RESEARCH PAPER

Descriptive Epidemiology of Unintentional Childhood Injuries in India: An ICMR Taskforce Multisite Study

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Background: Children 0-14 years constitute about 31.4% of Indian population, among whom the magnitude and risk factors of childhood injuries have not been adequately studied.

Objective: To study the prevalence of and assess the factors associated with unintentional injuries among children aged 6 month - 18 years in various regions.

Methodology: This multi-centric, cross-sectional, community-based study was conducted at 11 sites across India. States included were Gujarat, Karnataka, Madhya Pradesh, Punjab, Sikkim, Tamil Nadu, Uttarakhand, and West Bengal between March, 2018 and September, 2020. A total of 2341 urban and rural households from each site were selected based on probability proportionate to size. The World Health Organization (WHO) child injury questionnaire adapted to the Indian settings was used after validation. Information on injuries was collected for previous 12 months. Definitions for types (road traffic accidents, falls, burns, poisoning, drowning, animal-related injuries) and severity of injuries was adapted from the WHO study. Information was elicited from parents/primary caregivers. Data were collected electronically, and handled with a management information system.

Results: In the 25751 households studied, there were 31020 children aged 6 months - 18 years. A total of 1452 children (66.1% males) had 1535 unintentional injuries (excluding minor injuries) had occurred in the preceding one year. The overall prevalence of unintentional injuries excluding minor injuries was 4.7% (95% CI: 4.4-4.9). The commonest type of injury was fall-related (842, 54.8%) and the least common was drowning (3, 0.2%). Injuries in the home environment accounted for more than 50% of cases.

Conclusions: The findings of the study provide inputs for developing a comprehensive child injury prevention policy in the country. Child safe school with age-appropriate measures, a safe home environment, and road safety measures for children should be a three-pronged approach in minimizing the number and the severity of child injuries both in urban and rural areas.

Keywords: *Animal-related injuries, Burns, Falls, Poisoning, Road traffic injuries*.

Globally, injuries and violence are major public health problems. Children are at a higher risk for injuries due to their physical and psychological attributes. Their small body size and the softness of tissues lead to greater vulnerability for severe impact. Children's risk perception is limited, making them more susceptible to involvement in road accidents, drowning, burns, and poisoning. Psychological characteristics of children like impulsiveness, curiosity, experimentation, an inadequate judgment of distance/speed, and low levels of concentration make them vulnerable to injuries [1].

The precise number of deaths and injuries due to specific causes or any reliable estimates of injury deaths in India are not available from a single source. The National Crime Records Bureau data and a study based on available data reveal that nearly 10-15% of India's injury deaths occur among children [2,3]. An examination of 'years of potential life lost' indicates that injuries are the second most common cause of death after 5 years of age in India [2]. While there are selected studies related to unintentional childhood injuries from hospital-based data, the true magnitude of the issue with population-level determinants is mostly lacking.

This study presents the results of a national level community-based multi-centric task force study of unintentional childhood injuries in India, commissioned by the Indian Council of Medical Research (ICMR).

METHODS

This multi-centric community-based cross-sectional study was conducted at 11 different sites across eight states in India between March, 2018 and September, 2020. A purposive selection of study sites was made, ensuring adequate geographical representation. The study population comprised children aged six months to <18 years from both rural and urban areas viz. Siddlaghatta, Bangalore, Karnataka; Pauri Garhwal, Srinagar, Uttarakhand; Vellore, Tamil Nadu; Perundurai, Erode, Tamil Nadu; Mangalore, Karnataka; Bardhman Sadar North, Bardhman, West Bengal; Dhoraji, Rajkot Gujarat; East Sikkim, Sikkim; Dholka, Ahmedabad, Gujarat; East Ludhiana, Ludhiana, Punjab; Huzur, Bhopal, Madhya Pradesh (**Fig. 1**).

