and females regarding burn type and TBSA. However, length of stay was statistically significant between males and females. While McGwin et al. in his study reported no statistical significance regarding length of stay and TBSA but there was difference in burn etiologies as males had higher odds for chemical, electrical/lightning and steam burns on the other hand females had augmented odds for flame and liquid/scald burns.² this signifies that male occasionally suffer from occupational burns and females from household burns that is in consistency with the likely interpretation postulated above. Scalds and flame burns were reported to be most common burn etiologies in our study followed by electric, cylinder and other burn injuries which is persistent with the results of other published reports.²² Most of the burn injured patients reported to hospital were having TBSA within range of 0-41% in our study but keeping in view the mortality, people with TBSA more than 41% were more prone to suffer from death. Other studies also reported TBSA as a risk factor for mortality declaring 60% and above TBSA having strong association with mortality.²³ Over the years, advancement in hospital care and production of better health equipment has reduced overall mortality resulting from burn

incidents.²⁴ Length of stay could be taken as a predictor defining the standard of care offered by a health institute.²⁴ Mean length of stay in our study was 0-7 days with total of 1663 out of 3065 individuals stayed for a week followed by 7-30 days and more than one month.

Strengths and Limitations: The strength of our study lies in the sample size of our population which is 3065 patients i.e., data from 2019 to 2023. Furthermore, it is conducted in Burns Care Centre, PIMS, which is the largest government hospital in Pakistan and receives patients from all over the country, so the results can be applied to overall general population. Though there are certain limitations to our study. First, it is retrospective so a prospective study should be done including some variables which if present might affect the results of our study. Some studies have included factors such as body surface area, past medical and past surgical records of the patient, and complications after burn injury. In addition, estrogen levels and menstrual history were not documented at the time of admission in females so a meaningful evaluation of differences in outcomes between pre- and post-menopausal women was not possible.

Conclusion

This study was conducted to explore the role of gender as a risk factor in causing mortality. However, after analysis females are reported to have greater mortality as compared to males. Many studies have reported a significant association and explained it on the basis of biological and environmental grounds. Confounding variables like TBSA, length of stay and burn type were also analyzed but no difference was notified between males and females except for length of stay which is significant for 15-49 age group across gender.

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