The burden of fatal and non-fatal injury in rural India

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ABSTRACT

Background: Little is known about the burden or causes of injury in rural villages in India.

Objective: To examine injury-related mortality and morbidity in villages in the state of Andhra Pradesh, India.

Methods: A verbal-autopsy-based mortality surveillance study was used to collect mortality data on all ages from residents in 45 villages in 2003–2004. In early 2005, a morbidity survey in adults was carried out using stratified random sampling in 20 villages. Participants were asked about injuries sustained in the preceding 12 months. Both fatal and non-fatal injuries were coded using classification methods derived from ICD-10.

Results: Response rates for the mortality surveillance and morbidity survey were 98% and 81%, respectively. Injury was the second leading cause of death for all ages, responsible for 13% (95% CI 11% to 15%) of all deaths. The leading causes of fatal injury were self-harm (36%), falls (20%), and road traffic crashes (13%). Non-fatal injury was reported by 6.7% of survey participants, with the leading causes of injury being falls (38%), road traffic crashes (25%), and mechanical forces (16.1%). Falls were more common in women, with most (72.3%) attributable to slipping and tripping. Road traffic injuries were sustained mainly by men and were primarily the result of motorcycle crashes (48.8%).

Discussion: Injury is an important contributor to disease burden in rural India. The leading causes of injury—falls, road traffic crashes, and suicides—are all preventable. It is important that effective interventions are developed and implemented to minimize the impact of injury in this region.

Injury is a leading cause of death and disability worldwide,[1] and approximately 90% of the global injury-related deaths occur in low and middle income countries.[2] Injury morbidity and mortality in low and middle income countries such as India is not recognized as a major public health issue by the local authorities because of poor availability of robust data on the injury burden, thereby inhibiting the development of effective preventive strategies.

India is the second most populous country in the world, with most of its population (70%) residing in rural areas.[3] Except for large studies of verbal autopsies in the state of Tamil Nadu,[4 5] published studies describing the burden of injury in India have been limited to either small areas or small sample sizes—for instance, traffic and household injuries in urban slums,[6] verbal autopsies of subsamples of deaths in a locality,[7] cross-sectional study of road traffic injuries presented to a city hospital,[8] geo-coding of small numbers of road traffic crashes,[9] and reports examining only one type of injury (agricultural injuries, traumatic brain injury, and burns).[10–12] As India undergoes rapid epidemiological transition in response to economic and social change, injury will become responsible for a higher burden of death and disability. It is important to understand the extent of this burden in order to instigate an effective response.

The Andhra Pradesh Rural Health Initiative is a collaboration between The Byrraju Foundation (Hyderabad, India), the Centre for Chronic Disease Control (New Delhi, India), the CARE Foundation (Hyderabad, India), and The George Institute for International Health (Sydney, Australia) in the Indian state of Andhra Pradesh. A key component of the initiative is ascertainment of the disease burden so that the most urgently required interventions can be introduced. The aim of this paper is to report on the burden of fatal and non-fatal injury in select rural areas in Andhra Pradesh.

METHODS

A mortality surveillance study and a cross-sectional morbidity survey were conducted in 2003–2005 in the 53 villages of East and West Godavari Districts of the state of Andhra Pradesh participating in a rural development scheme. Of these villages, 45 participated in the mortality surveillance study, 20 in the cross-sectional morbidity survey, and 12 in both. Most of the adults in these villages are engaged in agriculture and aquaculture.

Ethics and consent

Approval for this work was obtained from the ethics committees of the CARE Foundation in India and the University of Sydney in Australia. Most participants provided written informed consent. For participants who could not read or write, the participant information sheet and consent form were explained by the trained interviewer, and a thumb print was taken.

Mortality surveillance study

The mortality surveillance study covering all ages was established in 45 villages (population, 180 162) and was based on a verbal-autopsy method that was incorporated into the primary healthcare system. As reliable cause-of-death statistics were not available for these villages, we used a verbal-autopsy-based mortality surveillance system. Verbal-autopsy methods have been widely used in mortality studies[13–15] and remain the foundation of mortality surveillance systems in developing countries.

