Injuries in India: A national perspective

GURURAJ G.

India is passing through a major sociodemographic, epidemiological, technological and media transition. The political, economic and social changes have altered the health scenario. In the past two decades, India has witnessed rapid urbanization, motorization, industrialization and migration of people resulting from socioeconomic growth and development. With mechanization and revolution in technology, traditional ways of living and working are being altered. Injuries are a major public health problem in India. Lack of reliable and good quality national or regional data has thwarted their recognition. Many injuries are linked to social, environmental, cultural and biological issues in causation; recognized as man-made and behaviour-linked disorders and linked to sociodemographic transition. Prevention, acute and long-term care, and rehabilitation are the major challenges faced today.

Motorization in India

The rapid and unprecedented motorization in India combined with the lack of a safety environment has been a noticeable feature. Figure 1 shows that the number of vehicles has grown from a mere 306,000 in 1951 to 58,863,000 by 2002 (Ministry of Road Transport and Highways, Transport Research Wing 2001–02). The 23 metropolitan cities account for 33% of total vehicles in India. Two-wheelers; cars, jeeps and taxis; buses; goods vehicles; and others account for 71%, 13%, 1%, 5% and 10%, respectively of the total vehicle population (Fig. 2). While the total number of buses increased from 331,000 in 1991 to 669,000 in 2002 (an increase of 102%), two-wheelers increased from 14,200,000 to 41,478,000 (an increase of 300%). Rapid and accelerated motorization has been witnessed in some States such as Andhra Pradesh (4,336,000), Gujarat (6,008,000), Madhya Pradesh (7,414,000), Tamil Nadu (5,658,000) and Uttar Pradesh (5,171,000) as compared with other States. During 2001–02, nearly 3,473,401 two-wheelers were added on the roads of Andhra Pradesh, while the number of cars added was 279,903, with similar patterns across other States. Correspondingly, in Bangalore, nearly 1,253,408 two-wheelers were added in 2001–02 as against 11,267 buses and 234,888 cars. Nearly 35/1000 persons own a two-wheeler while only 6/1000 are in possession of a car (CSO 2004).

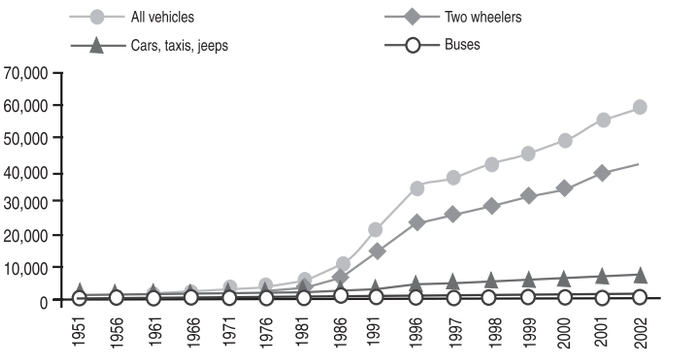

Fig. 1 Motorization pattern in India, 1951–2002

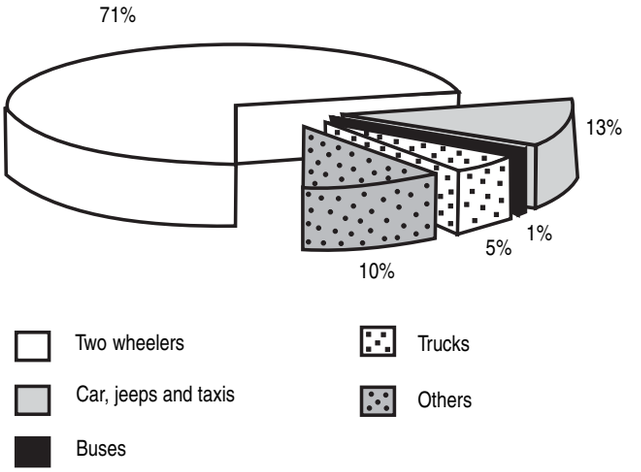

Fig. 2 Distribution of vehicles in India 2002

Department of Epidemiology
WHO Collaborating Centre for Injury Prevention and Safety Promotion
National Institute of Mental Health and Neuro Sciences
Bangalore 560029
e-mail: guru@nimhans.kar.nic.in

Injuries: An emerging public health problem

The term 'injury' by definition means that there is a body lesion due to an external cause, either intentional or unintentional, resulting from a sudden exposure to energy (mechanical, electrical, thermal, chemical or radiant) generated by agent–host interaction. This leads to tissue damage, when it exceeds the physiological tolerance of the individual (Robertson 1983; Baker 2000). On the contrary, injury can also occur due to the sudden withdrawal of a vital requirement of the body, e.g. withdrawal of air in drowning. Thus, an injury is damage to a body organ which occurs rapidly and is visible, with the causative mechanism being sudden energy transfer (Barss *et al.* 1998). Four factors that differentiate injury from other health conditions are: (i) a definite interaction between agent–host and environment, (ii) acuteness of the event, (iii) varying severity, and (iv) chances of repetitiveness (Bangdiwala 2000).

Information from around the world indicates that injuries account for more than half the deaths in the age group of 5–44 years. An examination of 'years of potential life lost' indicates that injuries are the second most common cause of death after 5 years of age in India (Mohan and Anderson 2000). Like any other health problem, injuries also have a definitive causative pattern and mechanism in terms of agent (product/vehicle), host (human beings) and environmental (roads, homes, workplaces) factors along with system-related issues. A precise understanding of this mechanism is crucial to develop and implement mechanisms for prevention and control of injuries. Every year, injuries contribute to a significant number of deaths, hospitalizations (for short and long periods), emergency care, disabilities (physical, social and psychological), amputations, disfigurement, pain, suffering and agony. Many children become orphans, women become destitute and the elderly grieve in isolation. In addition, injuries also result in disruption of several activities leading to loss of work, income, education and other social activities, causing long-term suffering among survivors and families. The extent of economic loss is yet to be recognized due to lack of systematic research. As India moves forward in its quest for growth, development and economic prosperity, the dark and ugly side of this progress is rapidly emerging due to the absence of accompanying safety systems.

Global burden of injuries

Nearly 50 lakh people lost their lives due to injury as per WHO estimates during the year 2002 (WHO 2004a). Injuries caused 9% of the total deaths. The global injury mortality rate is estimated to be 98/100,000 population, with male and female rates of 128/100,000 (38 lakh deaths) and 67/100,000 (19 lakh deaths), respectively (WHO 1999). Five of the top ten causes of death globally are due to injuries. Among the total disability-adjusted life-years (DALYs), 13% were due to injuries. Unintentional and intentional injuries contributed to three-fourth and one-fourth of total DALYs, respectively. Among unintentional injuries, road traffic injuries (RTIs), falls and burns resulted in, respectively, 29%, 12% and 9% of total DALYs. In the intentional group, suicide and violence accounted for 41% and 43% of total DALYs, respectively (WHO 2003a). The WHO–World Bank Report, which reviewed the disease transformation scenarios, indicates that RTIs will be the third leading cause of mortality by 2020, moving up from their present ninth position. Similarly, suicide and violence will move from the twelfth and sixteenth to tenth and fourteenth positions by 2020 (Murray and Lopez 1996).