Sample size and sampling strategy: The sample size was calculated considering the overall prevalence of childhood injuries to be 11.0% (including minor injuries) as per the guidelines for conducting community surveys on injuries and violence by WHO [4], with a relative precision of 13% and 95% desired confidence level, with increase in sample size by 10% to allow for non-responses, design effect of 2 to account for cluster sampling and relative precision of 13%. Hence, 2341 households from rural and urban areas (combined) were selected from each site proportionately based on the population's rural-urban distribution as per 2011 census [5]. In each site, the district predominantly served by the participating institution was selected. Subsequently, one taluk was selected through a simple random sampling technique. Applying probability proportionate to size (PPS) sampling, within each taluk, clusters of households in rural areas and urban areas were selected. Each cluster consisted of 16 houses (estimated based on the number of households to be covered by four field workers in a day) both in urban and rural areas.

Further, within the rural areas, all villages in the selected taluk were in the sampling frame. In each village, each cluster consisted of 16 households. The number of clusters to be surveyed to meet the required sample was arrived at.

In the case of urban areas, one town was selected using a simple random sampling technique from the total number of towns in the taluk. Like rural areas, 16 households made up one cluster. The required number of clusters were selected from a randomly chosen locality in the town.

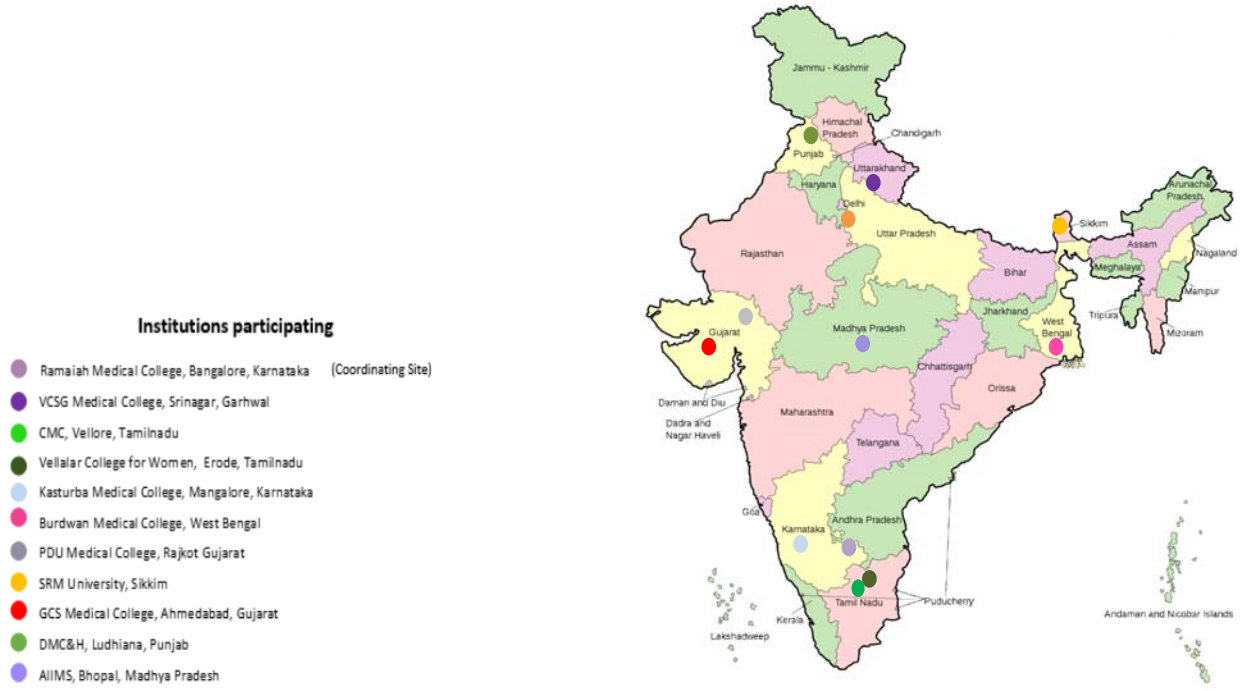


Fig. 1 Map of India with location of participating institutions and study sites.

The inclusion criterion was to have all six months to <18-year permanent resident children, and visiting children living in that area for a minimum duration of previous six months. Additionally, information pertaining to deaths in the above age group due to unintentional injuries was sought from the government sources. Birth injuries or injuries consequent to intra-natal complications, and disabilities due to other conditions were excluded.