Methods for the mortality surveillance system used in this study have been previously described.[16]

Table 1 Causes of fatal injury for all ages by sex in select rural areas of Andhra Pradesh, 2003–2004

Cause of death	Total	Male	Female	p Value
Intentional self-harm	36.8 (29.6 to 44.0)	35.8 (26.8 to 44.8)	38.5 (26.7 to 50.3)	0.96
Fall	20.1 (14.1 to 26.1)	18.3 (11.0 to 25.6)	23.1 (12.9 to 33.3)	0.49
Road traffic injury	13.2 (8.2 to 18.2)	17.4 (10.3 to 24.5)	6.2 (0.3 to 12.1)	0.03
Accidental drowning	8.6 (4.4 to 12.8)	5.5 (1.2 to 9.8)	13.8 (5.4 to 22.2)	0.11
Contact with venomous animals and plants	6.3 (2.7 to 9.9)	9.2 (3.8 to 14.6)	1.5 (−1.5 to 4.5)	0.04
Exposure to smoke, fire and flame	4 (1.1 to 6.9)	0.9 (−0.9 to 2.7)	9.2 (2.2 to 16.2)	0.01
Assault	2.9 (0.4 to 5.4)	1.8 (−0.7 to 4.3)	4.6 (−0.5 to 9.7)	0.37
Exposure to electric current	2.9 (0.4 to 5.4)	4.6 (0.7 to 8.5)	0 (0)	0.08
Accidental poisoning	1.1 (−0.4 to 2.6)	1.8 (−0.7 to 4.3)	0 (0)	1
Exposure to animate mechanical forces	0.6 (−0.5 to 1.7)	0.9 (−0.9 to 2.7)	0 (0)	1
Other unspecified injury	3.4 (0.7 to 6.1)	3.7 (0.2 to 7.2)	3.1 (−1.1 to 7.3)	1
Total	100	100	100	0.01

Values are percentage (95% CI).

Trained multipurpose primary healthcare workers identified all deaths in their respective villages, and interviewed a close relative of the deceased using a verbal-autopsy questionnaire. The questionnaire (forms A–C), based on the tools developed for the Registrar General of India's Sample Registration System,[3] comprised a series of structured questions and an open narrative section where details of the circumstances leading to death were collected from the close relative of the deceased. This included specific information about the type and cause of injury for deaths resulting from injury. Two independent trained and experienced doctors reviewed each questionnaire to assign a cause of death, using pre-defined algorithms derived from the International Classification of Diseases 10th Revision (ICD-10). Disagreements were resolved by a third doctor.

The verbal-autopsy method was validated by identifying all deaths that took place in a hospital in the same rural area over 1 year (January–December 2004).[16] Data were collected from the hospital medical records, and an underlying cause for these hospital deaths was assigned by a doctor trained in ICD-10 coding (''gold standard'' cause of death). Independent verbal autopsies were conducted for these deaths, and the verbal autopsies were analysed using the same methods as the mortality surveillance study, described above. The causes of death assigned using the verbal autopsies were compared against the gold standard cause of death assigned using the hospital medical records. This was carried out by one of the authors (RJ).

Morbidity survey

The interviewer-administered cross-sectional survey was conducted as part of a comprehensive baseline adult population survey of non-communicable conditions between February and April 2005. Sampling was conducted using a two-stage stratified random-sample approach. From the 53 participating villages, 10 pairs of comparable villages comprising 36 068 residents were randomly selected and stratified by population size and distance from a major urban centre (a proxy for remoteness). People aged 30 years and above were then sampled at random (using computer-generated random numbers) in age–sex strata from the registered adult population of each of the 20 villages. In the survey population, the average household size was four people, 52.7% were illiterate, and the mean monthly household income was US$51 (range $23–55).

Trained social workers administered a structured 10 min injury questionnaire to those who responded yes to the screening question: ''During the past 12 months have you been hurt in any way which required you to seek medical attention, or to stay away from work or study for at least 1 day?'' Injuries that did not limit ability to perform usual duties for at least 1 day were not included in the study. The questionnaire sought information on sociodemographic variables (including age, education level, household income, and occupation) with questions based on previous Indian government and non-government administrative processes.[17] The injury questionnaire covered characteristics of the injuries sustained in the preceding 12 months: number of injuries, severity, type of injury, place where the injury occurred, and intent (accidental versus intentional). These were designed on the basis of the ICD-10 criteria[18] and WHO injury surveillance guidelines,[19] with various questions adapted to suit the cultural context. Injury severity was defined in terms of the number of days the subject was unfit to perform usual activities—that is, an injury that resulted in 1 day of work being missed was defined as mild, a moderate injury required hospitalization for 2–9 days, major injury required hospitalization for 10 or more days, and severe injury resulted in permanent disability.

