1. Introduction

Review of literature
1.1 Injury definition

The World Health Organization (WHO) defines injury as "a bodily lesion at the organic level, resulting from acute exposure to energy (mechanical, thermal, electrical, chemical or radiant) in amounts that exceed the threshold of physiological tolerance. In some cases (e.g. drowning, and strangulation), the injury results from an insufficiency of a vital element". \(^{(1)}\)

Injuries are classified according to human intent of causing harm. The term unintentional injury implies accidental injuries, whilst intentional injuries imply deliberate harm. Intentional injuries are further subcategorized as interpersonal (e.g. assault and homicide), self-harm (e.g. abuse of drugs and alcohol, self-mutilation, suicide), legal intervention (e.g. action by police or other law enforcement personnel) or as arising from war, civil insurrection and disturbances (e.g. demonstrations and riots). A final category of injury is injuries arising out of undetermined intent. \(^{(2)}\)

Unintentional injuries may be classified based on the mechanism leading to the injury that is, road traffic injuries, poisoning, falls, burns, drowning and other unintentional injuries. The latter category includes, for example, exposure to animate and inanimate mechanical forces; exposure to electric current, radiation and extreme ambient temperature and pressure, and to forces of nature. \(^{(1)}\)

1.2 Statement of the problem

The Global Burden of Disease estimates that injury accounted for 12.3% of the total burden of disease and for 9.8% of the world's deaths in 2004. Unintentional injuries constituted 67% of all injury deaths and 74 % of injury Disability Adjusted Life Years (DALYs) (i.e. nearly four million deaths in 2004). The Global Burden of Disease reports that the share of unintentional injuries amongst the total burden of diseases is increasing rapidly. For example, the rank of road traffic injuries as the
main contributor towards burden of unintentional injuries is estimated to increase from 9 to 3 between the years 2004 to 2030.\(^{(3)}\)

Low and Middle Income Countries (LMICs) are disproportionately affected by the burden of unintentional injuries and account for more than 90% of unintentional injury deaths and DALYs lost, which is responsible for 7% and 8% of total deaths and DALYs respectively in these countries. Injury death rates per 100,000 population are higher in LMICs (62 per 100,000) than globally (57 per 100,000). \(^{(4)}\) Unintentional injuries have a significant adverse impact on economic status of LMICs. The burden of road traffic injuries alone is estimated to be 1.5 to 2% of total Gross National Products (GNP) in these countries. \(^{(20)}\)

In India, the precise number of deaths or any scientific estimates of injury deaths are not available from any single source due to scarcity of knowledge about injury. \(^{(9)}\) The available reports from vital registration system or reports by the National Crime Records Bureau (NCRB) or police suffer from severe under-reporting and consider only severe cases of injuries that result in either death or hospitalization. Most of the available literature is hospital based and those which are population-based are mostly concerned with a specific type of injury like road traffic injuries \(^{(21-32)}\), alcohol use \(^{(33)}\), etc. A bibliographic search on published data from India shows two population based studies which cover all types of injuries. A study on causes of death in rural India using verbal autopsy revealed that 13% of the total deaths were due to injury and external causes. \(^{(10)}\) An epidemiological survey of injuries in the Municipal Corporation of Delhi (sample size 30,554) estimated that the annual incidence rate of unintentional injuries was 109.6 per 1000 population and the annual incidence rate of major unintentional injuries was 71.1 per 1000 population. \(^{(11)}\)

**1.3 Relevance of the Study**

Over the last few decades, better understanding of the etiology of injuries has shown that death and disability from injuries can be largely prevented. The experience of
developed countries in reducing the burden of injuries as a result of systematic study of injury and applying this knowledge for the prevention and control of injuries is the best evidential proof of this statement.

In India, injuries have been traditionally regarded as random, unavoidable accidents. The scarcity of data on magnitude of unintentional injuries results in lack of injury prevention and control in national or regional health planning in India. Insufficiency of information on the pattern of unintentional injuries and lack of authentic studies providing information on the etiology of unintentional injuries in India are the main obstacles towards designing injury prevention and control plans. Thus, a population based cross sectional study was conducted amongst 2100 households randomly selected by using multistage cluster random sampling, from the 14 administrative wards of Pune city. Data on magnitude, pattern and risk factors for unintentional injuries in Pune city was collected between March 2007 and February 2008.

1.4 Objectives

1- To assess the burden of unintentional injuries in Pune city.
2- To determine the pattern of unintentional injuries amongst socio-demographic strata in Pune city.
3- To identify risk factors associated with unintentional injuries in Pune city.

1.4.1 Specific Objectives:

1.1- To measure incidence of unintentional injuries in Pune city

1.2- To determine the burden of unintentional injuries on private and public medical services in terms of utilization.

1.3- To assess the burden of unintentional injuries on families in terms of absenteeism from school or employment or any productive activity and direct cost of treatment.

2.1- To measure the distribution of direct mechanism leading to injuries
2.2- To measure the magnitude and type specific distribution of unintentional injuries among different demographic and socioeconomic strata.

3.1- To assess the demographic and socioeconomic risk factors for incidence of unintentional injuries.

1.5 Utility of this study

The findings of this study can be utilized in a number of ways:

- As a reliable source for control and prevention at local and national level and for designing a surveillance system with identification of minimum data sets, required specifically for Indian situations
- Identifying at-risk groups
- Creating public awareness and sensitizing health and other sectors involved in prevention strategy
- For establishing baselines to monitor and evaluate preventative measures
- To plan strategies for improved reporting mechanisms and development of common definitions for the causes and nature of injuries.
Diagram of content organization of the review:

2.1 Injuries
- Definition of injury, epidemiological triad of injuries

2.2 Burden
- Global burden of injuries
- Burden of injuries in LMICs
- Burden of injuries by mechanism

2.3 Pattern
- Burden of injuries in India
- Burden of injuries in Pune
- Mechanism, nature, site and place of injuries, activity at the time of injuries, time of injuries

2.4 Risk factors
- Factors considered includes: Age, Gender, Marital status, Type of family, Socioeconomic status, Occupation, Education, Religion and ethnicity, Mother education and age, Alcohol use/use disorder, Visual impairment, Disability, Number of individuals at home, Risk factors for type specific injuries like RTI, fall burn, poisoning, drowning, occupational injuries, sport related injuries

2.5 Methodology
- Methodology used for population based studies on injury in some of developing countries (Vietnam, Ghana, Tanzania, Brazil, Uganda, Pakistan, and India) was reviewed.
2.1 Injuries

2.1.1 Definition

The origin of the term "injury" lies in the Latin phrase "in+jus", which means "not right". The WHO defines injury as "a bodily lesion at the organic level, resulting from acute exposure to energy (mechanical, thermal, electrical, chemical or radiant) in amounts that exceed the threshold of physiological tolerance. In some cases (e.g. drowning, strangulation), the injury results from an insufficiency of a vital element". However, this is not a widely accepted definition amongst scientists. A theoretical definition of injury is difficult because the distinction between disease and injury is sometimes unclear. For example, the result of a brief exposure to toxic gas is often called injury whereas the eventual pulmonary effect of chronic exposures to low concentrations of the same gas may be called disease. Also, in this definition, only physical damage to the body is taken into consideration and mental trauma has not been defined or included.

Injuries may be categorized in a number of ways. Intent of injury, which is the role of human purpose, is the first criteria in the classification of injuries due to its importance for analytical purposes and in identifying interventional opportunities. The WHO classifies injuries according to the intent or human purpose in occurrence of events leading to unintentional injuries and intentional injuries. Intentional injuries may be further subcategorized as interpersonal (e.g. assault and homicide), self-harm (e.g. abuse of drugs and alcohol, self-mutilation, suicide), legal intervention (e.g. action by police or other law enforcement personnel) or as arising from war, civil insurrection and disturbances (e.g. demonstrations and riots). A final category of injury is injuries arising out of undetermined intent.