Burden of injuries in India

The precise number of deaths and injuries due to specific causes, or any scientific estimates of injury deaths in India are not available from any single source. The National Crime Records Bureau (NCRB) is the principal nodal agency under the Ministry of Home Affairs, Government of India, and is responsible for the collection, compilation, analysis and dissemination of injury-related information (NCRB 2001a, 2001b). As per the report of 2001, 2,710,019 accidental deaths, 108,506 suicidal deaths and 44,394 violence-related deaths were reported in India. There has been an increase in accidental deaths from 122,221 to 188,003, from 40,245 to 78,450 for suicidal deaths and from 22,727 to 39,174 for violence-related deaths between 1981 and 1991. The injury mortality rate was 40/100,000 population during 2000. The number of deaths due to accidents increased by 47% during the period 1990–2000; 93% were due to unnatural causes and 7% (17,366) due to natural causes. The mortality rate among different age groups was: 8.2% (<14 years), 62% (15–44 years), 20% (45–59 years) and 9.2% (>60 years). Seventy-three per cent of total deaths occurred among men, with a ratio of 3:1 between men and women (Figs 3a–c). Significant regional variations were noticed across States. The 23 metropolitan cities (population of >10 lakh)

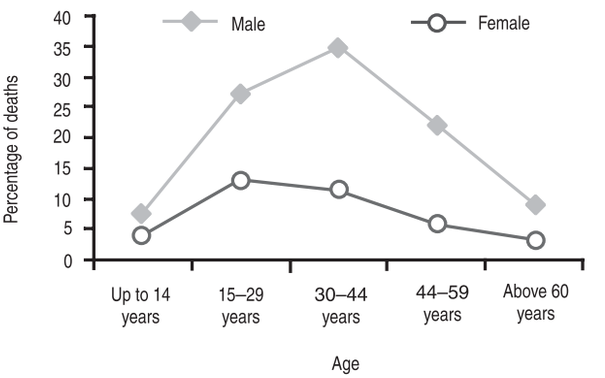

Fig. 3a Age–sex distribution of deaths due to injuries in Indian reports (%)
Source: National Crime Records Bureau (NCRB), 2000

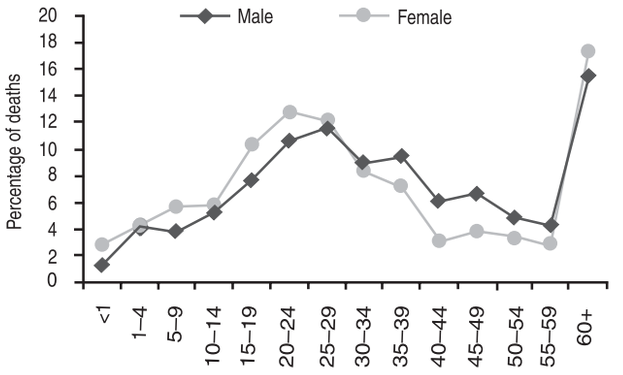

Fig. 3b Age–sex distribution of deaths due to injuries in Indian reports (%)
Source: Survey of Causes of Death (SCD), 1998

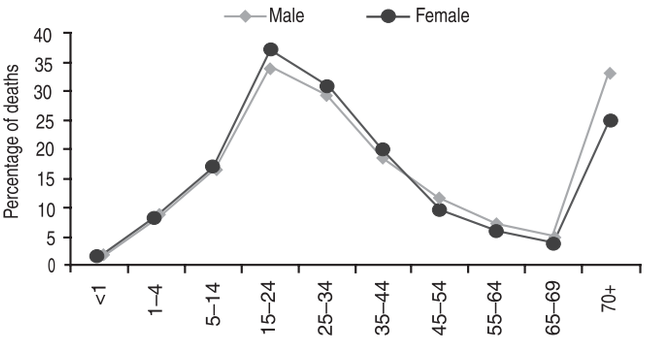

Fig. 3c Age–sex distribution of deaths due to injuries in Indian reports (%)
Source: Medical Certification of Causes of Death (MCCD), 1998
Note: Peaks in the 60+ years age group under SCD and MCCD are due to the combination of further age subgroups

accounted for 12% of deaths and 13% of injuries. The precise number of people hospitalized and injured is not available for intentional injuries. RTIs (20%), suicide (27%), violence-related deaths (11%), burns (9%), poisoning (6%) and drowning (6%) were the major causes of injury deaths (Table 1).

The Survey of Causes of Death (SCD) under the Sample Registration System (SRS; Registrar General of India 1998b) of India examined causes of death from 1602 of the 2059 (selected) primary health centres (PHCs) covering 40,351 deaths. The rate of injury-related deaths increased from 9% of total deaths to 11% between 1994 and 1998. Sixty-eight per cent of total deaths were in the age group of 5–44 years, with a male to female ratio of 1.5:1.

The Medical Certification of Causes of Death (MCCD; Registrar General of India 1998a) survey covered 15% of

Table 1. Distribution of external causes of injuries in national reports and population-based studies from India (%)

Year	Place	Author/ Agency	Source of data	RTIs	Domes-tic	Burn	Poison-ing	Fall	Animal-related	Work-related	Suicide	Vio-lence	Drown-ing	Other
2001	India	National Crime Records Bureau	National report based on police records	20	2	9	6	2	0.1	0.1	27	11	6	14.8
1998b	India	Registrar General of India (SRS)	National report based on cause of death by verbal autopsy	20	—	9	3	6	7	—	25	4	10	8
1998a	India	Registrar General of India (MCCD)	National reports based on medically certified death	22	—	37	9	6	—	2	10	12	3	—
Population-based studies														
1990	Haryana	Varghese	Rural, community-based study	14	33	—	—	—	—	36	—	6	—	10
2003b	New Delhi	WHO	Urban, community-based study	25	—	10	1	34	6	13	0.3	6	0.7	3
1998	Faridabad Haryana	Verma	Rural, community-based study	29	—	17	2	25	12	—	—	—	2	14
Hospital-based studies														
2004	Mumbai, Mahara-shtra	Murlidhar and Nobhojit	Urban, commu-nity-based study	39	—	—	—	29	—	1	—	3	—	1
2004b	Bangalore, Karnataka	Gururaj *et al.*	Urban, rural, urban slum, community-based study	52	12	3	—	13	7	4	2	3	—	4

RTIs: road traffic injuries; SRS: Sample Registration System; MCCD: Medical Certification of Causes of Death

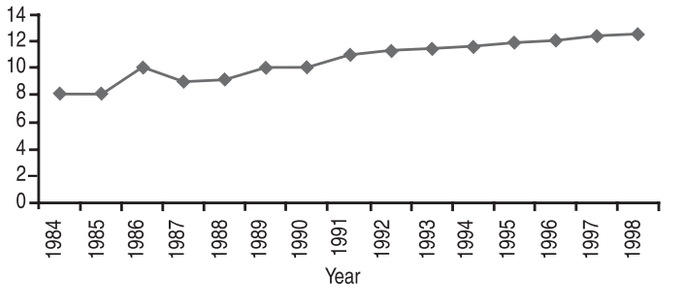

Fig. 4 Trends of death due to injuries, Medical Certification of Causes of Death (MCCD), 1984–98 (%)

total and 41% of urban deaths. Injuries accounted for 12.1% of total deaths in 1998 (*n*=60,577), an increase from 8% in 1984 (Fig. 4). Among total reported deaths (*n*=498,586), injuries and poisoning were the fourth leading causes of death. Sixty-nine per cent of deaths occurred in the age group of 5–44 years. Injuries were the leading cause of death in the age group of 15–24 years (13,309; 35%), second leading cause of death in 5–14 years (3003; 16.2%), and 25–34 years (15,330; 30%), third in 35–44 years (10,352; 19%) and fourth in 45–54 years (6238; 11%). RTIs (22%), burns (37%), violence (12%), suicide (10%) and falls (6%) were the leading causes of deaths.