Analysis of fatal injury

This analysis is based on the first year of the mortality surveillance study which was undertaken from 1 October 2003 to 30 September 2004. The proportion of injury-related deaths was calculated by dividing the number of injury-related deaths by the total number of deaths for which a verbal autopsy was performed, and these results were expressed as percentages with 95% CIs. The age and sex distributions of fatal injury were calculated, with differences assessed by χ^2 test. The validity of the cause-of-death assignment process was confirmed by comparing for a subset of deaths the verbal-autopsy diagnosis with a reference gold standard diagnosis made using hospital medical records. Measures of sensitivity, specificity, and positive predictive value were thus calculated. Mortality analyses were conducted using SPSS V12.

Analysis of non-fatal injury

We produced non-fatal injury incidence estimates for each age and sex group within the adult population (aged 30 years and above) from the morbidity survey using weights based on the

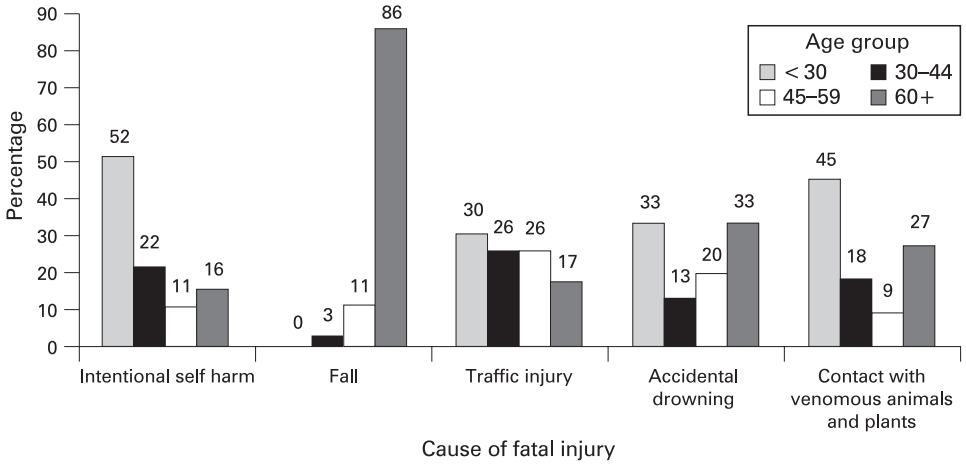


Figure 1 Age distribution of fatal injury for each leading cause for all ages in select rural areas of Andhra Pradesh, 2003–2004.

recent census figures for the 20 participating villages included in the survey. We applied an intracluster correlation coefficient of 0.01 to estimate the design effect based on another South Asian study of similar design.[20] Groups were compared using t tests for continuous data and χ^2 tests for categorical data as appropriate. Survey analyses were performed using Stata V8.0 statistical software, with adjustment for the effects of clustering.

RESULTS

Fatal injury

In the first year of surveillance (1 October 2003 to 30 September 2004), 1354 deaths were recorded, for which 1329 (98%) verbal-autopsy interviews were completed. Chronic disease and injuries were the leading causes of death, with cardiovascular disease contributing to a third of all deaths.[16] Injury was the second leading cause of death and was responsible for 13% of all deaths (95% CI 11% to 15%). The mean age of the people who died from an injury was 47 years. Injuries were responsible for more deaths among men than women ($p = 0.01$), and about 64% of all deaths from injury occurred below the age of 60 years.