After clearance from the institutional ethics committee (IEC), permissions were obtained from the district and taluk administrative authorities at all sites, the zilla panchayat CEO, and the Child Development Project Officer for accessing information of village panchayats and community health workers.

Data collection: Each site recruited four field workers (medico-social workers) who underwent standardized training of 5 days, through a workshop conducted at each site. The workshop oriented the field investigators to undertake an initial pilot study about child injuries, the tool, rapport building in the community, data collection procedures and hands-on instructions on using the electronic handheld device.

Subsequently, field investigators prepared a spot map of each selected village (rural area) or locality (urban area) and numbered the houses serially. After explaining the study's purpose in the local language, informed written consent was obtained from the respondent (parent/primary caregiver). Verbal assent was taken from children more than or equal to 7 years of age. In addition to interviewing the adult, children 7 years and above were also interviewed to substantiate parents' information. A history of previous three months was used to collect information relating to all injuries whereas information about fatal injuries was collected for the previous 12 months and verified in the register maintained in the panchayat office. At the end of every interview, the caregivers were verbally provided education regarding injury prevention among children.

Tool employed for data collection: The World Health Organization (WHO) child injury questionnaire adapted to the Indian settings was used [4]. Definitions for types (road traffic accidents, falls, burns, poisoning, drowning, animal-related injuries) and severity of injuries (mild, moderate and severe) was adapted from the WHO standard definitions [6]. Injuries other than these types were categorized as miscellaneous. A cloud-based software was developed through an external vendor and validated. Each center received four handheld devices for the field workers and one for the supervisor. Quality assurance of data was built into the software with features of valid entries, skip logic and consistency checks.

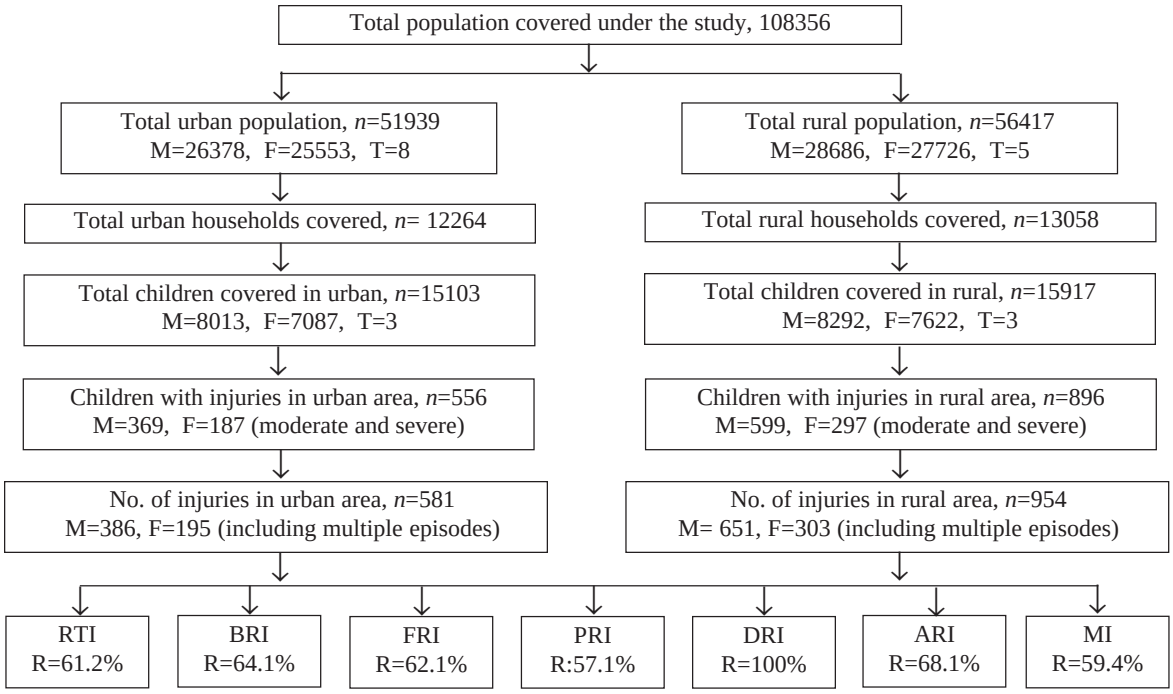
A robust management information system and dashboard was developed through which each site could visualize their respective electronic data on the web and download a copy of their data. Data were analyzed centrally based on the approved statistical analysis plan.

