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Alarming rise in fatal electrocutions in Bangladesh: Comparison of two national surveys

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ABSTRACT

Background and objectives: Electrical injuries are major contributor to burn-related mortality and morbidity. Mortality data were compared from the two largest community-based health and injury surveys in Bangladesh conducted thirteen years apart to investigate the changes in epidemiological features of this adverse health event.

Methods: The nationwide Bangladesh Health and injury surveys (BHIS) were conducted among 819,429 people in 2003 and 299,216 in 2016 using a pretested semi-structured questionnaire at the household level. History of electrocution death events in previous one year in the household was determined by verbal autopsy method in both surveys. Thus, each survey result represents the scenario of the year before. Descriptive and comparative analysis was done to investigate the changes in the distribution of electrocution deaths.

Results: The incidence of electrocution deaths was 1.7 and 4.3 per 100,000 population respectively in the 2003 and 2016 survey. The majority of the cases were aged between 18 to 59 years in both years. The comparison of the two survey results shows that the death rates increased in every age group those were examined. The rates were persistently higher in rural areas compared to the urban. Moreover, the rural mortality rate increased strikingly in 2015. The highest proportion of fatal electrocution events occurred at workplaces and males had a higher mortality rate in contrast to females in both the surveys. The death rate in males doubled in 2015 (6.0 per 100,000) from 2002 rate (3.1 per 100,000).

Conclusion: Electrocution mortality rates have raisen alarmingly between 2002 and 2015. Working persons and males have a higher susceptibility to deaths from electrocution. Rural areas pose greater threats compared to urban Bangladesh. Being derived from a nationwide survey, these facts provide with useful direction to set priorities for prevention of this emerging unnatural cause of death in the country.

Abbreviation: BHIS, Bangladesh health and injury survey; IRB, Institutional review board; CI, Confidence interval; UK, United Kingdom.

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1. Introduction

People started using electricity as a source of power commercially from 1849 and since then its use only spread ever so rapidly [1]. Electricity is now an inseparable part of modern living. It is ever-present in our lives either as the natural static electricity source from lightning or as artificially generated electric current utilized in numerous daily affairs. Despite its unquestionable contribution to the rapid technological advancements, electricity can be sometimes disastrous by instigating significant injuries of various severity when not utilized with due precautions. Consequently, electrocution has become a well-known mechanism of unnatural deaths in human [2]. As a matter of fact, a distressing share of burn injuries is caused by electrocution [3]. The damage produced by electrocution is largely dependent on the duration and intensity of the current that passes through the body. An electrical contact with human body results in death when the flow exceeds roughly above 50 mA only for more than 1 s [4]. Most of the unintentional electrocution deaths are caused by low voltage current, although, both low and high voltage currents can result in fatalities [2,5]. Evidently, some basic preventive steps may prevent the hazards [6,7] as most of the incidents are accidental [4,7,8].

Due to widespread awareness and safety practices, electrical injuries are not much common in developed countries. Unfortunately, the scenario is inversely true for the less developed nations [6,8]. Developed countries like the United States [9], Australia [10], Canada [8] and Japan [11] have succeeded to downslope the trend of electrocution deaths. Nonetheless, it is still one of the leading cause of occupational injury deaths in the United States [12]. In South Asian countries, electrocution deaths are increasing in number according to a systematic review report [13]. India has few studies which show an increasing trend in electrocution mortalities [5,8]. Routine encounter with activities related to electricity has been proven to make people more vulnerable to the event [3]. For instance, greater fractions of electrical fatalities were observed among electricians and their helpers, utility workers, construction workers and people working in manufacturing industries [14]. Male gender is another important predisposing factor that has been identified so far [14]. Most of the researchers have reported hospital data while community-based studies are scarce. There exist almost no scientific paper reporting the changes in the epidemiology of electrocution deaths in this country. Hence, mortality data were compared from the two largest community-based health and injury surveys in Bangladesh conducted thirteen years apart to investigate the changes in epidemiological features of this adverse health event related to electrocution.

2. Methods

Two Nationwide surveys named Bangladesh Health and Injury Survey (BHIS) were conducted at the community level in 2003 and 2016 to investigate the heath and injury situation in a population of all age group. The studies were conducted following nearly identical methodologies. However, some methodological improvements were made in the second survey, however, the sample size was lesser. The total sample was 819,429 in 2003 whereas, in 2016 it was 299,216. Sampling was done through a multistage cluster sampling method. Enumerators were trained to collect data through household visits using a pretested semi-structured questionnaire. Descriptive and comparative analysis was done to derive the desired outputs. The survey explored the events retrospectively with a 1-year recall period for mortality cases, thus the results presented here are relevant to 2002 and 2015 respectively. Detailed methodologies and comparison of the studies are published in another scientific paper where changes in overall burn mortality were compared between these two studies [15].