A selective examination of injury studies from hospitals reveals that injuries account for 10%–30% of total registrations, with case-fatality rates of 5%–20% in different studies in India. A few population-based surveys with varying sample sizes reveal a significantly higher incidence and mortality rates of injuries compared with national figures (Table 2). Varghese *et al.* (1990), in a survey of 25,000 people from rural Haryana, revealed the incidence to be 8%. Sathyasekaran (1996) in a study of 4333 slum-dwellers in Chennai observed an incidence rate of 12.7%, with rates in males and females being 13.7% and 11.8%, respectively. Ashok *et al.* (2004), in a study of 720 households, noticed that nearly 5% of the population had suffered a hospital-registered injury in the past year. From Delhi, in a study of 30,554 individuals, an incidence rate of 11.3% was observed (WHO 2003b); 6% without long-term disabilities and 1% with disabilities. In the largest population-based survey from Bangalore, covering 96,569 individuals from 19,969 households, the injury incidence rate was 12% in the total population; 10% each in urban and slum areas and 14% in rural areas. The injury mortality rates were 5/1000, with rates in urban, slum and rural areas being 4, 5.1 and 7.4/1000, respectively (Gururaj and Suryanarayana 2004; Aeron Thomas *et al.* 2004). These studies (Table 2) clearly indicate that while mortality rates are 5–10/1000 population, the injury incidence rates vary from 70 to 140/1000, with a ratio of 1:14 in India. Due to recall bias, many of these surveys might have excluded minor injuries. In all studies, higher rates have been observed among men, with an overall injury ratio of 3:1. Few of the studies have reported higher rates from rural areas compared with urban areas (14% *v.* 10%) (Gordon *et al.* 1962; Varghese 1990; Gururaj and Suryanarayana 2004).

Road traffic injuries

On an average, 3242 persons die each day around the world in road crashes (Road Peace 2003). As per WHO estimates, nearly 12 lakh people died in road crashes in 2002 (WHO 2004a). The overall global mortality rate was 19/100,000 with nearly 90% of these occurring in low- and middle-income countries. The motorization of India, especially during the past two decades, has resulted in greater number of deaths and injuries due to absence of safety policies, programmes and environmental norms.

About 70%–80% of people in high-income countries (HICs) have cars and only 5%–10% have motorized two-wheelers. Whereas in India cars comprise around 10% of the total vehicles while 75% are motorized two-wheelers. Consequently, pedestrians, two-wheeler occupants and bicyclists are killed and injured in greater numbers in India (Table 3). Although buses and trucks constitute only 7%–10% of the total vehicles, they are associated with nearly 30%–50% of total deaths. The 23 metropolitan cities have an RTI mortality rate of 1000±200/lakh, which is higher than the national average of 800/lakh.

In 2001, road accidents caused 353,100 injuries and 80,262 deaths, with a male to female ratio of 5:1, and mortality and incidence rates of 8/100,000 and 34/100,000, respectively (NCRB 2001a). Deaths due to road accidents increased in India from 40,000 in 1986 to 85,000 by 2001 (Fig. 5). Nearly two-thirds of deaths occurred among those 16–44 years of age, with the highest rate among 30–44-year-olds (35%). The death rates among children and the elderly were 9% and 7%, respectively. The 10 States recording highest number of deaths caused by road accidents were Tamil Nadu (15.8%), Maharashtra (12.4%), Kerala (11.5%), Karnataka (10.1%), Andhra Pradesh (7.9%), Gujarat (7.2%), Madhya Pradesh (7.1%), Rajasthan (6.5%), Tripura (4.3%) and Uttar Pradesh (3.4%). The 23 metropolitan cities accounted for 12% of total deaths. Among cities, the highest number of deaths occurred in

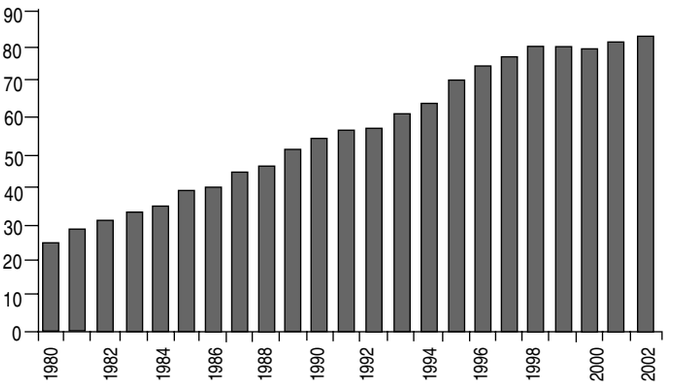

Fig. 5 Deaths due to road accidents in India, 1980–2002

Table 2. Incidence and mortality rates of injuries in India (includes all types of injuries)

Author/Agency	Place	Year	Total no. of subjects/Total population	Source of data	Injury incidence		Injury mortality	
					Number	Rate	Number	Rate
National Crime Records Bureau	India	2001	All India	Information from police records	870,839	87/100,000 per year	391,504	40/100,000 per year
Registrar General of India (SCD)	India	1998b	40,351 deaths from 1602 PHCs	Based on cause of death lay reporting	Injuries were responsible for 8% of total deaths (8.4% of deaths among males and 6.7% among females)*			
Registrar General of India (MCCD)	India	1998a	498,586 deaths from 2129 hospitals	Medically certified death	Injuries and poisoning contributed to 12% of total deaths (11.8% of deaths among males and 12.8% among females)			
Population-based studies								
Gordon *et al.*	Punjab	1962	4377 rural population	Rural, community-based study	—	115/1000	—	—
Varghese	9 villages of Haryana	1990	25,000 population from 3500 households	Rural, follow-up study	2164	80/1000	—	—
Sathyasekaran	Chennai, Tamil Nadu	1996	4333 slum dwellers	Urban slum, cohort study	542	127/1000 Men: 137; Women:118	—	—
Ashok *et al.*	Bangalore, Karnataka	2004	3538 population from 720 households	Urban, community-based study	210	51/1000	—	—
WHO	Delhi	2003b	30,554 population from 5412 households	Urban, community-based study	3566	Total 116/1000 62/1000 without disability 9/1000 with disability	46	2/1000
Gururaj *et al.*	Bangalore, Karnataka	2004b	96,569 population from 19,919 households	Urban, rural and urban slum, community-based study (hospitalized injured persons only)	Total=1112 Urban=324 Slum=343 Rural=445	Total =12/1000 Urban=10/1000 Slum=11/1000 Rural=14/1000	Total=53 Urban=13 Slum=16 Rural=24	(/100,000) Total=55 Urban=40 Slum=51 Rural=74
Verma	Faridabad, Haryana	1998	1095 population from 215 households	Rural, community-based study	102	93/1000	—	—
Hospital-based studies								
Sidhu *et al.*	Patiala, Punjab	1993	2482 cases	Urban, hospital-based study	2482	9% of total hospital admission	208	8%
Gururaj *et al.*	Bangalore, Karnataka	2000a	—	Urban, hospital-based study	—	23% of emergency room registrations	—	—
Goel *et al.*	Lucknow, Uttar Pradesh	2004	180 trauma cases	Urban, hospital-based study	—	—	55	31%

SCD: Survey of Causes of Death; MCCD: Medical Certification of Causes of Death
*No rates could be calculated due to the absence of population figures

Delhi (1736), Mumbai (1362), Chennai (761) and Bangalore (659). In these places both the human and the vehicle population have been growing at the rates of 39% (compared with 23% for India) and 15% (compared with 2.5/1000 for India), respectively.