Quality assurance: An operation manual and a training manual for field workers were prepared by the coordinating team and shared with the participating sites to ensure uniformity. Online monthly meetings were organized by the central and national coordinating sites with other site investigators and field workers for centralized monitoring and supportive guidance to ensure regular interaction and quality of data collected. The coordinating center continuously monitored data through the dashboard. A team from the coordinating center and ICMR team visited each of the sites during data collection for supportive supervision. The investigators in each site revisited 5% of households randomly and collected information independently to check data quality and discrepancies if any, were resolved.

Statistical analyses: Data from all sites were analyzed by the coordinating team using Statistical Package for the Social Sciences 16.0 (SPSS Inc.). Data were coded according to severity of injuries. Minor injuries were excluded for subsequent estimates. The association between factors such as prevalence rate with age, gender, and other factors was tested for statistical significance by Chi-square test or Fisher's exact test. The difference in mean values between two groups was tested for statistical significance by Student's t-test. Probability value <0.05 was considered as cutoff for statistical significance. Prevalence rates (period prevalence for 3 months) with 95% confidence intervals were estimated.

RESULTS

The overall prevalence (95% CI) of unintentional childhood injuries, including minor and trivial was noted to be 14.5% (14.1-14.9). **Fig. 2** describes the samples selected and the distribution of the types of injuries in all sites combined. However, after excluding minor and trivial injuries, it was noted that 1452 children reported 1535 events of unintentional injuries. The prevalence rate of injuries in various sites ranged from 0.6-12.0% (rural areas) and 1.1-8.4% (urban areas) (**Fig. 3**). The prevalence was higher among males as compared to females (5.9% vs 3.3%, $P<0.001$). The differences in the prevalence rates between different age groups was found to be statistically significant ($P=0.01$), with the lowest prevalence rate among children below 1 year. The prevalence rate showed a decreasing trend with increasing socioeconomic status. The difference in prevalence based on the number of children in the family was minimal (**Table I**).



RTI-road traffic injuries, FRI-fall related injuries, BRI-burn related injuries, PRI-poison related injuries, DRI-drowning related injuries, ARI-animal related injuries, MI-miscellaneous injuries, T-transgender, M-males, F-females.

Fig. 2 Study flow and injury types at all participating sites (excluding mild/trivial injuries).

Among the different types of injuries, fall-related injuries had the highest prevalence rate of 2.7% (95% CI: 2.5-2.9) followed by road traffic accidents (RTA) (1%; 95% CI: 0.8-1.1). Drowning related injuries were the least (**Table II**). As per the World Health Organization severity grading, burn injuries (44.7%) followed by fall injuries (30.8%) reported a large number of severe type of injuries. A total of five fatal injuries were reported across the different sites (**Table III**).

Male children from rural areas in the age group of 5-9 years were commonly involved. The commonest location of injury for all categories was at home. Age was an important factor associated with different types of injuries.