Intentional self-harm was responsible for 36% of all injury-related deaths followed by falls (20%) and road traffic injury (13%) (table 1). Most (29; 45.3%) of the deaths from intentional self-harm were attributed to poisoning, with 11 (17.2%) poisoning deaths caused by intake of pesticide or insecticide. The next most common means of intentional self-harm causing death were hanging (10; 15.6%) and self-immolation (3; 4.7%). Men were significantly ($p = 0.03$) more likely than women to die as a result of road traffic injuries or contact with venomous animals and plants, whereas women were significantly ($p = 0.04$) more likely than men to die after exposure to smoke, fire, or flame. No other gender differences were observed (table 1). Most (75%) of the intentional self-harm occurred in the age group 15–44 years, and 86% of all fatal falls occurred in people aged over 60 years (fig 1). Validation of the cause of death for various injuries yielded a sensitivity of 100%, specificity of 98%, and positive predictive value of 78%.

Non-fatal injury

Of 5627 people aged 30 years and above invited to attend the morbidity survey, 4535 (80.6%) agreed to participate, gave informed consent, and presented for interview. About half (50.5%) of survey respondents were male. The mean age of those who reported an injury in the preceding 12 months was 46 years, and about a half were illiterate.

Of the 4535 participants, 304 (6.7%) had sustained an injury in the past 12 months that required them to seek medical attention, or to stay away from work or study for at least 1 day. Most reported injuries (96.5%) were unintentional. The five leading causes of non-fatal injury among adults were falls, road traffic crashes, mechanical forces, animal bites, and other (table 2). Included under ''other'' were assaults, bull attacks, contact with venomous plants and animals, and unclassified. Women were significantly more likely to experience falls than men, and falls mainly occurred in the home, with tripping and slipping being the leading mechanisms (72.3%). Likewise, women were significantly more likely than men to sustain an injury from exposure to electricity. Non-fatal road traffic injuries were far more common among men than women and predominantly involved motorcycles (48.8%), bicycles (21.3%), and pedestrians (13.7%). Non-fatal injuries caused by

Table 2 Causes of non-fatal injury for adults by sex in select rural areas of Andhra Pradesh, 2004–2005

Cause of injury	Total*	Male	Female	p Value
Falls	38.8 (36.9 to 40.8)	21.1 (18.7 to 23.6)	52.9 (50.2 to 55.7)	<0.0001
Road traffic	25.5 (23.8 to 27.3)	39.7 (36.8 to 42.6)	12.1 (10.4 to 14.0)	<0.0001
Mechanical forces	16.4 (15.0 to 18.0)	17.7 (15.5 to 20.1)	14.7 (12.8 to 16.8)	0.28
Bites	8.5 (7.5 to 9.7)	5.7 (4.5 to 7.3)	10.7 (9.1 to 12.5)	0.32
Poisoning	2.1 (1.5 to 2.7)	4.3 (3.2 to 5.7)	–	0.02
Contact with heat	1 (0.6 to 1.5)	0.97 (0.5 to 1.7)	1.2 (0.7 to 1.9)	0.94
Exposure to electricity	1 (0.6 to 1.3)	0.09 (0.02 to 0.5)	1.8 (1.1 to 2.7)	0.013
Smoke, fire or flames	0.3 (0.1 to 0.6)	0.5 (0.2 to 1.2)	–	0.25
Other	6.3 (5.3 to 7.3)	9.9 (8.2 to 11.8)	6.7 (5.4 to 8.2)	0.33

Values are percentage (95% CI).
*Weighted estimates; difference in gender distribution (column %).

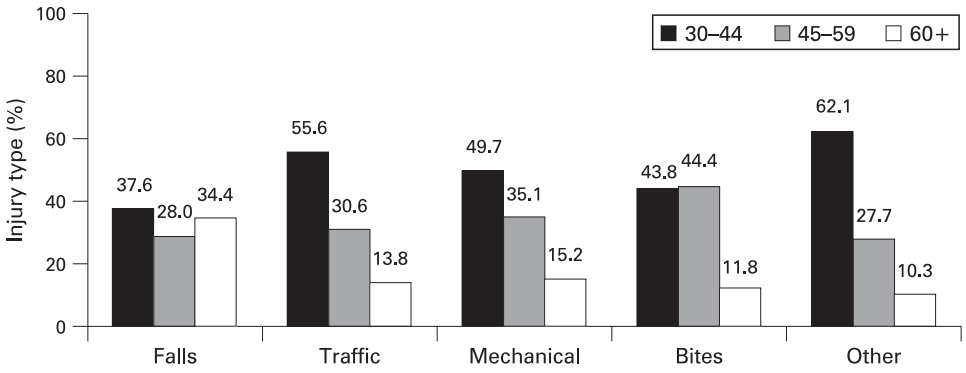


Figure 2 Age distribution of non-fatal injury for each leading cause for adults in select rural areas of Andhra Pradesh, 2004–2005.