Unintentional injuries are classified occurring to the mechanism leading to the injury and the categories are:

- Road traffic injuries
- Poisoning
Review of literature

- Falls
- Burns
- Drowning
- Other unintentional injuries

The latter category includes any injury which is not included in the above categories, for example, exposure to electric current, radiation, etc. (1) Sometimes the word "accident" is used synonymously with the term "unintentional injuries". However a distinction has been made between the term "accident" and "unintentional injuries". The former implies a random or chance event and therefore unpredictable. (36) In contrast the latter term implies predictability, suggesting methods of prevention. Thus the term injury has been consistently used in this thesis.

2.1.2 Epidemiology of injuries

William Haddon in 1968 proposed an analytical matrix (Table 1) to examine the interplay between the environmental, host and agent factors over time in order to better understand the etiology of injuries. (37)

Table 1: Haddon's Matrix

<table>
<thead>
<tr>
<th></th>
<th>Human (or host)</th>
<th>Vector</th>
<th>Physical environment</th>
<th>Socio-economic environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-event</td>
<td>Is host pre-disposed or overexposed to risk?</td>
<td>Is vector hazardous?</td>
<td>Is environment hazardous? Does it have hazard-reduction features?</td>
<td>Does environment encourage or discourage risk-taking and hazard?</td>
</tr>
<tr>
<td>Event</td>
<td>Is host able to tolerate force or energy transfer?</td>
<td>Does vector provide protection?</td>
<td>Does environment contribute to injury during event?</td>
<td>Does environment contribute to injury during event?</td>
</tr>
<tr>
<td>Post-event</td>
<td>How severe is the trauma or harm?</td>
<td>Does vector contribute to the trauma?</td>
<td>Does environment add to the trauma after the event?</td>
<td>Does environment contribute to recovery?</td>
</tr>
</tbody>
</table>

(Source: Holder et al. Injury Surveillance Guidelines, 2001) (2)
This approach provides opportunities for primary, secondary and tertiary prevention. Primary prevention is any measure to reduce the chance of occurrence of injury like putting protective barriers around fires. Secondary intervention which involves early diagnosis and management of an injury like applying basic first aid at the scene of an incident to stop an injury from having more serious consequences. Tertiary intervention, for example, would imply proper functioning of the trauma care system in order to reduce the chances of disability and death, thereby, improving the final outcome. \(^{(2)}\)

Based on Haddon’s approach, an etiological model for injury was described by Rivara \(^{(38)}\) (Figure 1). The model suggested three broad areas of etiological research. Firstly, approaches from epidemiology, psychology and sociology could be used to understand the risk and protective factors for injury. Biochemical studies, for example, would lead to better understanding of human tolerance of damage in injury, whilst basic research into the pathophysiology of trauma and healing would lead to better clinical management. Rivara proposed that the interaction from such studies could be used for guiding interventions such as primary prevention programs, product and environmental design changes or clinical trial for preventing injuries.

Figure 1: Model of injury research

<table>
<thead>
<tr>
<th>Etiologic research</th>
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<tbody>
<tr>
<td><strong>Epidemiology</strong></td>
</tr>
<tr>
<td>Psychology, sociology</td>
</tr>
<tr>
<td><strong>Biomechanics</strong></td>
</tr>
<tr>
<td><strong>Basic science</strong></td>
</tr>
<tr>
<td>Causes of injury</td>
</tr>
<tr>
<td>Risk and protective factors</td>
</tr>
<tr>
<td>Human tolerance for damage</td>
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<tr>
<td>Pathophysiology of trauma and healing</td>
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</tbody>
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<tr>
<th>Interventions</th>
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<tbody>
<tr>
<td><strong>Prevention programs</strong></td>
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<tr>
<td>Product and environmental design</td>
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<tr>
<td>Clinical trials</td>
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</tbody>
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<table>
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<tr>
<th>Outcomes</th>
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<tbody>
<tr>
<td>Injury rate and severity</td>
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<tr>
<td>Cost effectiveness</td>
</tr>
<tr>
<td>Quality of care</td>
</tr>
<tr>
<td>Health-related quality of life</td>
</tr>
</tbody>
</table>

(Source: Rivera, Prevention of injuries to children and adolescents .2002) \(^{(38)}\)
The opportunity for prevention and control of injuries after systematic investigation of the epidemiology and etiology of injury event is apparent from the dramatic decrease in almost all causes of injury death in developed nations. For example (Figure 2) demonstrates that whilst road traffic fatality rate decreased by 10% in developed nations, during the same period, road traffic fatality increased by 30% in developing nations. (20)

Figure 2: Global road fatality trends

In the United States of America (USA), the overall injury death rate has been decreasing since 1970, with the majority decline occurring among unintentional injuries. (39) Projections predict that road traffic deaths would decline by about 30% in high-income countries (HICs) but increase substantially in (LMICs) between 2000 and 2020. (40) Philippakis et al. (41) in an ecological study of cause specific unintentional childhood injury mortality rate reported that unintentional childhood injury mortality rate declined by 3.5% per year during the period 1989–98 in the United States. Edwards et al. (42) have reported that there was a decline in annual
injury mortality rate amongst children in the age group 0-15 years from 11.1 deaths (95% CI 10.8 to 11.5 deaths) per 100,000 children in 1981 to 4.0 deaths (95% CI 3.8 to 4.2 deaths) per 100,000 children, according to the 2001 census in England and Wales.

2.2 Burden of injuries

Figure 3: Global injury-related mortality

Global Injury-related Mortality


2.2.1 Global burden of injuries

The best estimate of injuries available at the present time comes from the Global Burden of Disease. (2) The Global Burden of Disease bases its estimate on reports submitted by each country in standardize reporting format. The Global Burden of
Disease estimates that injury (intentional and unintentional) was responsible for 12.3% of total DALYs corresponding to 187,614 thousand DALYs and 9.8% of all deaths corresponding to 5,784 thousand deaths in 2004. It projects a 28% increase in global deaths due to injury between 2004 and 2030, predominantly due to the increasing number of road traffic injuries.

Globally, injuries accounted for 17% of the disease burden in adults aged 15–59 years in 2004. (3) Young people between the ages of 15 and 44 years accounted for almost 50% of the world’s injury-related mortality. (6) Injury mortality among men was nearly twice that among women. Injuries were responsible for 12.3% of total death amongst males and 7.1% of total death amongst females. Injuries accounted for 17% of the disease burden in adults aged 15–59 years in 2004. (3) Unintentional injuries were the 6th leading cause of death with a share of 5.0% of total deaths amongst females and 8.1% of deaths amongst males.