The SCD (Registrar General of India 1998b) revealed that 2.6% of total deaths were due to vehicular accidents. The highest number of deaths were reported in those 25–34 years of age (21%), followed by 15–24-year-olds (19%), 35–44-year-olds (16%), 45–54-year-olds (15.3%), those above 60 years of age (14%), 5–14-year-olds (11.2%), 1–4-year-olds (2.5%) and those below 1 year of age (1.3%). Vehicular accidents were the tenth leading cause of death in the overall ranking. The MCCD (Registrar General of India 1998a) reported that vehicular accidents resulted in 1.5% of total (n=7258) and 16% of injury deaths. The distribution of RTIs revealed that 675 of 1161 deaths occurred in those 5–44 years of age. The incidence of RTIs in hospital emergency rooms varied from 23% to 53% in a few studies, with a male preponderance in every setting (Sidhu *et al.*1993; Verma *et al.* 2004; Gururaj 2000). The case-fatality rate varied from 5% to 10% depending on the available facilities. The incidence of RTIs in community-based studies varied from 649 in Bangalore to 2857/100,000

Burden of injuries 2000–2015

Estimating the burden of injuries is crucial for understanding the magnitude of the problem, developing mechanisms for intervention, allocating physical, human, financial resources for control of the problem, and for reducing the burden of injuries in the coming years. A review of Indian studies and observations by other agencies indicate the ratio of deaths to serious injuries needing hospitalization to minor injuries as 1:20:50. In Bangalore and Haryana this ratio was 1:18:50 and 1:29:70, respectively (Gururaj *et al.* 2000b; Varghese and Mohan 2003). A recent population-based survey of health behaviour surveillance in Bangalore has shown the ratio of completed:attempted:suicidal ideation to be 1:8:20 (Gururaj *et al.* 2004). A large-scale population-based survey of 96,569 individuals from Bangalore revealed a ratio of 1:20:40 for deaths:hospitalizations:injuries (Gururaj and Suryanarayana 2004). Thus, based on a conservative ratio of 1:20:50 for deaths, serious injuries and mild injuries, it is estimated that injuries will contribute to nearly 850,000 deaths during the year 2005, and nearly 17,000,000 persons would be hospitalized (for short or long periods). Further, nearly 42,500,000 persons would have minor injuries, incapacitating them for short or long periods during 2005 (detailed calculations are available in the original report [Gururaj 2005c]). Nearly 70% of these deaths and injuries would occur among men 15–44 years of age. Eighty per cent of these deaths and injuries would occur in rural areas, where health care is poor and deficient. One-third of disabilities are due to injuries with an estimated 70 lakh persons suffering from various disabilities. If no systematic efforts are introduced and implemented, the number of deaths due to injuries is likely to increase to 11 lakh by 2010 and 12 lakh by 2015.

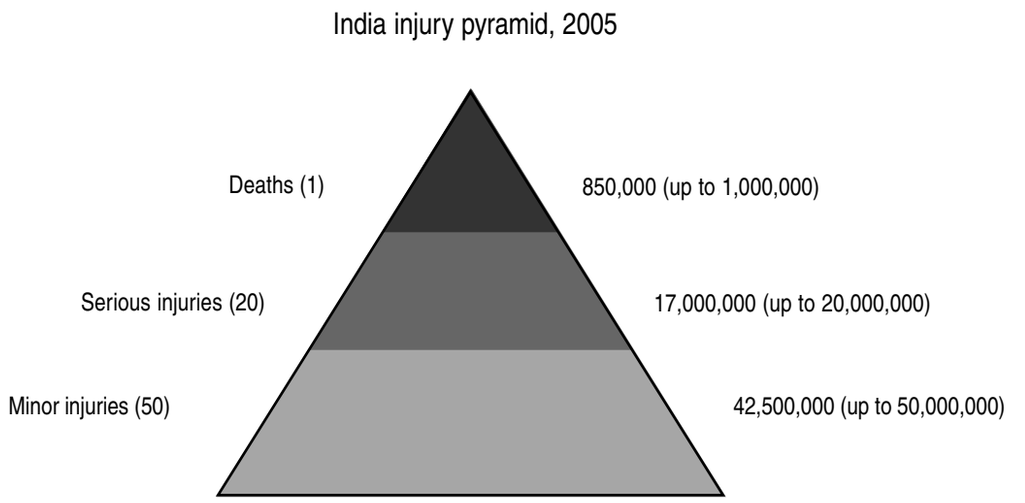

Table 3. Categories of road users injured and killed in road accidents in India

Author(s) and year	Place	Pedestrians	Two-wheeler occupants	Bicyclists	Three-wheeler occupants	Four-wheeler occupants	Heavy vehicle drivers and passengers	Others
National Crime Records Bureau 2001a and 2001b	New Delhi	9	11	3	4	17	46	7
Sidhu *et al.* 1993 (dead)	Patiala, Punjab	16	17	8		58		
Sidhu *et al.* 1993 (injured)	Patiala, Punjab	14	29	12		43		
Mohan and Bawa 1985	New Delhi	33	16	21	3	3	4	10
Jha *et al.* 2003	Pondicherry	23	23	23		10	15	7
Maheswari and Mohan 1989	New Delhi	26	39	12		1		14
Gururaj *et al.* 1993	Bangalore, Karnataka	31	35	10		1	21	3
Sathyasekaran 1991	Chennai, Tamil Nadu	28	15	29		8	4	4
Gururaj *et al.* 2000a	Bangalore, Karnataka	26	44	4		5	21	
Gururaj *et al.* 2005a	Bangalore, Karnataka	26	43	8		3	7	13
Colohan *et al.* 1989	New Delhi	20	22	1		25		32
Sahadev *et al.* 1994	New Delhi	33	40	6		4		17

in Delhi (Gururaj and Suryanarayana 2004; Jha *et al.* 2003; Varghese 1990; Sathyasekaran 1996; Gururaj 2004a; WHO 2003a). The RTI mortality varied from 33 to 56/100,000 population in different places. The ratio of deaths to injuries varied from 1:20 in Bangalore and Haryana to 1:67 in Delhi. In a recent population-based survey of RTIs and other injuries in Bangalore, the mortality and incidence rates were found to be 11 and 649/100,000, respectively. Nearly 60% of brain injuries are caused by RTIs as revealed by studies from Bangalore and Delhi (Gururaj *et al.* 1993, 2005a; Colohan *et al.* 1989). The incidence of traumatic brain injuries alone is 150/100,000, with a mortality rate of 20/100,000 and a case-fatality rate of 10% (Gururaj 2000).

Police reports capture nearly 90% of deaths and 50% of severe injuries. A recent report of the working group on RTIs estimated the ratio of deaths to serious injuries needing hospitalization to minor injuries registering in emergency rooms of hospitals to be 1:15:70 (Planning Commission 2003). This amounted to 80,000 deaths, 12 lakh hospitalized persons and 56 lakh sustaining minor injuries in the year 2000. If there is a 5% increase in RTIs every year, it is estimated that in 2004, nearly 100,000 persons would have died; 15 lakh sustained serious injuries and about 70 lakh received care for minor injuries (Mohan 2004; Gururaj 2005).

Severity and nature of RTIs

The severity, nature and outcome of road crashes is determined by the impact of the crash; the amount of energy transferred to the host; physiological factors such as age, sex, fragility of body organs; presence of protective devices such as helmets, seat belts, child restraints; nature and speed of vehicle-impacting crash; and availability, affordability and accessibility to health care. Rautji and Dogra in a study of 127 autopsy reports noticed that in a majority of cases, exsanguination (31%) and brain injury (11%) were the major causes of early deaths, while sepsis and multiorgan failure contributed to late deaths (Rautji and Dogra 2004). Sahadev *et al.* (1994) in an autopsy study of 177 RTI deaths noticed that neurological injury and haemorrhagic shock were responsible for 60% and 25% of deaths, respectively. It was concluded that 23% of deaths were preventable, 46% possibly preventable and 30% not preventable by any intervention. The average Injural Severity Score (ISS) for mortality was 37.8 in the series. As per the study of Sidhu *et al.* (1993) in Patiala, 41.3% of those dead had polytrauma and 25% had brain injury. Polytrauma was observed in 21% of those injured in road accidents (Gururaj *et al.* 2005a). Information from the Bangalore City Police for RTI deaths during 2002 reveals that 26% of victims died at the crash site, 12% during transit to hospital and 62% during or after their hospital stay (Gururaj, personal communication with the Bangalore City Police).