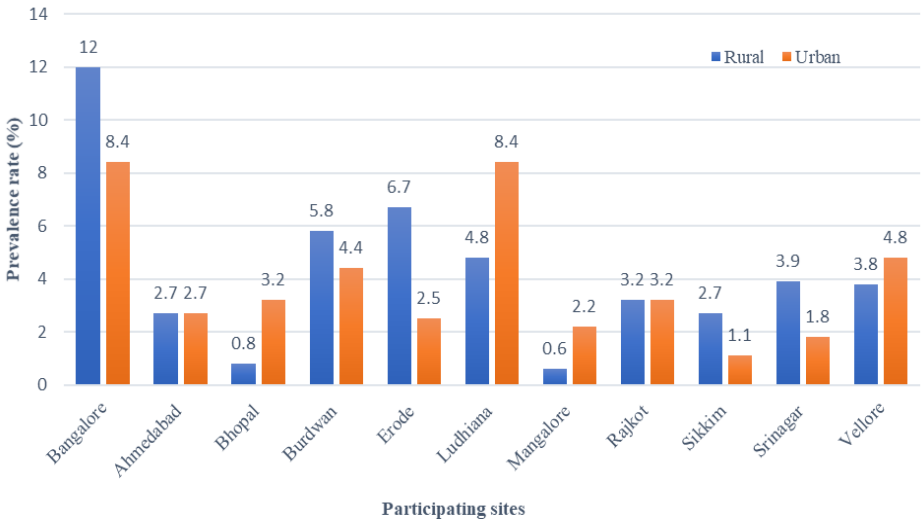


Fig. 3 Site-wise injury prevalence rate (%) by rural and urban areas.

Table I Socio/Demographic Characteristics and Prevalence of Injuries

	No. of children n=31020	*No. with injury n=1452*	*Prevalence (95% CI)*
Age group			
6 mo - < 1 y	768	2	0.3 (0.03-0.9)
1-4 y	6375	266	4.2 (3.7-4.7)
5-9 y	8682	449	5.2 (4.7-5.7)
10-14 y	9326	471	5.1 (4.6-5.5)
15-<18 y	5869	264	4.5 (3.9-5.1)
Gender[a]			
Male	16305	968	5.9 (5.5-6.3)
Female	14709	484	3.3 (3.0-3.6)
Area of residence			
Urban	15103	556	3.7 (3.3-4.0)
Rural	15917	896	5.6 (5.2-6.0)
Socioeconomic status			
Lower	3879	194	5.0 (4.3-5.7)
Lower middle and Upper lower	24323	1190	4.9 (4.8-5.5)
Upper middle and Upper	2818	6	2.4 (0.8-4.5)
Number of children in the family			
1-2	21313	1009	4.7 (4.2-5.2)
>2	9597	443	4.6 (4.0-5.1)
Type of family			
Nuclear	19323	921	4.8 (4.4-5.1)
Joint	6759	316	4.7 (4.2-5.2)
Three generation	4938	215	4.3 (3.8-4.9)

[a]*6 were transgenders and none of them had injuries. Comparisons of prevalence rates between different age group, gender, area of residence, socioeconomic status, number of children in the family, and type of family showed all P<0.001.*

While road traffic accidents, predominantly involved rural 10-14 year-old males (61.2%), fall-related injuries were common among the younger 5-9 year-old children resulting in considerable impairment (74.8%). However, in case of burn injuries, infants and toddlers had a higher proportion (45.6%) as compared to their older counterparts.

Table II Prevalence of Different Types of Injuries (*N*=31020)

Type of injury	*Prevalence rate (95% CI)*
Road traffic injuries, *n*=304	1.0 (0.8-1.1)
Falls, *n*=842	2.7 (2.5-2.9)
Burns, *n*=103	0.3 (0.2-0.4)
Poisoning, *n*=14	0.05 (0.02-0.08)
Drowning, *n*=3	0.01 (0-0.03)
Animal-related, *n*= 94	0.3 (0.2-0.4)
Miscellaneous, *n*=175	0.6 (0.4-0.7)

More than 80% of respondents with different types of moderate and higher grades of injuries sought care at private clinics initially. Most of the respondents reached the facility within one hour of the occurrence of major injuries. Although activities of daily living were affected among 88% of children with major injuries, more than 77% of the children returned to their usual level of activity in a short time. Less than a quarter of the respondents reported borrowing money for treatment related to injuries. Although a large proportion of children with injuries had some disability, most of them were temporary. Permanent disability was noted in 4.3% in road traffic accidents, 11.8% in falls, 16.5% in burns, 14.3% in poisoning, 11.7% in animal-related and 10.3% in miscellaneous injuries.

DISCUSSION

This study was undertaken to obtain the population estimates of unintentional childhood injures and major factors associated with them. The all-site prevalence of injury including minor and trivial was noted to be 14.5%. As per the reports from several studies done in various parts of India, the prevalence of injury ranges from 11% to 64% [7-9]. This wide range of prevalence may be attributed to the variation in the sources of data, definitions used, and selection criteria for assessing the burden of injuries.