Injuries impact a high economic burden. Corso et al. (43) in their study on incidence and lifetime costs of injuries in the United States showed that 50 million Americans experienced a medically treated injury in 2000, resulting in lifetime costs of $406 billion; $80 billion for medical treatment and $326 billion for lost productivity. The economic burden of injury is great but hidden, considering the indirect economic costs of productive work lost of injured and when one or more family members are forced to leave work to care for a disabled family member or relative, and costs associated with premature death and disability. Countless hours of productivity are lost as family, friends and society adapt to the death or disability of loved ones. (44)

2.2.2 Burden of injuries in LMICs

LMICs suffer from an enormous burden of preventable injuries resulting in reduced life expectancy and quality of life. Injuries are overlooked although the long-term disabilities that arise as a consequence of injuries may represent a significant burden. (45)

The number of annual deaths and DALYs lost in LMICs were estimated to be ten times higher than those of HICs (4,715,000 versus 471,000 Deaths and 155,850,000
versus 11,244,000 DALYs). Norton et al. estimated a higher injury related mortality rate in LMICs (62 per 100,000) compared to the global injury mortality rate (57 per 100,000). Such a disproportionate burden of injuries in LMICs is due to a significant disparity in the mortality rates for injured patients. For example, in a study of the mortality rates of all seriously injured adults in three cities of countries at different economic levels, it was found that the mortality rate (including both pre-hospital and in-hospital deaths) was 35% in a high-income setting, 55% in a middle-income setting and 63% in a low-income setting. In another study, a six-fold increase in mortality for injuries with moderate severity was observed from high to Low Income Countries (LIC) (6% amongst hospital admissions in a high-income country to 36% in a rural area of a low-income country).

In Uganda, injury mortality rate was as high as 92/100,000 persons, and disabilities had a prevalence of 0.7% in rural areas and 2.8% in urban areas. Intentional injuries comprised 21% fatal injuries, 2% disabling injuries and 12% recovered injuries. In a study on causes of death in rural Iran, it was shown that injuries were responsible for 16.6% of all deaths in a total population of 11.3 million. Unintentional non-fatal injuries were an important health problem in rural Vietnam. The high incidence rate of 89/1000 per year reflected almost one tenth of the population being injured every year. The increasing burden of injuries is reflected from data in Taiwan, where the number of deaths due to injury among adolescents aged 10–19 years increased 81% from 983 in 1965 to 1783 in 1994.

2.2.3 Road traffic injuries

According to the Global Burden of Disease estimate, road traffic injuries were the second major cause of death in the age group of 5 to 29 years, the third major cause of death in the age group of 30 to 44 years and the 9th leading cause of death amongst all age groups. Road traffic injuries accounted for 33% of all unintentional injury mortality with 1.2 million deaths globally due to road traffic injuries. The World Report on Road Traffic Prevention estimates that the number of injured could be as high as 50 million and these figures would increase by about 65% over the next
20 years in absence of any intervention. The global cost of road traffic injuries is estimated to be $500 billion.

The International Road Traffic and Accident Database revealed that 90% of the burden of road traffic injury was borne by LMICs. In 2001 road traffic injuries accounted for 34% of unintentional injuries and 28% of DALYs from unintentional injuries in LMICs. In African and Asian countries, despite relatively low vehicle densities, the number of fatalities per 10,000 vehicles was higher than the industrialized European and North American states. The WHO estimated the risk of road traffic injuries for people living in LMICs as being 1.5 times than that of people in HICs. The rate of road traffic injuries in Nigeria showed a fivefold increase and in Kenya there was a fourfold increase in traffic-related fatalities over the last 30 years. In Viet Nam, road traffic injuries mortality increased five times over the last ten years. This increase has been projected to continue in LMICs and decline in High Income Countries (HICs) over the next two decades. Norton et al. reported that the average annual cost of road crashes was equivalent to about 1.0 percent of the gross national product in developing countries, 1.5 percent in transition countries and 2.0 percent in highly motorized countries. The annual burden of road crash costs was about US$500 billion globally and about US$65 billion in LMICs. A comprehensive review of epidemiological studies on road traffic injuries in developing countries showed that traffic-related injuries accounted for between 30 and 86% of all trauma admissions in developing countries with the overall mean length of stay of 20 days.

The Global Burden of Disease report showed that road traffic injuries contributed to 41.2% of the share of total deaths and 31.4% of total DALYs in SEA region. Researches revealed that the burden of road traffic injuries were mainly on pedestrians, bicyclists and motorized two-wheeled vehicle riders in the SEA region.
2.2.4 Fall-related injuries

According to Global Burden of Disease, falls were responsible for 6% of the total global injury mortality in 2000, with an estimated 283,000 deaths. A quarter of all fatal falls occurred in the high-income countries. In all regions of the world, adults over the age of 70 years, particularly females, had significantly higher fall-related mortality rates than younger persons. Children less than 15 years of age experienced nearly half of the total number of DALYs lost due to falls. Falls were responsible for 39,000 deaths and 5,085,000 DALYs lost in SEA region. Falls were responsible for the largest number of hospital visits for non-fatal injuries, especially for children and young adults, in many countries of the SEA region. Mohan and Varghese (2002) predicted that as life expectancy increased in these countries, the incidence of hip and other fractures due to falls among the elderly were likely to assume greater proportions.

2.2.5 Burns

Globally, burns often rank as a major source of morbidity and mortality after road traffic injuries and falls globally. Fire-related burns were responsible for 31,000 deaths or 0.5% of all deaths in 2004 and 11,271,000 DALYs lost. Children and young persons under the age of 44 years accounted for the highest proportion of global mortality due to fire-related burns. Global Burden of Disease estimated that more than 95% of fatal fire-related burns occurred in LMICs. In a hospital based study in Uganda, burns were shown to be the second leading reason for hospitalization and accounted for 61% of injuries in children less than 5 years. SEA region accounted for just over one-half of the total number of fire-related burn deaths and more than 50% of the total number of DALYs lost due to fire related burns globally. An estimated number of 128,000 persons died of burn injuries in this region. Several hospital-based studies indicated that burn-related injuries contributed to 20 to 40% of mortalities amongst the injured and increasing hospital admissions by 10-30 percent. An estimated two-thirds of the global burden of burn mortalities amongst females occurred in SEA region. Furthermore the majority of burns occur at home. The
impact of burns, especially severe ones, was worse in the SEA region as compared to that in high-income countries because of infections and lack of adequate physiotherapy. (54)

2.2.6 Poisoning

Globally an estimated 346,000 people died and 7,447,000 DALYs were lost as a result of unintentional poisoning in the year 2004. LMICs suffered more than 90% of the global fatality due to poisoning. SEA region accounted for nearly one third of the total global deaths due to poisoning which was estimated to be 96,000 fatalities in these countries. Over 60% of the global mortality due to poisoning occurred among adolescents and adults aged between 15–59 years. (3) Hoy et al. (55) in a hospital based study in Victoria showed that unintentional poisoning was a significant cause of childhood morbidity with the annual average rate of 210.7 per 100,000. The most common agents responsible for poisoning were pesticides, kerosene, prescription drugs and household chemicals. (8) In a hospital based study in Sri Lanka, it was shown that poisoning was the most common cause of death, being 3.9-fold more common than road traffic crashes. (56)

2.2.7 Drowning

Global Burden of Disease estimated that 388,000 people drowned in 2004. Among the various age groups, children under 5 years of age had the highest drowning mortality rate worldwide. Over one-half of the global mortality due to drowning occurred among children aged between 0–14 years. Nearly one third of these deaths occurred within the SEA region with 100,000 deaths due to drowning in 2004. (3) A hospital based study of all hospitals in Denmark showed that the annual incidence of serious immersion events was 5.2/100,000 in children, 4.3/100,000 in adult males and 1.2/100,000 in adult females. (57)

In the SEA region, drowning is one of the major causes of injury deaths. Deaths due to drowning were reported to account for about 10 to 25 per cent of child deaths during 1983-1995 in Bangladesh and for more than 80 per cent of all injury-related deaths in this age group. (58) A hospital-based study from Thailand reported that 35
per cent of the injury-related deaths among children were due to drowning. In the SEA region, most of the drowning related deaths took place in ponds, rivers, or the ocean, or during floods and cyclones. Very few of them were swimming pool related. (8)