Varghese (1990), in a population-based survey, observed that only 11% had sustained injuries of Abbreviated Injury Score (AIS) category 2 or 3 while 87% were in AIS 1 category. Studies at NIMHANS (Gururaj *et al.* 1993; Gururaj *et al.* 2005a; Gururaj *et al.* 2000a), Bangalore revealed that minor, moderate and severe brain injuries (due to RTIs) were recorded in 60%–65%, 16%–20% and 15%–20% of cases as per the Glasgow Coma Scale (GCS) grading. Mortality was higher among those with severe brain injuries. Polytrauma was documented in 1%–21% of cases. Facial, chest, abdominal and limb injuries were documented in 48%, 3%, 1% and 10% of cases, respectively. Bharati *et al.* (1993) in Meerut reported that based on the GCS grading, 32% had severe, 25% moderate and 42% minor brain injuries at the time of admission. Mortality rates were higher among those with severe brain injuries (41%). The study at Chennai by Sathyasekaran (1991) revealed that among the victims of road accidents, 11% had life-threatening injuries, 11% had serious disabling injuries and 38% had mild disabling injuries. Thirty-eight per cent of injured persons had a serious injury to the head and face region.

Occupational injuries

The past two decades have witnessed the expansion of industries in India. Of the total employed population in the country during 2001, 17.8% (270 lakh) was in the organized sector (Registrar General of India 2001). Among the 830 lakh engaged in the unorganized sector (82.2%), agriculture was the major activity, followed by manufacturing, retail trade and other activities.

As per the International Labour Organization (ILO) (1994) estimates, nearly 2 lakh workers die annually and about 1200 lakh are injured. Nearly 50% of these deaths and injuries occur in developing countries. The fatality rates are estimated to be 30–43/100,000 in these countries, which are much higher than those in developed countries. In India, occupational injuries contributed to 2% of total deaths, 1.8% of total life-years lost due to disabilities and 2% of DALYs in 1990 (Sudhir 1998). It is estimated that 19 fatal and 1930 (1:100) non-fatal accidents occur annually per 100,000 workers (Nag and Patel 1998). The incidence of industrial injuries among employed workers was 9/1000, with a frequency of 2.6 per 100,000 man-days work (CSO 2004). As per the NCRB report of 2001, 667 people were killed in factory/machine accidents. Related deaths in other occupational categories include 446 deaths in mine/quarry disaster, 220 deaths due to leakage of poisonous gases and several work-related deaths in traffic accidents. According to the report, 2346 deaths occurred due to collapse of structures, the source of which could be work related.

A limited number of population-based epidemiological studies reveal that occupational injuries constitute approximately 10% of total deaths due to injuries and 20%–25% of all injuries. Mohan (1992) in a study of industrial workers

reported a death rate of 6/1000 workers. Varghese *et al.* (1990), in a cohort of 25,000 people from 9 villages of Haryana, observed the incidence rate of work-related injuries to be 31% over a one-year period. From a study of 2682 workers in Digboi, Assam, Sharma *et al.* (2001) reported that nearly 35% of total injuries occurred at the workplace. An incidence of 3.6/1000 workers/year was reported from Jaipur by Mathur and Sharma (1988). Malhotra *et al.* (1995) observed the incidence to be 4.1% among 2008 workers in a hydroelectric project in the Shivali range of Jammu and Kashmir. The injury incidence rate was 2% in a study in Chennai among 4333 slum dwellers (Sathyasekaran 1996). In a recent study by WHO in municipal areas of Delhi, it was seen that 2% of total injuries were work related (WHO 2003b).

Across studies, the highest number of injuries occur among men and in the economically productive age group of 21–49 years. In India, 25%–30% of injuries occur in those 16–20 years of age, 30%–45% in those 21–35 years of age and about 30% in those 36–49 years of age.

No information is available on agricultural injuries in India. Adarsh *et al.* (1998) revealed an incidence rate of 28% in phase 1 and 49% in phase 2 in a sample of 2635 workers from 9 villages of Uttar Pradesh and 30 villages of Haryana. In a review of equipment-related injuries in Indian agriculture, it was observed that 5% and 46% of injuries are caused by tractors and hand-held equipment (Adarsh *et al.* 2000). In a longitudinal study of 12,189 agricultural workers by Tiwari *et al.* (2002) in Madhya Pradesh during 1995–99, the incidence rate was 1.25/1000 workers/year. Nearly 9.2% of the incidents were fatal and 43% each were caused by tractors and snake bites. Seventy-eight per cent of all injuries were due to farm machinery, 12% due to hand tools and 11% due to other causes. Mohan and Patel (1992), in an epidemiological study in Haryana, identified 576 agricultural injuries in one year; of these, 87% were minor, 11% moderate and 2% severe injuries. It was estimated that agricultural activities caused 5000–10,000 deaths, 15,000–20,000 amputations and 150,000–200,000 serious injuries every year in Haryana, Punjab and Madhya Pradesh alone. Mittal *et al.* (1996) reported from Punjab that 9% of agricultural injuries were fatal and 91% non-fatal. The incidence rate (per 1000 machines/year) was highest for tractors (23.7), sprayers (15.5), electric motors (7.1), threshers (5.7) and cutters (2.2).

Children comprise nearly 10%–20% of the workforce in developing countries (ILO 1994). In India, 25% of children work in hazardous places especially in rural areas, slums and the unorganized urban labour sector. Both community- and hospital-based studies in India reveal that nearly 10%–15% of injuries occur among children (Mathur and Sharma 1988; Malhotra *et al.* 1995). Children are primarily involved in manual jobs exposing them to physical injuries. Banerjee (1993) in a study of 500 agricultural child workers reported an injury incidence rate of 57%.

There is no centralized agency in India to examine occupational injuries. Workers are exposed to many hazards resulting in musculoskeletal injuries. Occupational deaths are listed under general medical conditions and the underlying causes are not documented and reported; hence, the precise extent of occupational injuries is difficult to establish.

Burns and fire-related injuries

Burn injuries can be accidental, suicidal and homicidal (for details see under Injury causation, p. 337). Depending on the extent and severity of burns, and the availability and accessibility to health care, the impact of burns varies from superficial burns and scalds to damage of the internal body organs. Absence of facilities in district and peripheral hospitals, combined with traditional unscientific household practices and lack of safety systems result in high mortality and disability from burn injuries. Secondary complications of burns leading to contractures, deformities and disfigurement are extremely common. Secondary infections could lead to a number of complica-tions resulting in delayed recovery and death.

During 2001, 32,509 persons died in India due to burn injuries. This amounts to 15% of unnatural deaths (12,120 burns-related deaths classified as suicide are not included here). The various causes of burns were: electrocution (7%, *n*=5570), explosion (2%, *n*=666), fire (71%, *n*=23,043) and firearms (10%, *n*=3230). The total number of injured were 6030, indicating that burn injuries are highly under-reported (32,509 deaths *v.* 6030 injured persons). The mortality due to burn injuries was 3.5/100,000 population. The highest number of injuries occurred in the age group of 15–44 years (72%). More women suffered burn injuries compared to men (1.6:1) in all age groups, except among those 44–59 years of age (NCRB 2001).