Table 1 – Distribution ofrespondents by age and sex.

Variables	2002		2015	
	n	%	n	%
Age group				
Less than 17 yrs	351651	42.9	100842	33.7
18-59 yrs	421621	51.5	175542	58.7
60 yrs and above	46157	5.5	22832	7.6
Sex				
Male	416807	50.9	149995	50.1
Female	402622	49.1	149221	49.9
Total	819429	100	299216	100

Percentages may not total 100 due to rounding.

3. Results

3.1. *Age and sex distribution of respondents*

The population characteristics are presented in Table 1. In BHIS 2003, the majority (51.5%) of the people were from the age group of 18 to 59-years and in 2015, 58.7% were from this age group. Male to female ratio was 1.03 in 2003 and 1.00 in 2015.

3.2. *The burden of electrocution mortality*

The fatal electrocution rates were found 1.7 (95% CI: 1.0, 2.8) and 4.3 (95% CI: 2.4, 7.2) per 100,000 population in the first and second survey respectively (Table 2). In 2015, the highest rate was observed in the age group of 18–59 years (5.1, 95% CI 2.5, 9.4). The age group of 60 and above had the mortality rate of 2.2 (95% CI 0.1, 10.7) in 2002 which increased to 4.4 (95% CI 0.2, 21.6) in 2015. Death rates among population under the age of 18 was estimated 1.4 (95% CI: 0.5, 3.2) and 3.0 (95% CI: 0.8, 8.1) per 100,000 in 2002 and 2015 respectively.

The rural death rate in 2015 (6.2 per 100,000 population; 95% CI 3.5, 10.6) was found more than two times higher than in 2002 (2.5 per 100,000 population; 95% CI 1.3, 4.4). Mortality rate in urban was 0.8 per 100,000 (95% CI 0.2, 2.1) in 2002 and 0.9 per 100,000 (95% CI: 0.1, 4.6) in 2015. Males had two times higher rates in 2015 (6.0; 95% CI 2.9, 11.0) as compared to 2002 (2.8; 95% CI 1.6, 4.9) while women had a drastic rise in electrocution mortality rates (0.5 per 100,000 population; 95% CI 0.8, 1.6) from in 2002 to (2.7 per 100,000 population; 95% CI 0.9, 6.5) in 2015.

Table 2 – Electrocution mortality rates by socio-demographic characteristics and year.

Variables	2002		2015	
	n	Rate per 100,000 (95% CI)	N	Rate per 100,000 (95% CI)
Age group				
Less than 17 years	5	1.4 (0.5, 3.2)	3	3.0 (0.8, 8.1)
18-59 years	8	1.9 (0.9, 3.6)	9	5.1 (2.5, 9.4)
60 years and above	1	2.2 (0.1, 10.7)	1	4.4 (0.2, 21.6)
Area				
Urban	3	0.8 (0.2, 2.1)	1	0.9 (0.1, 4.6)
Rural	11	2.5 (1.3, 4.4)	12	6.2 (3.5, 10.6)
Sex				
Male	12	2.8 (1.6, 4.9)	9	6.0 (2.9, 11.0)
Female	2	0.5 (0.8, 1.6)	4	2.7 (0.9, 6.5)
All population	14	1.7 (1.0, 2.8)	13	4.3 (2.4, 7.2)

4. Mechanism of electrocution

The death rate was 1.6 per 100,000 population due to the electricity used in industries and households, whereas, death rate caused by lightning was 0.1 per 100,000 population in 2002. Death rates due to natural (lighting) and man-made electricity sources found in the survey in 2015 were 1.3 and 3.0 per 100,000 population respectively. Lightning injury deaths thus raised over ten folds and other electric injury deaths raised by two folds between the two survey years (Fig. 1).

4.1. *Place of electrocution injury*

In 2002, Open places and workplaces had the highest proportion of fatal electrocution events. In 2015, the proportion of deaths at workplaces only increased from 35.7% to 46.2% and was the most common place for electrocutions causing deaths. Interestingly, all the electrocution deaths at the workplace in 2015 took place in agricultural fields. In contrast, in 2002, about 60.0% of fatal electrocutions at workplaces occurred in the agricultural fields. The proportion of fatal electrocution at home was found 14.3% in 2002 which escalated to 30.8% in 2015. (Fig. 2).