2.2.8 Occupational injuries

Leigh et al. (60) based on analysis of the Global Burden of Disease data, estimated that approximately 100,000,000 occupational injuries, 100,000 deaths, 11,000,000 occupational diseases, and 700,000 deaths occurred in the world each year. The burden of occupational injuries was the heaviest in the developing world where the greatest concentration of the world’s workforce was located. In these countries, hazardous industries such as agriculture, logging, and mining that were not governed by any safety standards or regulations were reported to be a major cause for injuries. In an emergency department based injury surveillance system in Nicaragua it was found that occupational injuries accounted for 18.6% of the total injuries captured by the surveillance system. Injuries occurring outside of a formal work location accounted for more than 60% of the work related injuries. (61) International Labour Organization estimated that the mortality rate of occupational injuries in LMICs was 30-43/100000. (9) Reliable estimates of work related injuries and deaths were not available in the SEA region, partly because a majority of the workers were employed in the unorganized sectors. The Inter-country Consultation meeting in Bangkok (2002) estimated from the few available studies that nearly one per cent of deaths and 10 per cent of permanent impairment result from agricultural injuries in this region. It was estimated to be 120 million injuries and 200,000 deaths per year in this region. (54)
2.2.9 Burden of injuries in India

2.2.9.1 Sources of information

Gururaj (9) in his review on injuries in India highlighted the lack of injury data in India. Precise estimates of morbidity and mortality from injuries are not possible since few population based studies on pattern and burden of unintentional injuries are available from India.

2.2.9.2 Injuries in India

Joshi et al. (10) in their study on causes of death in rural India using verbal autopsy, showed that 13% of total deaths in a sample of 180,162 individuals were due to injury and external causes. Garg et al. (62) in their review on road traffic injuries in India reported that injuries were the seventh leading cause of death in India and unintentional injuries were responsible for 13% of DALYs lost in India in 1990.

Deaths due to accidents were estimated to have increased by 47% during the period 1990–2000. (9) Inter-country Consultation meeting in Bangkok (54) reported 5.2% increase in injury rate only in the duration of one year from 1999-2000, with the actual number of deaths increased from 122,221 to 188,003 for unintentional, from 40,245 to 78,450 for suicidal and from 22,727 to 39,174 for violence-related deaths between 1981 and 1991. In 1999 nearly 418,505 individuals died in India due to injuries.

A prospective community-based study was conducted in the Kaniyambadi Block of Tamil Nadu, covering 108 000 population resident in 85 villages. Injury was responsible for 18.9% of deaths with an incidence of 137/100,000 per year. Unintentional injuries contributed to 7.6% of all deaths across all age groups. (63) Data from a population based-study in Delhi with a sample size of 30,554 revealed that the incidence rate of unintentional injuries was 109.6 per 1000 population and road traffic injuries, falls, mechanical force, burns and animal bite contributed to 26.5%, 37.1%, 13.5%, 8.9% and 7.1% respectively, of the total share of unintentional injuries. The
incidence rate of major injuries was 71.1 per 1000 and the share of major road traffic injuries, falls, mechanical force, burns and animal bite related injuries was 31.3%, 38.3%, 10.7%, 7.9% and 7.5% respectively, of the total. \(^{(11)}\)

Gururaj \(^{(9)}\) based on data from the National Sample Survey Organization (NSSO) estimated that injuries of various types were directly responsible for one-third of disabilities in 1994. The Census 2001 data revealed that the disability rate in India was 2.1%, indicating that nearly 70 lakh people were disabled due to injuries in India. It was predicted that without any systematic effort, the number of deaths due to injuries was likely to increase to 11 lakh by 2010 and 12 lakh by 2015.

2.2.9.3 Road traffic injuries

Figure 4: Global road traffic injury mortality

Garg et al.\(^{(62)}\) in a review of the literature on road traffic injuries in India reported that road traffic injuries constituted 78% of total the unintentional injuries in India, with an annual total mortality estimated to be over 80,000. Road traffic injuries accounted for over 1.2 million injuries and about 300,000 permanent disabilities.\(^{(64)}\) Gururaj estimated that by the year 2015, India will witness the deaths of 150,000 persons and hospitalization of 3 million people annually.\(^{(65)}\) The Global Burden of Disease study predicted that males in China and India had the greatest road traffic injury burden, with the number of DALYs lost by men in these countries exceeding those lost in any other world region.\(^{(1)}\) Dandona et al.\(^{(22)}\), in their study on death due to road traffic injuries in Hyderabad reported that 70% of those who were killed due to road traffic injuries were between age 16-49 years. Based on a review of hospital-based studies and few population-based studies, Garg et al.\(^{(62)}\) reported that road traffic trauma accounted for a large majority of emergency room visits (15–20% of total Emergency Room visits and about 35% of trauma related visits). The review reported that 3–10% of victims did not survive their injuries, with the proportion of deaths being as high as 17% in one of the studies included in the review. The cost of road traffic injuries in India was estimated to be more than 322 billion rupees (US$7.4 billion).

Mohan\(^{(29)}\) estimated that the cost of road traffic injuries was 3.2% of Gross Domestic Products (GDP) in India. Pedestrians, bicyclists and motorized two wheelers were the most vulnerable group constituting 60-80% of road fatalities in India.\(^{(48, 49)}\) Nearly 75% of road traffic injuries were earning members and majority reported a decline in earnings after injury.\(^{(9)}\)

### 2.2.9.4 Falls

Gururaj\(^{(9)}\) reported that fall were the second leading cause of unintentional injuries and death in India, contributing to 20%–30% of total traumatic brain injuries. Nearly two-thirds of falls occurred at home. Children and the elderly account for 30%–40% and 10%–20% of the total falls respectively. Falls often resulted in a variety of musculoskeletal injuries including fractures. In a large population based study
conduct in Delhi, the largest cause of unintentional injuries was due to falls (37.1%). (11)

2.2.9.5 Animal Related Injuries

Animal related injuries include injuries due to dog-, scorpion- and snake-bites. In the Delhi study, the incidence of animal bites was 2.5/1000 for minor injuries and 5.3/1000 for major injuries, with an overall rate of 8/1000/year. (11) In another population-based study, the incidence of rabies was 1.4/1000 and 1.8/1000 in urban and rural areas respectively. The prevalence of rabies was 2/100,000 in the study population. (9) Poisoning by animal bites, especially snake and scorpion bites, was reported to be extremely common in rural India. (9)

2.2.9.6 Burns

The extent of burn related injuries was evident from national reports indicating 35,000 burn related deaths in the year 1999. (54)

Figure 5: Global fire-related burn mortality

Ahuja and Bhattacharya in an analysis of 11,196 burn admissions reported that almost 80% of admissions were in the 16-55 years age group and the overall mortality was 51.8% \(^{(66)}\). More women suffered burn injuries than men (1.6:1). \(^{(9)}\)

### 2.2.9.7 Poisoning

Figure 5: Global poisoning mortality

![Global Poisoning Mortality](image)


India ranked second in poisoning related deaths in the world with 4.0-7.0 deaths per 1000 population. \(^{(1)}\) As per the NCRB report in 2001, 24,775 persons lost their lives due to poisoning out of which 63.6% were males and 26.4% were females. Nearly 10%-25% of emergency room registrations and 2%-3% of total admissions were due to poisoning. \(^{(9)}\) In an epidemiological study of poisoning cases reported to the National Poisons Information Centre, New Delhi, a high incidence of poisoning (36.5%) was observed in children with 79.7% of poisoning being accidental in nature. \(^{(67)}\)
2.2.9.8 Drowning

Figure 6: Global drowning mortality


India reported more than 22,000 drowning fatalities in 1999. (54) The incidence of drowning increased from 31/100,000 in 1991 to 44/100,000 population by 1997. (9) Mathew et al. (68) reported that in some parts of India drowning was the leading cause of death in the 1–12 year age group. Drowning in India commonly occurred in rivers, ponds, lakes and wells and could be accidental, suicidal or sometimes homicidal in nature. (9)

2.2.9.9 Occupational injuries

Leigh et al. (60) in their study on global burden of disease and injury due to occupational factors estimated that 45,000 occupational deaths occurred in India. Gururaj (9) reviewing two studies on injuries in agricultural workers and work accidents among shift workers in industry, estimated that occupational injuries
contributed to 2% of total deaths, 1.8% of total life-years lost due to disabilities and 2% of DALYs in 1990. The incidence of industrial injuries among employed workers was 9/1000, with a frequency of 2.6 per 100,000 man-days of work.