mechanical forces were mostly accidental events such as piercing with glass or a knife (38.2%), struck by falling objects (16.6%), and caught by hand tools (4.1%) and machinery (2.7%). About a third of the injuries caused by mechanical forces (29.5%) were the result of lacerations and cuts by trees, household items, and animal attacks (other than bites). Falls were common across all age categories, but road traffic injuries and mechanical injuries were more common in younger age groups (fig 2).

Most reported injuries were mild (63.9%), and the numbers of injuries decreased with increasing severity (moderate, 18.4%; major, 14.6%; severe leading to permanent disability, 3%). Mild injuries were more common among women across all age groups (range 68.3–81.2%), and men under 50 years were more likely to sustain moderate (range 17.5–30.2%) to major (range 17.5–25.3%) injuries. Place of injury was the home for 38.6%, the road for 30.5%, the workplace for 27.4%, and "other places" for 3.5%. The occupational group most often affected by injury was unskilled manual workers (54.1%) followed by housewives (25.5%). Those who reported road traffic injuries were mainly male (85.2%); the male to female relative risk was 4.2 for non-fatal road traffic injuries and 0.28 for household injuries.

DISCUSSION

To our knowledge, this is the first comprehensive attempt to gather population-wide injury data for rural areas of the Indian state of Andhra Pradesh. The mortality surveillance study covered all ages in 45 villages over 1 year, and the cross-sectional morbidity survey reached 80.6% of adults aged 30 years and above in 20 villages the following year. These results therefore give a reasonable estimation of the burden of injury in these rural areas.

We found that 13% of all deaths in the last 12 months were due to injury. Most of the injury-related deaths, such as intentional self-harm, road traffic injuries, and drowning, occurred in the most economically productive age groups. The economic impact of such deaths has been shown to be substantial in other settings,[21] and these results highlight the need for urgent intervention.

Intentional self-harm, falls, and road traffic injury were found to be the leading causes of injury-related death. The high proportion of deaths from intentional self-harm confirms results from previous studies in India,[4 22] and possibly highlights the unmet burden of depression in the population.[23–25] The finding that ingestion of pesticides and insecticides for self-poisoning was the most common suicide method is not surprising. This population is largely rural, with agriculture as the main occupation. Therefore, there is easy access to agricultural chemicals, and these are a readily available method of suicide. As it would be difficult to restrict access to chemicals in such a context, further understanding of other suitable approaches is needed to reduce deaths caused by intentional self-harm as well those caused by unintentional poisoning.[26] The excess female mortality from burns reported in this study is similar to the findings of other studies conducted in India.[12 27 28]

These findings on fatal injury are based on a verbal-autopsy-based mortality surveillance system, which has known limitations, as it depends on the recall of the respondent, the skill of the interviewer, the questionnaire used, and the process of coding the cause of death. We aimed to minimize these errors by using validated questionnaires and pre-defined algorithms for coding causes of death, and by training and supervising interviewers. Furthermore, our validation study to compare the verbal-autopsy diagnoses with diagnoses based on comprehensive hospital records provided substantial reassurance about the reliability of these findings.

We found that 6.7% of adult survey respondents had sustained a non-fatal injury during the preceding 12 months that required them to seek medical attention, or to stay away from work or study for at least 1 day. This prevalence is lower than that reported from an urban population in India,[7] but differences in sampling frames, environmental setting, and methodologies between studies may account for this. We recognize that a population survey excluding the most severe injuries due to non-attendance to the survey site can contribute to underestimation. Our interviewers visited the homes of eligible adults who had consented to participate but did not present for an interview on the day of the survey. None of these eligible respondents who had failed to participate had severe injuries, and hence it is unlikely that our survey underestimated severe injuries. Usually the non-participants were away from home or at work on the day of data collection or refused to participate because of the requirement for a blood sample for the detection of diabetes. We cannot comment on underestimation of non-fatal injuries in the non-participants that required them to seek medical attention, or to stay away from work or study for at least 1 day. Underestimation is probably due to recall bias, particularly if the injury sustained was not moderately or extremely severe and had occurred more than 3 months before the interview.[29 30]