Burns contributed to 1% of total deaths (*n*=398) and 15% of total injury deaths under the SCD, with a male to female ratio of 4:1. Under the MCCD, burns accounted for 12.5% of total deaths, with a male to female ratio of 1:2.2. Burns were responsible for 27% of total injury deaths; 15.6% were in males and 53.5% in females, respectively. Studies on hospital-based burns reveal that nearly 4%–12% of total trauma registrations are of patients with burns. The age distribution reveals that the incidence and mortality of burns are the highest in those 10–44 years of age, with 65% occurring in 15–39-year-olds. Studies undertaken in various hospitals have revealed higher admissions of women with burns, varying from 58% to 83% (Ghuliani *et al.* 1988 (83%); Singh *et al.* 1998 (62%); Kumar *et al.* 2000 (75%); Ahuja *et al.* 2002 (58%); Sharma *et al.* 2002 (75%); and Batra 2003 (80%). A population-based survey of 30,554 people in New Delhi revealed the mortality and incidence due to burns to be 10/100,000 and 955/100,000 population/year, respectively (WHO 2003b). A recent population-based study from Bangalore covering 96,569 individuals from

19,919 households reported an incidence of 2500/100,000, with a higher rate in slum (4100/100,000) and rural areas (2300/100,000) (Gururaj and Suryanarayana 2004).

Mortality on account of burns is influenced by several factors such as severity, level of care and nature of study. Mortality due to burns has varied from 8% to 56% in hospital series. Based on data from police records, the case-fatality rates varied from 6.3% among men to 44% among women in Wardha, Maharashtra. Sharma *et al.* (2002) reported a case-fatality rate of 25% in a study of burn injuries during 1994–2001. Subramanyam (1996) reported a case-fatality rate of >70% in severe burns, which is similar to that of other studies.

One of the major determinants of outcome of burn injuries is the severity of body involvement. In Indore, Madhya Pradesh, the mortality rate was 22% among hospitalized subjects with burns (Mukerji *et al.* 2001). In a study of burn injuries at Solhapur, Maharashtra, 70% of patients with >70% burns died, while only 6% died among those with <40% burns (Subramanyam 1996). Singh *et al.* (1998) from Chandigarh observed that 56% of cases had >80% burns. Septicaemia, neurogenic shock and hypovolaemic shock caused death in 55%, 28% and 15% of cases, respectively. Kumar (2000) observed that among those with burn injuries, 63% had an involvement of <20% of the body surface area. Sepsis (35%) and multiorgan failure (26%) were the major causes of death (Kumar 2000). Ahuja and Bhattacharya (2002) in New Delhi noticed that 47% of patients had >50% burns. Even among those with 60% burns, the mortality was only 6% if they reached a hospital early and received good-quality first aid at the site of injury. The major causes of death were resuscitation failure, inhalation injury or infections.

Burns-related injuries are frequent during the festival of lights (Diwali) in India. A study from two hospitals in New Delhi revealed that children were injured in greater numbers while lighting crackers. In addition, many of the injured were unaware that the application of cold water soon after suffering burns was helpful (Mohan and Varghese 1990).

Poisoning

Poisoning may be accidental, commonly suicidal and sometimes homicidal, the precise distinction of which is based on the intent and skills of investigating agencies. With the usage of pesticides since the beginning of the 1950s in agriculture, deaths and injuries due to poisoning have increased. Poisoning commonly occurs with adulterated food and alcohol, pesticides, herbicides, rodenticides, a variety of drugs such as sedatives, anxiolytics, hypnotics and barbiturates. Some types of poisoning such as those due to aluminium phosphide and plant extracts result in deaths and injuries in specific parts of India. Leakage of various poisonous gases and chemicals in industrial settings also results in a large number of cases of accidental poisoning. Poisoning by animal bites, especially snake and scorpion bites, is extremely common in rural India.

As per the NCRB reports (2001a and b), 24,775 persons lost their lives due to poisoning and only 1989 were reported as injuries (underreporting!). There were 15,304 (63.6%) deaths among males and 8773 (26.4%) among females, with a ratio of 1.8:1. Two-thirds of the total poisoning deaths were in the age group of 15–44 years. Food poisoning/accidental intake of insecticides (40.3%), consumption of spurious liquor (2.4%), leakage of poisonous gases (0.5%), snake/animal bite (27.6%) and others (29.4%) were the commonest types of poisoning. As per the SCD (Registrar General of India 1998b), poisoning caused 5% of total injury deaths, and varied from State to State. Poisoning was more common among men (63%) and in younger age groups. The MCCD report (1998a) examined 498,586 deaths from urban India and noticed that poisoning contributed to 8331 deaths among males and 4307 females, respectively, accounting for 2.5% of total deaths (2.7% among males and 2.3% among females). Within this group, poisoning and toxic effects accounted for 22.7% of deaths among males and 18% among females. Some of the hospital- and community-based studies (Gururaj 2005) reveal that those in the age group of 15–44 years are involved in higher numbers. Nearly 10%–25% of emergency room registrations (Sharma 2002) and 2%–3% of total admissions are poisoning-related. Case-fatality rates vary from 2% to 5%, with very high rates in case of aluminium phosphide poisoning.

Drowning

Drowning in India commonly occurs in rivers, ponds, lakes and wells and can be accidental, suicidal or sometimes homicidal in nature. The entire coastal belt of India is a risk-prone area. Owing to easy access to water bodies, the occupation of individuals, occurrence of natural calamities at frequent intervals, the risk-prone nature of young children and adolescents, drowning is common in India. Drowning as a suicidal method is also responsible for a significant number of deaths and is discussed under suicide.

According to the NCRB (2001a and b), 20,739 deaths (5.6% of total injury deaths) and 355 injuries (under-reporting!) were reported due to drowning in 2001; the male and female rates were 71% and 29%. Eighty-two per cent of deaths were in the age group of 15–59 years. The SCD report (1998b) reveals that 1.1% of total deaths and 18% of total injury deaths were due to drowning. Drowning was one of the top 10 killers among children 5–14 years of age (7.2%). A recent study from Vellore, Tamil Nadu among 106,000 people, reported sex-specific rates of 37 and 14 per 100,000 population among men and women, respectively (Bose *et al.* 2000). The incidence of drowning increased from 31/100,000 in 1991 to 44/100,000 population by 1997.

Falls and domestic injuries

Studies on domestic injuries are virtually non-existent in India (underreporting!). The type of domestic injury is often determined by several host factors (age, sex, residence, co-morbidity, alcohol and drugs, etc.), agent factors (a number of domestic products which are commonly used by people for day-to-day activities) and environmental factors (type of housing, flooring, roofing, safety environment, etc.). Studies on traumatic brain injuries at NIMHANS reveal that falls are the second leading cause of deaths and injuries contributing to 20%–30% of total traumatic brain injuries (Gururaj *et al.* 1993; Gururaj 2005). Nearly two-thirds of falls occur at home. Children and the elderly account for 30%–40% and 10%–20% of the total falls. Falls often result in variety of musculoskeletal injuries including fractures. The outcome of the fall is mainly dependent on the nature of the landing surface, height of fall and use of any protective devices.

As per the MCCD reports, fractures constituted 7.5% of total injuries; fractures of the skull and face, and lower limbs accounted for 52% and 24%, respectively. Seventy-seven per cent of these occurred in the age group of 15–44 years, with a male to female ratio of 3:1. Sathyasekaran (1996) noticed that the incidence of domestic injuries was 55/1000, 52/1000, 61/1000 and 56/1000 in the age groups of 0–14 years, 16–30 years, 31–45 years and 45+ years, respectively. A survey of 759 households in Bangalore revealed that domestic injuries accounted for 6% of total injuries (Ashok *et al.* 2004). A large-scale community-based survey in Bangalore revealed that domestic injuries accounted for 14% of total injuries, with the majority occurring among children and the elderly (Gururaj and Suryanarayana 2004). Common household objects were responsible for all injuries.