2.2.10 Burden of injuries in Pune

Pune is the seventh largest industrial city in India and the second most important city in Maharashtra after Mumbai. Pune is known for its cultural heritage, educational activities. It is identified as a growing metropolis. Over the past three decades, Pune has witnessed remarkable development, particularly along the Mumbai-Pune expressway and in most regions in the hinterland. Pune city has an area equal to 244 square kilometer. The total registered vehicle population (transport and non-transport) in Pune city in 2002 was 658,313 out of which 537,956 were non-transport vehicles such as two-wheelers, cars, and jeeps. Two-wheelers constitute the highest among non-transport vehicles (491,747, or 74.6 percent of total vehicles), followed by cars (63,489, or 9.6 percent of total vehicles) in 2002. According to the report of the Ministry of Roads and Highways in India, the number of registered vehicles in Pune had increased by 165% from 1995 to 2000. According to the report of State Transport Authority, the road traffic injuries had increased by 93% and road traffic fatality had increased by 16% from 1990 to 1997. Other data (Figure 7) reported that transport caused fatality per number of vehicles had reduced between 1998 and 2001.
Review of literature

Figure 7: Transport caused fatality/10,000 vehicle in Pune

(Source: Central Institute of Road Transport, Sustainable Urban Transport for Pune Metropolitan Area 2005.)

Pune police traffic report for the year 2004, reported 303 cases of severe injuries and 1,529 cases of minor injuries due to road traffic accident in Pune city. The same report indicated that Mumbai Road, Solapur Road, Satara Road, Nashik road and Ahmednagar road had the maximum fatal cases of road traffic injuries in Pune and private vehicles were responsible for maximum cases of injuries followed by trucks and other heavy vehicles. Figure 8 shows the time trends of road traffic injury occurrence according to the traffic police report. The trends show sudden increase in rate of injuries from 6 am and slow increase till maximum injury occurrence around 8 pm.
2.3 Pattern of injuries

2.3.1 Mechanism of injuries

The Global Burden of Disease study estimated that in the year 2004, 67.5% of injury mortality was due to unintentional injuries. Road traffic injuries, poisoning, falls, fires, drowning and other injuries contributed a share of 22%, 6%, 7%, 5%, 7% and 20% respectively to the total global injury mortality and 33%, 9%, 11%, 8%, 10% and 30% respectively of the total share of global unintentional injury related mortality. (3)
The WHO estimated that the share of unintentional injuries was 75% of the total injuries in the SEA region and road traffic injuries, poisoning, falls, fires, drowning and other injuries constituting 30%, 6%, 3%, 9%, 7% and 20% respectively of the total injury mortality rate in this region.\(^{(52)}\)

Gururaj\(^{(9)}\) estimated that road traffic injuries (20%), suicide (27%), violence-related deaths (11%), burns (9%), poisoning (6%) and drowning (6%) were the major causes of injury deaths. The Delhi study revealed that road traffic injuries, falls, burns, animal bites, poisoning, drowning and other injuries contributed to 31%, 37%, 9%, 7%, 1%, 1% and 20% respectively of the total injury occurrence.\(^{(11)}\)
2.3.2 Nature of injuries

The major nature of injuries were superficial injuries (51.3%) followed by fracture (14.1%). (11) In a hospital-based study in Pune city, cut and open wound has been reported as the major nature of injuries. (72) For the victims of road traffic injuries superficial injuries (47.4%) followed by fractures (20.7%) contributed to the major nature of injuries. (73) Hospital-based studies on road traffic injuries in India revealed that fracture, dislocation, sprain or strain were the most common patterns of injury among all the age groups in both sexes. (31)

In a study on childhood injuries in Velestino, (74) cuts/scrapes/bruises were the most common types of injuries for all ages, followed by broken/fractured bones and dislocations/sprains/strains. The number of cuts/scrapes/bruises and burns/scalds decreased as children got older. However, more severe injuries such as broken/fractured bones increased with age occurring more frequently in school going children than in the younger age groups.
2.3.3 Site of injuries

Verma and Tewari (11) reported that limbs were the most affected parts of the body in majority of the injuries. Head injuries were more common among falls, mechanical injuries and homicidal injuries. Studies on road traffic injuries showed that maximum number of injuries was sustained in the head and neck region followed by lower and upper extremities. In pedestrians, the lower extremities were most commonly involved followed by head and neck region whereas in drivers, the upper extremities were most commonly involved followed by lower extremity. In passengers and bicycle riders most of the injuries were sustained in the head and neck region followed by the upper extremities. The proportion of injuries to the thorax, abdomen and spinal cord was lesser as compared to injuries on the head, neck, upper and lower extremities. (31) (74) (28) Hand injuries were the commonest occupational or domestic injury events. In Denmark, the incidence of occupational hand injuries was 1.7%, with the highest incidence among employees in the production and building industries. (75)

Childhood injuries most commonly occurred in the upper extremities, the lower extremities and in the skull and head–face area. Boys, infant/toddlers and preschoolers experienced significantly more facial, head or neck injuries. School-aged children sustained the majority of injuries to the upper and lower extremities. (74) (76)

2.3.4 Place of injuries

Different population-based studies in third world countries revealed that most of the injuries occurred at home or on the road. Home injuries exceeded road injuries. A study in Uganda showed that in a rural community, 29% of the deaths occurred at home and another 29% on roads. Forty five per cent of disabling injuries were at home and 38% on the roads. (15) In another population-based study in rural Vietnam, home injuries exceeded road injuries. (77) In Damascus, (78) almost 75% of injuries in preschool children occurred inside the home. In an Indian study, mechanical injuries were common at home followed by the work place like a factory. The maximum fall cases were observed at recreational places. (11)
2.3.5 Activity at the time of injuries

Epidemiological survey of injuries in Delhi showed that most of the injuries occurred during daily routine work (69%) followed by recreational activities (20.5%). In another study in rural Thailand, it was found that unpaid work followed by paid work were the main activities at the time of injuries.

2.3.6 Time of injuries

Ganveer and Tiwari in their study on injury patterns among non-fatal road traffic accident cases and Oder et al. in a comprehensive review of road traffic injuries in developing countries reported that 60 to 80% of injuries occurred during the daytime and 20 to 40% during the night. However, the case fatality rate was higher for nighttime crashes than for those occurring during the day. A significant number of nighttime injuries were due to alcohol consumption. In the Delhi study, most of the injuries (22.8%) occurred between 12 to 4 pm followed by the period between 4 to 8 pm (21.6%) and 8 to 12 am (19.6%). A comprehensive review of epidemiological studies on road traffic injuries in developing countries showed that more than 50% of the weekly traffic injuries occurred on Friday, Saturday and Sunday, with a high peak on Saturdays.