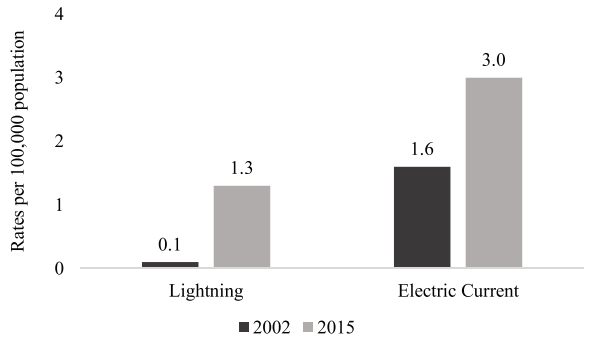

Fig. 1 – Electrocution mortality rates according to mechanism of electrocution. Number of electrocution deaths in 2002, N1 = 14 and in 2015, N2 = 13.

5. Discussion

The study has demonstrated that electrocution mortality rates have doubled over a decade. To be specific, an extrapolated 2211 deaths due to electrocution injury occurred in 2002 and the figure raised to 6634 in 2015. Almost all population groups that were examined and compared had higher death rates in 2015 as compared to 2002. Generalizable data on electrical injuries for Bangladesh are not readily available from the literature. Nonetheless, this injury mechanism has been recognized as an emerging health concern in low and middle-income countries [6]. The reason behind this budding issue can be that electricity has become more accessible to the common people in low and middle countries like Bangladesh without them being well-informed about the precautions they must take to prevent the associated hazards. Examples from our neighboring country like India, makes us understand that failure to make people aware of the electrical hazards costs numerous lives in developing countries. Compromising the standards for using electric connections to save some money eventually backfires [1]. Meanwhile, developed parts of the world have been successful in reducing their rates of electrocution deaths by the successful implementation of protective measures and safety campaigns [10]. However, the reason for the increased incidence of lighting is not well understood yet and needs more exploration.

In a real-world scenario, any place where people are not exposed to electricity is hard to find as it has become an integral part of any setting, be it residential or commercial. Nonetheless, specific places pose a greater risk of electrocution. According to this study, agricultural areas or other workplaces were the commonest areas where fatal electrocutions occurred in 2002. The rank was well maintained in 2015 given that the proportion was higher than before. Lack of recognition and poor planning to prevent electrocution in occupational settings is most likely the cause of this finding. While workplace electrocutions contributed the highest fraction of electrocution deaths in both study years, the proportion of events at home has also doubled during the period. Other studies have also denoted that, accidental electrocutions usually occur in occupational settings [5,16] where the working people are electrocuted by high or low voltage current mostly through electric machinery [16]. Mukherjee et al. found that fatal electrocution victims in India were more commonly involved in agricultural labor [17]. On the contrary, the majority of fatal electrical injuries were found to take place in domestic setting according to a recent study by Reddy et al in that country [2].

The contrast in the urban-rural scenario of electrocution mortality rates was also noticed in this investigation that directed the emphasis of future actions on the rural backdrop. Rural death rates were more than six times higher than the urban in 2015 whereas, in 2002 the contrast was comparatively a lot lower. The rapidly expanding electric

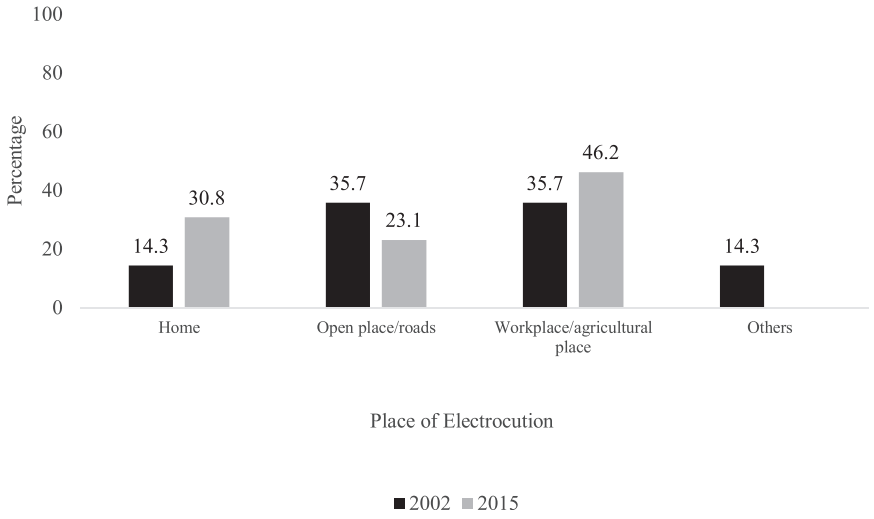

Fig. 2 – Distribution of electrocution mortality cases according to Place of electrocution. Number of electrocution deaths in 2002, N1 = 14 and in 2015, N2 = 13.