Five deaths due to injuries were reported in one year of the study recall period (0.16 per 1000 children). According to the Bangalore Injury Surveillance Program (BISP), the ratio of fatal to nonfatal injury in children below 18 years was 1:27 and male to female ratio 3:1 [3]. Lower mortality rate reported in the present study may be attributed to the poor reporting systems as well as absence of validation of mortality reports for children below 18 years of age. An ontological analysis of national programs in India revealed lack of structured reporting mechanisms for childhood mortality [10].

Occurrence of injury was high among male children compared to female children (2:1). This could be attributed to the cultural practice of boys playing more outdoors as compared to girls, especially in the higher age-groups. Higher prevalence in males was reported by other studies as well [7, 8]. However, a study done in Agartala did not find any relation between gender and injury prevalence [9]. The confounding effect of the socio-cultural factors related to gender and different activities across various age groups is to be noted while interpreting the relationship between gender and injuries among children.

We observed that injuries were more common among children aged 5-14 years compared to children less than 5 years and 15 years and above, which has also been reported by Peden, et al. [11]. Children younger than

Table III Severity of Different Types of Injuries (*N*=1535)

Type of injury	*Fatal injury n=5*	*Severe injury n=444*	*Serious injury n=404*	*Major injury n=423*	*Moderate injury n=259*
RTI	1 (0.3)	76 (25.0)	81 (26.6)	95 (31.3)	51 (16.8)
Falls	1 (0.1)	259 (30.8)	224 (26.6)	20 (19.4)	151 (17.9)
Burns	1 (0.9)	46 (44.7)	32 (31.1)	20 (19.4)	4 (3.9)
Poisoning	1 (7.1)	1 (7.1)	3 (21.3)	7 (50.0)	2 (14.2)
Drowning	0	0	2 (66.7)	1 (33.3)	0
Animal-related	0	15 (15.9)	20 (21.3)	39 (41.5)	20 (21.3)
Miscellaneous	1 (0.6)	47 (26.9)	42 (24.0)	54 (30.9)	31 (17.7)

Values in no. (% of row total). RTI: road traffic injuries. Classification of injury severity as per World Health Organization [6].

5 years usually have close adult supervision and children older than 15 are relatively less playful. The age group 5-14 years are associated with independent locomotion with lack of appreciation of risk of getting injured. Similar results were reported by two other studies [1,12].

Falls contributed to 55% of injuries and most of them occurred in the domestic environment. WHO global disease burden report suggests that in most countries, falls are the most common type of childhood injury seen in emergency departments, accounting up to 52% of assessments. In Asia, falls are responsible for 43% of all injuries in children [13]. Other studies have also reported falls to be the most common injury which occurs in the home environment [2,7,11,14].

In Bangalore in 2007, 26% of injury deaths were due to road traffic injuries, 17% due to burns, 13% due to falls, 6% caused by drowning, and poisoning accounted for 5%. RTAs accounted for 40% of hospitalizations due to injury. Surveys show that road traffic injuries are one of the five leading causes of disability among children [2,3].