2.3.7 Seasonal variation in injury occurrence

There is lack of consistency in Indian data related to the trends of injury occurrence in different months of the year. One study showed that both in rural and urban areas, the probability of injury were much lower in the monsoon season (July to September) and mild winter months (October to December) than the summer (April to June). The Delhi study showed that the maximum number of injuries occurred in the hot-wet season between July, August and September (1,265 out of 2,232 cases).
2.4 Risk factors for unintentional injuries

Factors which may lead to increased risk of injury vary in developed and developing nations. In developed countries, systematic study of risk factors of injuries was initiated three decades ago. The findings were applied to injury control plans, leading to environmental modification and creating a safer life for the community via passive preventive measures. In addition to environmental measures, behavioral risk factors like alcohol use disorder, or adolescent risky driving behavior were targeted for prevention. In developing countries, where injuries are yet to be identified and recognized as a public health problem, the unsafe environment remains a major risk factor for injuries as compared to behavioral risk factors.

There is very limited knowledge about risk factors for injuries in developing countries. The following discussion reviews the known risk factors for unintentional injuries.

2.4.1 Age

Age is considered as a risk factor for injuries, with young people in the age group of 15 to 29 years accounting for the largest proportion of deaths and the highest proportion of all unintentional injuries. Individuals in the age group of 45 to 59 years accounted for the highest proportion of injuries from poisoning, while those aged 70 to 79 years accounted for the highest proportion of injuries from falls in LMICs. In India, the incidence of injury was found to be the highest among children below five years and the number of injuries was the highest among those in the age group of 5-25 years (48%) followed by individuals in the age group of 25-45 years (28%). In road traffic injuries, majority of the victims were reported to be young adults between 15 to 37 years age group.

2.4.2 Gender

Male sex is considered as a risk factor for injuries and unintentional injuries. Globally, for most injury-related deaths, males had higher mortality rates than
females, with the exception of fire-related deaths. Mortality rates from road traffic injuries and interpersonal violence among men were almost three times higher than those among women. (1) In LMICs, males accounted for more than two-thirds of the deaths attributed to unintentional injuries in 2001. (5)(50)

Verma and Tewari (11) reported that the incidence of injury was almost double amongst males as compared to females in India and in some reports, even three times more in male than female. (9) The sex ratio of road traffic injury in India was reported to be 4.5 males: 1 female in the Delhi study (73)(28) and 6 to 1 in other studies. (27) The excess number of injuries in males was observed in studies from all over the world and in all age groups including children and adolescents. (82) (74) (83) (84)

2.4.3 Marital Status

In some Indian population-based studies it was reported that never married individuals had a higher chance of injuries compared with married individuals. (11), (34)

2.4.4 Type of family

In a study done by Kohen et al. (76) in Ontario, Canada, the single marital status was found to be a risk factor for injuries amongst boys. In another study in Velestino, Italy, (74) the extended families living in households with a larger number of cohabitants was a protective factor for injury risk. In contrast, findings from other parts of the world suggested that living in large family households increased injury risk both among preschool and school-age children. (85) Therefore, the risk of injuries may have a familial component, which may be mediated through shared environment, physical, social or psychological factors but the underlying mechanisms are not fully understood.

2.4.5 Socioeconomic status

The relation between socioeconomic status and risk of injuries is complicated. In some studies, especially among children and adolescents in developed nations, a direct and strong relationship was found between poverty and injury occurrence. (86-88) (76) (82) (84) In other studies, the relationship between socioeconomic status and injuries
were mostly reported to be type specific. For example, some studies reported that high material wealth was positively and consistently associated with medically treated and sports related injuries. Poverty was positively associated with fighting related injuries. In another study on childhood injury, a relationship between socioeconomic status and severity of injuries and different mechanisms of injuries were found to exist specially for pedestrian injuries, burns and scalds and poisoning. Potter et al. explained that the possible pathways through which socioeconomic factors may be related to injuries, especially in adolescence, included behaviors (e.g., physical activity and risk behaviors) and environmental characteristics (e.g., potential hazards in the physical environment) that could be influenced, for example, by both status and access to material resources. Lyons et al. in a population based study found that for all admissions, and admission due to falls, pedestrian injuries, poisoning and burns, there were socioeconomic gradients with higher rates in the more deprived communities for all younger age groups. In older people only pedestrian injuries showed a substantial socioeconomic gradient. Engström et al. in a cross sectional study in Sweden found that the relative differences between socioeconomic groups were more important in the case of violence-related injuries among adolescents than for unintentional ones. Plitponkampim et al. presented a model for injury occurrence in countries at different socioeconomic levels for childhood injuries: a stage of high magnitude, a stage of high priority, and a stage of improvement. Most MICs are in the high priority stage where both mortality rates due to injury and percentage of deaths related to injuries amongst total deaths are high and most LICs are in the stage of high magnitude but low priority. According to the model, when GNP per capita doubles, there will be a corresponding decrease in injury mortality. Moniruzzeman and Anderson in their study on relationship between economic development and risk of injuries in older adults and the elderly illustrated that there was an inverse correlation between the two variables among 45–54, 55–64 and 65–74 year olds, while a moderate positive correlation was seen among 75 year-olds and above for both sexes. In rural Vietnam, poverty was a risk factor for home, work and 'other' injuries. Poverty was protective for school injuries, while the risk of traffic injuries was not affected. Overall, poverty was associated with unintentional
injury morbidity. However, the relationship varied by sex, age and type of injury. Specifically, poverty increased the risk for children and elderly people being injured at home, and for adults (15 – 59 years) were being affected by work related injuries. 

2.4.6 Occupation

Verma and Tewari (73) (11) in their population-based study in Delhi reported that individuals involved in business had a higher incidence of injuries followed by those in professional services followed by labourers. Housewives reported the least incident rate of injuries. A hospital-based study reported that the maximum number of road traffic injuries occurred amongst labourers. (31)

2.4.7 Education

Some Indian studies have examined the association between risk of injury and education and have reported that individuals with lower level of education (illiterate or sixth or eighth level of education) have a higher chance of injuries. (73), (11), (31)

2.4.8 Mother’s education

In a study done in Velestino, it was shown that children of younger and less educated parents had a higher risk of injury. (74) McPhillips et al. (95) also reported that children of mothers with less than 12 years of education were at an increased risk of dying from an injury in early childhood. However, Kohen et al. (76) in a study on maternal reports of childhood injuries in Canada found that maternal levels of education greater than high school were associated with an increased risk of injury in children.

2.4.9 Mother’s age

In a study on frequent injury occurrence in children, it was reported that maternal age was associated with frequent childhood injury occurrence. (96) An increased risk of injury was associated with young maternal age. (95) In Malaysia, it was shown that
having a parent younger than 21 years was a risk factor for accidental poisoning in urban children. (97)

2.4.10 Alcohol use/use disorder

Various studies show a strong association between alcohol consumption and risk of injuries. Although alcohol-dependent people were at an increased risk of injury, there were few reports suggesting that episodic alcohol use also increased the risk of injury. Borges et al. (99) reported that increase in the relative risk of injury was concentrated within the first two hours after drinking. There was a positive association with the increasing number of drinks consumed. These authors also reported that fifty percent of trauma patients were found to have been injured while under the influence of alcohol. Norton et al. (5) referred to studies in LMICs, where, in 33 to 69% of crashes in which drivers were fatally injured, the drivers were found to have had consumed alcohol. This percentage was 8 to 29% for nonfatal injured drivers. It was reported that 60% of heavy drinkers and 55% of those meeting the criteria for alcohol use disorders reported having used alcohol within six hours prior to the injury event. (99) In the adolescent age group, frequent drunkenness was a strong and consistent risk factor for street injuries, and the risk estimates generally followed a dose-related pattern. (87)

In India, it was calculated that the adult per capita consumption of alcohol had increased from 0.4 litres of in 1970 to 1 litre during 1996. (100) Gururaj (101) in a hospital based study on the effect of alcohol on incidence, pattern, severity and outcome from traumatic brain injury reported that 16% of injured patients were intoxicated at the time of hospital registration. In the same study, the author reported that falls were higher in the alcohol user group. Evening-and night-time consumption of alcohol was a major risk factor for injuries. Drivers and occupants of motorized two-wheeled vehicles, and pedestrians were involved in crashes to a greater extent among alcohol users. Severity of brain injuries, duration of hospital stay, death and post-traumatic disabilities among alcohol users were significantly higher compared with non-users. (33) The author also reported a study by Lowenfels and Wynn on international trends in alcohol consumption and vehicular fatalities with data from 19
countries, reporting that a 1% reduction in per capita alcohol consumption was associated with a 1% reduction in vehicular deaths. Jagnoor \(^{30}\) considering the available literature reported that 44% of two-wheeled drivers seeking medical treatment due to road traffic injury were under the influence of alcohol.