Animal-related injuries

Injuries due to dog-, scorpion- and snake-bites are common. In a recent WHO-sponsored community-based study of 52,731 people from urban and rural areas, 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. The highest incidence of rabies was in those 10–44 years of age (72%) (Sudarshan 2004). In a community-based study in Delhi of 30,554 individuals, 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 (WHO 2003b).

Suicide

Suicide is defined as 'the human act of self-inflicting one's own life cessation' (Shneidman 1985). Due to complex medicolegal associations and stigma, suicide has always been concealed in Indian society, severely underreported and misclassified in official reports.

The NCRB (2001a and b) reported the death of 108,506

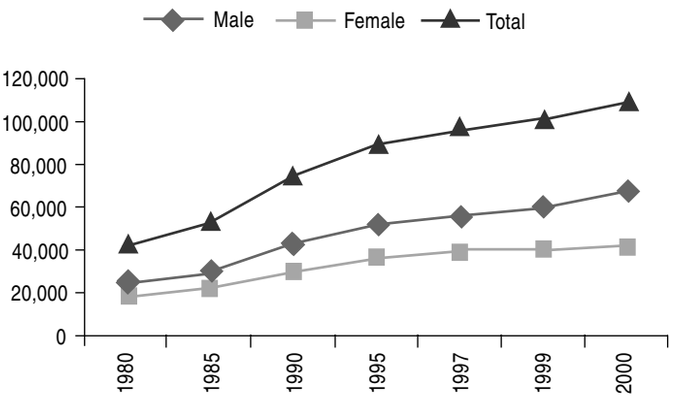

Fig. 6 Changing pattern of suicide in India, 1980–2000

persons due to suicide, with an incidence rate of 11/100,000/year during 2000 (Fig. 6). From nearly 46,008 suicides in 1974, the number of cases of suicide have nearly tripled during the past three decades. Suicide accounted for 28% of total injury deaths in 2001, with a male to female ratio of 2:1. The State-wise distribution revealed that Pondicherry (50), Kerala (29), Karnataka (24), Tripura (25), Tamil Nadu (18), Maharashtra (15), West Bengal (17), Goa (17), Andhra Pradesh (13) and Sikkim (15) reported higher than the national average rate of 11/100,000. The 23 metropolitan cities of India contributed to 9% of total suicides, revealing that a large majority of suicides occur in rural areas, *taluks* and districts of India. The cities of Bangalore, Chennai, Delhi and Mumbai recorded nearly half (49%) the number of suicides reported from other cities. In the age groups of 15–29 years and 30–44 years, the rates of suicides were 36% and 34%, respectively. Hanging (26%), poisoning (38%), fire/self-immolation (11%) and drowning (8%) were the commonest methods of committing suicide in India.

The SCD, covering 26 States, revealed that suicide accounted for 3.2% of total deaths, 25% of total injury deaths, and is the ninth leading cause of death in India. Of the total of 1107 suicides, 28.8%, 26.8%, 16.3%, 14.2% and 11.4% were in the age groups of 15–24 years, 25–34 years, 35–44 years, 45–59 years and 60+ years, respectively. Suicide was the leading cause of death among women 15–44 years of age (11.3%). The MCCD survey, covering 498,586 medically certified deaths, revealed that suicide (n=3032) accounted for 8% of total injury deaths (n=54,709).

Several researchers in India have examined suicide based on analyses of police data. These studies reveal regional differences, with suicide rates, which vary from 8/100,000 to 95/100,000 population (Gururaj and Isaac 2001a). The majority of studies are based on analyses of police or hospital records with the assumption that all suicides are reported to the police and misclassifications do not exist. An in-depth community-based study in Vellore, Tamil Nadu (Aaron *et al.* 2004) reported the incidence to be 95/100,000 population based on verbal autopsy methods. The male and female rates were 58 and 148/100,000, indicating a three-fold higher rate among women. A recent study from

Bangalore observed that the incidence was 35/100,000 population for completed suicide and 250–300/100,000 for attempted suicide, with 60% of deaths occurring in the age group of 15–34 years (Gururaj and Isaac 2001a). These studies clearly indicate that many cases of suicide may not be reported to the police. Several hospital-based reports have revealed the incidence of suicide among the hospital-based population to vary from 5% to 15% of the total emergency and medical admissions (Gururaj *et al.* 2005b and c).

Violence

The WHO (2002b) defines violence as 'the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, which either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation'. The types of violence are broadly classified as self-directed violence (deliberate self-harm or suicide), interpersonal violence (family and intimate partner violence and communal violence) and collective violence (social, political and economic violence). The nature of violent acts could be physical, sexual, psychological and involving deprivation or neglect. In 2000, an estimated 16 lakh people died as a result of violence globally, with an age-adjusted rate of 29/100,000 population. Half of these were suicides, one-third homicides and one-fifth war-related deaths (WHO 2002b).

The epidemiology of violence in India has been least understood, since violence is not considered a health problem. As per the NCRB reports, 44,394 persons were killed and 191,340 injured, with an annual mortality and incidence of 5/100,000 and 20/100,000 population, respectively during 2001. The problem, pattern and causes of violence vary significantly across rural/urban areas, between ages and sexes, and in different socioeconomic groups. The incidence of crimes as per the Indian Penal Code (IPC) in Kerala, Rajasthan, Madhya Pradesh, Tamil Nadu, Gujarat and Karnataka was higher than the national average of 177/100,000 population. Similarly, 15 of the 23 metro-politan cities reported higher rates of crime compared with the national average.

Indian cities contributed to only 10% of violence-related deaths and injuries. Among the total crimes, 13% were violent and nearly 50% of these had affected an individual's life directly and indirectly. The age groups of 18–30 years and 31–50 years accounted for 42% and 40% of deaths, respectively. Homicides registered an increase from 22,149 in 1980 to 44,394 by 2001. In 2001, an increase of 4.1% in the crime rate against women was officially recorded in India. Nearly 142,375 episodes of violent acts were reported among women during 2001. Rape (11%), dowry deaths (5%) and cruelty by husbands and relatives (35%) were the common patterns. The rate in urban India, especially in cities, was 19/100,000 which is much higher than the national figures. The offenders were known to victims in 87% of instances, 30% of them being neighbours. In the SCD (1998b), homicides constituted 1% of total deaths (n=476) and 7% of total injury deaths. The highest number of deaths (82%) occurred in the age group of 15–44 years, with a male to female ratio of 4:1. As per the MCCD report, 3535 deaths were related to acts of violence during 1998, resulting in 8% of injury deaths. The male to female ratio was 3:2. The highest number of deaths occurred in the age group of 15–44 years (79%).

In a recent examination of domestic violence in the cities of Thane, Bangalore and Mumbai (International Center for Research on Women 2000), it was observed that women subjected to violence approached official agencies only as a last resort (Haq 2000). As per a pioneering study undertaken in seven India cities (n=9938) during 1997–99, domestic violence is common in India. Overall, 45% of women reported experiencing at least one physical or psychological violent act in their lifetime. Thirteen per cent reported being subjected to physical violence (kicking, beating, burning) more than three times. In the total sample, 15% reported sexual abuse in the past 12 months. Among women subjected to violence, 30% felt ashamed to seek help, 30% were managed at home and 30% did not have economic access to help (International Clinical Epidemiologists Network 2000). In a recent study undertaken by Yuganatar Education Society, Nagpur (Planning Commission 2004), 1250 families were studied from the States of Andhra Pradesh, Chhattisgarh, Gujarat, Madhya Pradesh and Maharashtra; 250 families were selected from each State on a random basis. Seventy-eight per cent of women were in the age group of 18–40 years. Shockingly, 84% had experienced violence in one form or the other; 74% had experienced physical violence and 10% sexual abuse. Nearly 90% had undergone emotional abuse regularly. Seventy-three per cent had been subjected to violence for more than a year (Planning Commission 2004).