The overall injury profile, with falls and road traffic injury as the leading causes of injury, is consistent with that reported in the National Injury Survey of Pakistan, in which 36% of non-fatal injuries were due to road traffic crashes and 23% to falls.[31] Our survey did not include young people and that may explain why road traffic injuries were the second leading cause of non-fatal injury in our population. In this study, non-fatal road traffic injury occurred mainly among young men. The male

predominance of road traffic injuries was consistent with previously reported studies from India.[8 32]

Falls were a significant cause of both death and injury in women. Falls in older people are known to be a major cause of injury in high income countries[33] and have previously been reported in India,[34] and indeed there were high falls rates in older women in this study. However, there were also high rates of falls in younger age groups in this study, which may indicate the high level of risk encountered by women in rural India as they go about their usual household and agricultural tasks. However, we were unable to explore this in further detail, and a second study is underway to elicit more detail about circumstances of falls in women in this population. Although previous studies have indicated a potential misclassification between fatal stroke-related and injury-related falls among older people, our validation study indicated that only one fatal stroke was misclassified as a fall by the verbal autopsy (unpublished data).

Drowning and contact with venomous plants and animals were identified as significant causes of death, but were not often reported in the morbidity survey, highlighting the severe consequences of these injuries. Over half (58%) of the non-fatal injuries from mechanical forces in our study happened in the workplace, reflecting the poor standards of occupational health and safety in the region. These results are comparable to a previous study of agricultural workers from Central India, where 77.6% of all incidents were reported to be due to farm machinery, 11.8% were due to hand tools, and 10.6% were due to other sources such as snakes and wells.[30]

Although survey participants were selected using stratified random sampling, and the response rate was high, we are unaware of the injury status of selected residents who did not participate. Furthermore, as our main study targeted non-communicable diseases, we only interviewed adults aged 30 years and above about injuries. This precludes a full profile of non-fatal injury in younger age groups.

Cultural reasons prevented us from specifically addressing the issue of assault or self-harm in our survey, and these two circumstances were aggregated within the "other injuries" category. It was also impossible to ascertain whether respondents were under-reporting non-accidental injuries because of social stigma or fear of consequences in their local social circle. A different study type exploring qualitative aspects and offering support services is required to ascertain the extent and nature of this problem in the rural area.

Key points

- Injury was found to be the second leading cause of death after cardiovascular diseases and was responsible for 13% of all deaths.
- The leading cause of injury-related death was intentional self-harm, followed by falls and road traffic injury.
- The morbidity survey found that 6.7% of people aged 30 years and over had been injured one or more times in the preceding 12 months; most injuries were mild.
- The leading causes of non-fatal injuries were falls followed by road traffic crashes, mechanical forces, animal bites, and other.
- Injury was found to be an important cause of death and disability, and the most common injuries occurring in rural Andhra Pradesh are preventable.

Injury surveillance is recognized as a key step for identifying, monitoring, and preventing injuries and their risk factors in both developing and industrialized countries.[19 35–38] As India currently does not have a national injury prevention program, most injury prevention is the responsibility of police, transport, and legal sectors with no involvement of the health sector in primary prevention.[39 40]

From the results of our study, we conclude that the burden of injury is significant in rural Andhra Pradesh, probably reflecting the epidemiological transition India is undergoing. Although this study may have some limitations, the data presented here are recent and directly relevant, as they are not derived from extrapolations from other geographic regions.

This study highlights the urgent need for implementation of programs and policies aimed at reducing the burden of injury in rural India. Future interventions to reduce injury should include policy initiatives to develop community-based programs to reduce intentional self-harm and explore options to decrease access to poisons, increase use of motorcycle helmets, occupational health and safety measures, and interventions to reduce falls in the home and drowning. As interventions vary across regions and socioeconomic groups, further qualitative and quantitative work is needed to inform development of context-specific interventions and policies to reduce burden of injury in rural areas in India.

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