### 2.4.11 Visual impairment

The effect of visual impairment on increased risk of injury was reported from two different studies. One study was related to older people which showed that individuals with reduced visual acuity were 1.7 times more likely to have a fall and 1.9 times more likely to have multiple falls compared with fully sighted populations. \(^{102}\) In another study children with visual problems had a higher chance of injuries, although the association was not statistically significant. \(^{74}\)

### 2.4.12 Disability

Children with multiple disabilities had a 70% increased odds of injury compared with the developmentally disabled children. Disability increased the risk of injury and its patterns differed across different types of disabilities. \(^{103}\)

### 2.4.13 Number of individuals at home

Literature related to association between the number of members in a household and risk of injuries is scarce. In a study done in Malaysia, it was shown that living in a household with more than five occupants was a risk factor for accidental poisoning in urban children. \(^{97}\) In a study done in the USA, the presence of an older sibling was associated with an increased risk of injury. The risk was highest in those with very short birth intervals. It was suggested that the potential mechanism for this increased risk was possibly due to inadequate parental supervision. \(^{98}\)
2.4.14 Risk factors for type specific injuries

2.4.14.1 Risk factors for road traffic injuries

Risk factors related to the increased risk of road traffic injuries include increasing volume of traffic, specially motorized two-wheeled vehicles, one of the least safe forms of travel in LMICs, poor road infrastructure planning, highway design, traffic engineering, traffic management, increase in vehicle speeds, alcohol use, fatigue, use of hand-held mobile telephones, inadequate visibility of vulnerable road users and failure to wear helmets or use of seat belt. Driver fatigue has now been identified as a significant factor in road transport crashes, particularly amongst commercial drivers where as many as 40% of all accidents have been estimated as being sleep-related. According to the European Transport Safety Council (2001), driver fatigue is responsible for 20% of commercial road transport crashes, especially on long journeys on trunk roads and motorways. Fatigue, caused by overwork, excessive hours of driving, lack of rest and lack of nourishment, produces a state of reduced mental alertness which may include sleepiness or drowsiness. In some studies it was shown that crash related injuries occurred mainly in urban zones with 50 km/h speed limit. Two-wheeled vehicle riders wearing reflective or fluorescent clothing had a 37% lower risk than other riders. Compared with wearing a black helmet, use of a white helmet was associated with 24% lower risk.

The risk factors for children in road traffic injuries included age of five to nine years, male sex, poverty, household crowding, inadequate parental supervision, family stress, and a minority race or ethnic group. The most important environmental contributions to the risk of injury was living on streets with high traffic volumes and density, high average and posted speed limits, few pedestrian-control devices, few alternatives to the street for play and a high density of curb side parking. In India, other factors also were mentioned like faulty system of issuing licenses and bad vehicle and brake conditions. Other studies reported an increased risk of injury due to building highways specially for people in rural or suburban areas, lack of safe

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walking spaces, lack of crossing facilities, poor visibility of vehicles and roads, limited trauma care facilities in cities/towns, absence of trauma care in rural areas accompanied by a lack of human and physical resources in health care facilities and absence of scientific crash investigation. (9) (28)

2.4.14.2 Risk factors for fall-related injuries
Risk factors for fall-related injuries usually relate to falls in the elderly, which is related to the aging process. Some studies in LMICs have identified other factors. For example, studies in Thailand suggested that factors associated with poor socioeconomic status may increase the risk of falls, for example, not having electricity in the house and living in Thai-style houses or huts. (59) The literature specifically identifying risk factors for falls in younger people in LMICs is sparse, but the available information indicates that such falls usually occur in and around the home. Falling from a height including rooftops and trees share a significant portion of such injuries. However, falls other than from heights predominate and are frequently related to engagement in vigorous levels of physical activity. (5) A population-based case-control study in Auckland shows that drinking is strongly associated with unintentional falls at home that result in admission to hospital or death. Moreover, a substantial proportion of falls at home among working-age people can be attributed to alcohol consumption. (85)

2.4.14.3 Risk factors for burn-related injuries
Norton et al. (5) suggested the following environmental risk factors for burn related injuries in LMICs: lack of water supply, storage of inflammable substances at home, cooking equipment in the kitchen within reach of children and housing that is located in slums and congested areas. For children, the identified risk factors included children who were not the first born, who had a pregnant mother, whose mother was recently dismissed from a job, who had recently moved, who had a pre-existing impairment, whose sibling died from a burn or had a history of burns, whose parents lacked alertness to burns, whose clothing was made of synthetic fabrics, whose parents were illiterate and whose parents were from a low economic status. In India,
rural Hindu young females with low literacy and socioeconomic levels were at an increased risk of burns. (95) Chemicals, hot liquids, fumes and electrical items were other sources of burns. (9) Leakage of kerosene stoves, the practice of low-level cooking, use of synthetic, loose-fitting garments have also been identified as major causes of burns at home. Unsafe crackers used during festivals result in death, blindness, disfigurement among a number of children, though no official figures are available.

2.4.14.4 Risk factors for poisoning
Young males are at an increased risk of poisoning. In LMICs, the most common agents involved in childhood poisoning are paraffin (or kerosene) and other household chemicals, pesticides, and various plants or animals, including snakes. Socio-demographic risk factors, including young parents, residential mobility and limited adult supervision of children, the use of nonstandard containers for storage and the storage of poisons at ground level are other factors increasing the risk of poisoning. (5)

2.4.14.5 Risk factors for drowning
Most drowning incidents in LMICs are associated with everyday activities near bodies of water, including rivers, wells, and buckets. Men and children aged one to four years, young people using alcohol and rural people appeared to be at greatest risk, with drowning accounting for a high proportion of injury-related deaths. Risk factors for children drowning in Bangladesh were associated with increased age of mother and number of children in the family. A case-control study in Mexico reported that the risk of drowning increased seven times for children in homes having a well. (5)

2.4.14.6 Risk factors for occupational injuries
Gururaj (6) reported that in India there was a lack of knowledge about the causes of work-related injuries. Unsafe work environment like exposure to extremes of heat, chemicals, fumes, ill-ventilated places and unsafe equipment like old and unsafe
machines or even new but unknown machines were some identified factors. Also, worker-related factors like age, sex, co-morbidity, use of protective devices, alcohol use, being inexperienced, combined with a lack of safety systems including inspections and safety audits contributed to injuries and deaths.

2.4.14.7. Risk factors for sports and recreation related injuries

Pickett et al. (87), in a cross national study of injury in adolescents reported that sports and recreation were the most common activities associated with injury in adolescents. High material wealth was positively and consistently associated with medically treated sports related injuries.