connections and its amplified usage in the rural locale are reflected through this finding. Reddy et al also found that rural areas were more prone to electrical fatalities than the urban [2]. We also found that males had about two times increased mortality rates between the two studies while females had a higher increase in rates. However, males had the highest rates of electrocution deaths in both survey findings. Many studies have also affirmed that the greatest share of fatal electrocutions was borne by male gender [10,13,18,19]. The increased rates in females can be explained by the fact with the expansion of power supplies in the country, there are many illegal methods adopted to get power lines in the houses without proper safety considerations. Females being at the home most of the times are exposed longer to the hazards and thus may have contributed to the increased incidences of female deaths from electrocution in 2015. It is also supported by the finding that, the proportion of fatal electrocution at home settings increased in 2015. However, it does not imply that all females were electrocuted at home as females in this country are also involved in agricultural work in the rural areas. Further exploration of this issue is thus relevant to gain an in-depth understanding of the findings in this study. The most common age to die of electrical injury in 2002 was the age group of above 60 years while in 2015 the people aged 18–59 had higher death rates compared to other age groups. The death rate in children was found two times higher in 2015 than in 2002 although it was lower than other age groups in both studies. The comparison of the two survey results also indicated that death rates increased in every age group that were examined and the highest rise was detected among the age group of 18-59 years. Other pertinent studies had remarked that the young and middle-aged people were distinctly more vulnerable than the extremes of age [16,20].

Lightning and electric or domestic current were two possible mechanisms explored to cause these deaths. Strikingly, both the mechanisms caused higher death rates in 2015 when compared to 2002 data. Electric current used in households or industries was observed to cause greater death rates than lightning. A former study reporting the sources of fatal electrocution also found that lightning events were rarer than manmade sources [2]. Although developed countries like the UK are experiencing a drastic decline in lightning deaths [13], our study reports an opposing reality in Bangladesh.

5.1. *Strengths and limitations*

Bangladesh Health and Injury Survey (BHIS) is the largest injury related survey ever conducted in the country. Collection of data directly from the community through household visits is one of the major strengths of the studies. It checks the under-representation of cases from other hospital-based surveys. Like any other study, this research has also some limitations to consider. The population of the two surveys differs in age group distribution which is reflective of the demographic transition of the country. The sample size also varies in the two studies where the latter survey had a considerably lower sample size than the previous. The sample size was calculated to fulfill two different objectives in 2003 and 2016. Capturing electrocution cases was the objective in none of the above-mentioned studies. Moreover, electrocutions are uncommon events compared to other prevalent injuries. Thus, the statistical significance of the estimations could not be demonstrated in the results in this paper due to low number of electrocution events.

6. Conclusion

Death caused by electrocution has raised alarmingly. Rural and working age group people are more vulnerable to fatal

electrocutions. Males also are at greater risk than females in this regard. Agricultural area is the commonest place for electrical fatalities.

6.1. *Recommendation*

The study findings direct us to think about the existing flaws in electrical hazard prevention strategies in our country. As a developing nation, expansive use of electricity is anticipated to be going on in Bangladesh. It is high time that we explored the prevailing factors for electrocution deaths in depth through focused research. Examining the workplaces to find out the potentially hazardous environment for electrocution and lack of protective measures has become crucial. Agricultural areas demand a special attention from prevention perspective as per this study's findings. A qualitative exploration of people's knowledge, attitude and practices are also expected to be useful for designing directive interventions.

Ethics approval and consent to participate

Ethical clearance was received from IRB (Institutional Review Board) of the Institute of Maternal and Child Health granted the ethical clearance for the study in 2003. For the study in 2016, it was obtained from IRB of Centre for Injury Prevention and Research Bangladesh. Cases or their legal representatives gave informed written consent for participation in this research.

Consent for publication

The article does not contain any individual person's data in any form. Thus consent for publication is not applicable.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

Riffat Ara Shawon: Conceptualization; Data curation; Formal analysis; Visualization; Writing - original draft.

Junnatul Ferdoush: Visualization; Writing - review & editing.

Arifa Hasnat Ali: Visualization; Writing - review & editing.

Animesh Biswas: Investigation; Project administration; Resources; Software; Supervision and validation.

AKM Fazlur Rahman: Funding acquisition; Investigation.

Saidur Rahman Mashreky: Conceptualization; Formal analysis; Investigation; Methodology; Writing - review & editing.

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Conflict of interest

None declared.

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