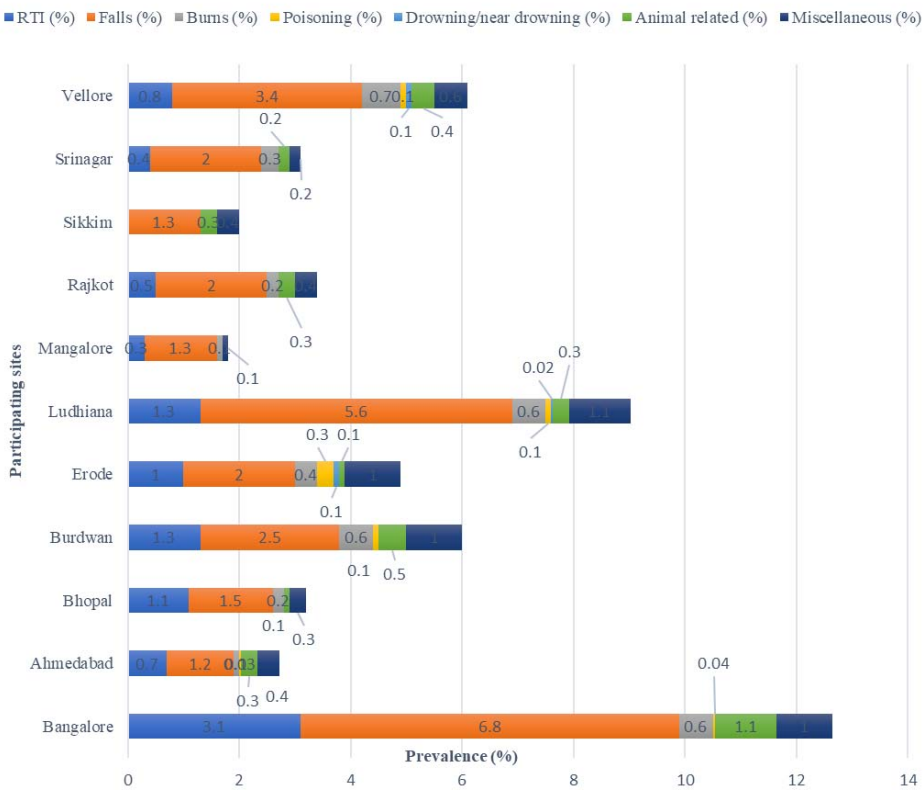


Fig. 4 Prevalence rate (%) of unintentional childhood injuries from different sites in India.

WHAT IS ALREADY KNOWN?

- Information on childhood injuries is largely available from hospital-based studies, with limited population-based data.

WHAT THIS STUDY ADDS?

- The all-site prevalence of injuries in children aged <18 years was 14.5% (including minor and trivial injuries).
- Fall-related injuries were most common (54.8%), and most injuries occurred in the domestic environment.

Burns (6.7% of injuries) were commonly reported due to electric shock or contact with hot liquids or steam. According to WHO, fire-related burns are the 11th leading cause of death for children between the ages of 1-9 years [15]. Children under the age of five years are at the highest risk of hospitalization from burns [12]. In India, cooking at floor level and wood fired stoves contribute significantly to burn injuries. Among older children, carelessness is an important contributor to burn injuries caused by fireworks [16].

Although this study reports only three cases of drowning in 5-9-year male children, it remains a health hazard. Fatal drowning is the 13th cause of death among children. Globally, rate of death due to drowning is 7.2 per 100000 population among children and the rate is 6 times higher in low- and middle-income countries compared to higher income countries [17]. Water storage sumps and ponds require special attention to make them safe for young children. Poisoning was reported more in rural areas. Kerosene poisoning is the most common accidental poisoning among children in India, especially in the age group of 1-3 years. Most injuries occur due to careless storage and use of pesticides, insect and mosquito killers, and naphthalene acids [18]. Animal-related injuries were also more common in rural areas and three-quarters of them were due to dog bites or scratches. The BISP has reported that 11% of injuries in children were due to animal bites [3,19]. A large portion of the Indian population live in rural communities, with likelihood of close contact with animals and hence a proclivity for animal-related injuries.

Domestic factors like inadequate living conditions, poor housing, no separate area for washing or cooking, use of smoke forming fuels, absence of cooking plat-forms, lack of safe storage area, absence of dedicated recreational area for children are key factors in the causation of injuries. Inadequate lighting would promote the chances of accidents at home. These factors are the major cause of falls, burns and accidental poisonings at home [7].

More than 50% of the children in the present study had cut injuries and lacerated wounds. In a study on unintentional injuries in the developing countries [20], cuts/bites and open wounds (23.9%) were the most common injuries. Bruise/superficial injury and burns accounted for 15% of all injuries while fracture was responsible for 19% of the injuries [7]. Another study reported that the most common physical nature of injury was bruise/superficial injuries (39.3%) and cut/bite or open wound injuries (35.3%) [12]. Abrasion and contusion contributed to around 1/3rd of injuries in our study, in contrast to another study done in Aligarh, which reported superficial injuries among under-five children and cut injuries among children aged more than 6 years [12].

A longitudinal study using verbal autopsy is helpful in collecting accurate information on fatal injuries. Logistic problems led to inability to collect data from all houses in hilly terrains and during winters and heavy rains. Clusters of 16 houses could not be found in sparsely populated areas/ hilly terrains and hence there is a need to develop newer approaches and smaller cluster size in such areas.