2.5 Methodological approaches used for injury research in LMICs

The WHO guidelines for conducting community surveys on injuries and violence emphasize community-based surveys in settings where vital statistics, surveillance data and hospital-based data are non-existent or unreliable. Community-based surveys have the potential for characterizing injuries by various demographic sub-populations (e.g. by age and areas, by place of occurrence, and by the type and nature of injury). Study samples can be designed such that they are representative of the general population and the denominator can be defined. Surveys allow for the computation of incidence and prevalence rates by demographic and other parameters, allows for direct comparison of injury rates between different demographic or geographic strata and provides opportunity to examine people’s perceptions with regard to causes and prevention of injuries. Community-based studies can provide estimates on injury burden in terms of costs, disability and mortality. They can be used to obtain information on health care utilization and explore the socio-cultural determinants of
injuries. Finally, community-based surveys provide baseline data that can be used for surveillance of different types of injuries. There is scarcity of community-based epidemiological studies in the field of injury in developing countries. Researchers in these countries have to face different challenges of sampling methods in absence of accurate data-bases of information on individuals. Obtaining reliable information from a population affected by ignorance and illiteracy are additional challenges. Despite this various methodological approaches have been used for community based studies in LMICs.

In a population based study in Vietnam, to assess the incidence of unintentional non-fatal injuries, together with their determinants and consequences, a prospective study of a defined population in a rural area was carried out. A one-year follow-up survey involved four quarterly cross-sectional household injury interviews. This cohort study was based within a demographic surveillance site in Bavi district, northern Vietnam, which provides detailed, longitudinal information in a continuous and systematic way. Findings related to three phases of the injury process: before, during and after the injury. In this study, the perception of the patients was used as a measure of severity.

In a community-based survey about incidence and outcome of injury in Ghana, a retrospective study was conducted. To acquire a representative sample, a two stage random sampling was used. In the first stage of the sampling, a subset of enumeration areas in rural and urban areas were randomly selected with probability proportional to their population. In the second stage, a random location within each selected enumeration area or village /town was chosen and the nearest household selected to begin the interview process. Adjacent households were added as needed to ensure a minimum of 30 people at each site or cluster. The inclusion criterion in this study was any injury that resulted in death or at least one day of lost activity. The recall period was one year. However due to 72% recall bias in a one year recall as compared to one month recall, specially for injuries with recovery period less than 30 days, the injuries were re-categorized to minor if there was <30 days of disability and major injuries as > 30 days of disability. Two annual incidence rates were estimated for these types of
injuries. Incidence of minor injuries was estimated from injuries in the recent month and incidence of major injuries was calculated from one year recall time.\(^\text{(14)}\)

An epidemiological survey on injury morbidity in urban and rural areas in Tanzania conducted surveys in one urban and one rural area which were part of a health and demographic surveillance system carried out by the Adult Morbidity and Mortality Project (AMMP). At the time this investigation was carried out, the areas were being prospectively monitored through repeated censuses to ascertain the resident population at risk. Deaths were recorded through an active reporting system and the probable cause of death determined by a validated verbal autopsy. There were eight administrative units in urban and peri-urban neighborhoods. In urban areas an initial cluster sample of 500 households were randomly selected. Since initial data yielded fewer injuries than expected in the first two enumeration areas, the sample size was increased to 2,000 households with the difference made up of households selected at random from the remaining six surveillance branches. Thus the final sample under represented the first two branches. A two-stage cluster sampling method was adopted in selecting the rural sample. In the first stage, using existing AMMP data on mortality and poverty, six out of 51 villages were selected to represent different levels of socio-economic status and injury mortality. A random sample of 2,000 households was obtained from the selected villages in the second stage. All individuals in the selected households were included in the survey. Two questionnaires were used in the study. First was a screening form used to identify whether a household member had an injury in the past one year that resulted in losing one or more days of 'normal' activity (e.g. not being able to work or go to school). A second data collection tool was used to record the circumstances in which the injury occurred. The number of days with restricted activity (disability days) was considered as a measure of severity of injury. In the case of multiple injuries, the most recent injury episode was considered in the analysis. The severity categorization was similar to the method used in the Ghana study.\(^\text{(17)}\)

In a population-based descriptive study with the goal of providing an overview of national data on fatal and nonfatal injuries treated in public hospitals in Brazil,
mortality data was obtained from the Mortality Information System. This database includes information from all death certificates filled out in the 26 State and Federal Districts of Brazil. The hospitalization data were obtained from the Hospitalization Information System of the Public Health System. Both datasets were maintained by Brazil's Ministry of Health.\(^\text{(16)}\)

In a community-based survey on injury patterns in rural and urban Uganda, in both urban and rural areas, a three stage sampling procedure was used to identify the households needed to generate the required sample. In the urban setting in stage I the 18 parishes were divided into seven strata, based on population density. One parish was randomly selected from each stratum. Stage II involved randomly selecting 50% of the zones from each of the seven parishes. Using computer generated random numbers, 18 zones were selected. For stage III, beginning at the village meeting grounds, interviewers systematically selected households based on the required sample size for that village until the total was realized. In the rural setting in Stage I, the 30 sub-counties in the district were grouped into seven strata by population density. One sub-county was randomly selected from each stratum. Stage II involved randomly selecting 50% of the villages in each sub-county and for stage III, interviewers started at the village meeting grounds, and selected households randomly until the required sample was realized. In every village at least 20 households were visited. The questionnaire had three sections: the first collected information about household characteristics, number of persons in the household, type of dwelling, types of energy used, views of the respondent on prevalent injuries, and feasibility of strategies for prevention. The second collected demographic details about each member of the household and whether they had suffered any injury or injury fatality. Those that had occurred in the five years preceding the survey were included. The third collected detailed information about each injury event reported. The respondent was the most responsible adult in the household. Outcomes were classified into death, disability or full recovery. To minimize bias, the recall period for fatal injuries was restricted to five years and for fully recovered injuries to six months. An injury was defined a "severe injury" when the injury led to either disability or death.\(^\text{(15)}\)
In a study on incidence, patterns and severity of reported unintentional injuries in Pakistan for persons five years and older, the information was obtained from the National Health Survey of Pakistan. The survey had a two-stage stratified design. The urban and rural areas of each of the four provinces of Pakistan were taken as strata. Based on the master sampling frame of the Federal Bureau of Statistics, enumeration blocks of approximately 200-250 households in the urban strata and villages in the rural strata were taken as primary sampling units. Eighty primary sampling units were selected for the survey. From each unit, 30 households were sampled using a systematic sampling technique by taking a random start and a sampling interval. All residents of the 2,400 households were included in the study. Operationally, the data was collected in two major parts: a household interview (from the head of the household) and health examination and interview of every individual from the selected household. From individuals over five years of age, a series of questions were asked about unintentional injuries that occurred over the past 12 months. Proxy respondents (usually mothers) were questioned for persons less than 12 years of age. Unintentional injuries were defined as any injury event which was not considered deliberate and for which medical treatment was sought. \(^{13}\)

In a population based study conducted in Delhi, a systematic random sampling method was used with a semi-structured interview schedule. Heads of 5,412 households residing in the Municipal Corporation of Delhi were interviewed for the socio-demographic factors, incidents of minor injury for last one month, major injury for the last one year, and injury related mortality for the last five years. The definition of injury used for this study was “external force/non-contagious substance, striking the body or entering into the body and causing anatomical discontinuity of tissue or deranged physiological function of the body”. For this study, injury included all recallable bodily injuries to any individual, either intentional or unintentional but it did not include mental injury or minor injuries. In this study, major injuries included all deep injuries for which either treatment was availed or it affected work. \(^{11}\)