The findings of the study point to the facets that will be needed to formulate a comprehensive child injury prevention policy in the country. Implementation of the policy should be underscored at the level of the school and household. Child-safe schools with age-appropriate measures, a safe home environment and road safety measures for children should be a three-pronged approach in minimizing the number and the severity of child injuries. These measures must be reinforced through adolescent education, by articulating specific interventions to control risk taking behavior. Focused attention on 'injury-safe' rural environments will also curtail the burden of child injuries.

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42, dated March 15, 2017; PDU Medical College, Rajkot; PDUMCR/IEC/11097, dated June 16, 2017; SRM university, Sikkim; SRMUS/MS/IEC/2018-01, dated February 10, 2018; VCSG Government Institute of Medical Sciences and Research, Pauri Garhwal; IEC/VCSGGMSI&R/2018/027, dated January 18, 2018; Christian Medical College, Vellore; IRB/10648/OBS; April 19, 2017; DMC & H-Ludhiana, Punjab; IRB/DMC & H XX/2017, and Burdwan Medical College, West Bengal; IEC/BMCXX/2017.

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ANNEXURE

List of Co-Investigators

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Web Table I Institution, Taluk and Urban:Rural Population Ratio of Each Site

Site	*Urban: Rural*[a]
Bangalore (Coordinating site)	24:76
Ahmedabad	37:63
Bhopal	89:11
Burdwan	26:74
Erode	46:54
Ludhiana	85:15
Mangaluru	79:21
Rajkot	45:55
Sikkim	53:47
Srinagar	37:63
Vellore	63:37

[a]*As per Census of India, 2011 [8].*

Web Table II Sociological Factors, Treatment and Outcome of Unintentional Injuries

Type of injury, n	*Commonest place where injury occurred*	*Commonest activity of the victim at the time of injury*	*Commonest physical nature of injury*	*Had impairment due to injury*	*Commonest nature of disability*	*Sought Medical attention for injury*	*Commonest Type of facility for medical care*	*Hospitalized at least for one day*	*Treatment received immediately*	*Reached health facility within 1 hrour*	*Affect daily activity*	*Return to usual level of activity*	*Did not borrow money for treatment*
RTI, *n*=304	260 (85.5) Road	140 (46.1) Travelling	160 52.6) Open wound	248 (81.6)	146 (48.0) Difficulty in walking	275 (90.5)	115 (37.8) Private clinic	57 (18.8)	206 (67.8)	217 (71.4)	281 (92.4)	246 (80.9)	223 (73.4)
Falls, *n*=842	427 (50.7) Home	479 (56.9) Leisure/play	259 (30.8) Open wound	630 (74.8)	254 (30.2) Difficulty or unable to use hand or arm	690 (81.9)	289 (34.3) Private clinic	74 (8.8)	603 (71.6)	557 (66.2)	737 (87.5)	652 (77.4)	706 (83.8)
Burn, *n*=103	93 (90.3) Home	52 (50.5) Leisure/play	62 (60.2) Scarring	80 (77.7)	46 (44.7) Difficulty or unable to use hand or arm	89 (86.4)	42 (40.8) Private clinic	12 (11.7)	79 (76.7)	69 (66.9)	89 (86.4)	74 (71.8)	86 (83.5)
Animal-related, *n*=94	47 (50.0) Home	36 (38.3) Leisure/play	47 (50.0) Other open wound	66 (70.2)	31 (32.9) Difficult to walk/walk with limp	86 (91.5)	34 (36.2) Government health center	12 (12.8)	68 (72.3)	75 (79.8)	80 (85.1)	76 (80.9)	82 87.2)
Miscellaneous, *n*=175	98 (56.0) Home	96 (54.9) Leisure/play	73 (41.7) Cut	139 (79.4)	61 (34.9) Difficulty or unable to use hand or arm	156 (89.1)	67 (38.3) Private clinic	20 (11.4)	128 (73.1)	129 (73.7)	155 (88.6)	132 (75.4)	141 (80.6)

All responses in no. (%).