The extent of violence in population-based studies is observed to vary from 10% to 20% across studies (Gururaj *et al.* 2005c). However, studies using qualitative research methods, which are focused and in-depth in nature, indicate that nearly one-third to half of women reported experiencing violence at regular intervals. Even studies among men have revealed that nearly 20%–30% had agreed that they had inflicted violence on their spouses (Narayana 1996).

Some hospital-based studies have reported the rate of violence to vary from 8% to 77% in different States. Nearly 5% of hospital-based mortality was due to violence as per the study conducted by Sidhu *et al.* 1993 in Patiala. The only autopsy study from Manipal, Karnataka revealed that violence was the cause of death in 31% of total autopsies (Kumar *et al.* 2000). Studies on traumatic brain injuries have reported that nearly 10%–15% of hospital admissions and 5% of mortality are related to violence (Gururaj *et al.* 1993, 2005a).

Impact of injuries

Economic impact

An injured person has to spend resources for care at different levels—before reaching the hospital and after discharge for transport, drugs, admission, investigation and interventions, depending on the place of care. The rehabilitation costs can be huge in certain types of injuries such as RTIs, burn injuries, violence and work-related injuries. Loans taken or savings spent put a strain on the resources of the family. With much of the care in public hospitals being subsidized, the costs to the public health care system can be enormous. The majority of the survivors with moderate and severe grades of injuries and their families experience life-long psychosocial impact and have a poor quality of life. Damage to goods, property and vehicles lead to repair costs based on the extent of damage. Work absenteeism leads to loss of productivity and indirect losses to the employer. In addition, related costs in medicolegal cases can be huge. Even costs towards funeral expenses may be substantial for a family with no income. Health care system costs in terms of investments in manpower, equipment, infrastructure and supplies are phenomenal and occupy 70%–80% of the allocated budget under trauma care. Due to lack of research, no comprehensive data are available from India on the impact of injuries.

Recent estimates from Global Road Safety Programme indicate the costs of RTIs alone to be 1% of the total GDP. Nearly 75% of RTI victims were earning members, with 9%–45% being sole earners (Ghee *et al.* 1997). In a recent study by Mohan (2004), the economic impact of RTIs was estimated to be Rs 55,000 crore, nearly 3% of the GDP, much higher than the 2% in high-income countries. In a population-based survey of 96,569 individuals from 19,919 households in Bangalore, the incidence of mortality due to RTIs was 23/100,000, with rates in poor and non-poor communities being 31 and 17/100,000, respectively (Aeron Thomas *et al.* 2004). The incidence of serious injuries was 212/100,000, with a higher rate among poor communities (238 *v.* 186). The majority of households reported a decline in earnings after injury; further, many had to borrow money from external sources for survival and only 5% received compensation from insurance agencies or their employers. The poor spent Rs 6000–25,000 (average Rs 18,000), while the non-poor spent Rs 32,000 (average Rs 27,000) on medical costs. The costs of property and vehicle damage varied from Rs 10,000 to Rs 25,000 across different groups. The economic loss due to nearly 108,595 suicides, and attempted suicide and suicidal ideators (10 and 100 times the number of suicides) has never been examined in a comprehensive way (Gururaj and Isaac 2001a and b). Similarly, the economic impact of violence resulting in nearly 40,000 homicides and a large number of other acts of violence is also not clearly known. It can be 'guesstimated' that injuries cost nearly 5% of the GDP for India.

Injury and disabilities

Disabilities due to injuries will increase significantly in the coming years (Suresh 1997). Disabilities of speech, hearing, neurological functions, vision, locomotor activities and psychosocial functioning are direct outcomes of injury. The pattern of injury, nature of body organs injured, extent of damage, and availability and utilization of rehabilitation services influence and determine the type and extent of disability. There is no information available in this area from India, except isolated studies in individual settings. However, nearly 100% of those with severe injuries, 50% of those with moderate injuries and 10%–20% of those with minor injuries carry disabilities of a physical and/or psychological nature requiring long-term rehabilitation services (Gururaj 2000). Using the Glasgow Outcome Scale, it was observed that nearly 1%–2% of persons with brain injury leave the hospital in a persistent vegetative state (Gururaj *et al.* 2005a). Many patients with fractures and bone injuries need short- to medium-term rehabilitation services. Disfigurement, chronic physical pain, loss of vision and hearing, neuropsychological disabilities such as memory problems, information processing problems, post-traumatic headache, post-traumatic epilepsy, post- traumatic syndrome are some common complications of RTIs.

The disability rate in India was 1.9% of its population in 1991; it increased to 2.1% in 2001, as per the 2001 Census. Injuries of various types are directly responsible for one-third of disabilities (National Sample Survey Organization (NSSO) 1994; Suresh 1997). Based on this estimate, nearly 70 lakh people are disabled due to injuries. As per the 47th round of the National Sample Survey (NSS) (NSSO 1981), the prevalence of injury-related visual disability was 35/1000 in rural and 32/1000 in urban areas. Similarly, the prevalence of injury-related speech disability was 32 and 47/1000 in urban and rural areas, respectively. Burns caused locomotor disability in 211 and 225/1000 population in urban and rural areas, respectively. The survey revealed that disabilities of all types were higher in rural areas, and more among men.

As per the NSSO (2003) report, the prevalence of mental retardation, mental illness, visual, hearing, speech and locomotor disabilities was 4%, 7%, 11%, 10%, 5% and 53%, respectively. Injuries caused the above-mentioned disabilities in 30 (head injuries only), 50, 51, 56 and 279 per 1000 population, respectively (mental retardation has not been included as most of the causes are congenital). The incidence of disability (in the past 365 days) was 69/100,000, with almost similar rates for urban and rural areas.

In a study of 425 persons with brain injury, it was observed that at 4 months' follow-up 42% had not recovered totally and 6% had died due to complications. Many disabilities in physical and cognitive areas were observed, which required rehabilitation (Gururaj *et al.* 1993). In a two-year follow-up of brain injuries by domiciliary visits in Bangalore, nearly 35% had problems in the health, social

and economic spheres of life, and more than 30% continued to have problems at the end of the second year. The quality of life was poor in 30% of persons with brain injury at 2 years' post-discharge (Gururaj *et al.* 2005a). From a hospital-based study at NIMHANS on persons with brain injuries caused by RTIs, falls and violence, it was observed that 46%, 30% and 24% were suffering from severe, moderate and minor disabilities at the time of discharge (Taly *et al.* 1996).

Injury causation

It is believed that injuries are events due to risky behaviors and human beings do not care for their safety. Absence of research in injury causation and mechanism has resulted in the belief that human being alone is responsible for every injury, thus resulting in trying to change his/her behaviour by only increasing his/her awareness.

Research in the past two decades has revealed that injuries occur due to a complex interaction of human, agent (vehicle/products) and environmental factors in any socioeconomic and political context (Berger and Mohan 1996). A precise and scientific understanding of these problems has resulted in a dramatic and significant reduction of deaths and injuries in high-income countries. However, in India, no systematic and scientific studies are available to highlight specific human, agent and environmental factors responsible for several types of injuries. Limited data indicate that excessive speed, non-usage of helmets, driving under the influence of alcohol, poor road design and infrastructure-related factors, poor visibility and crashworthiness of vehicles are some major risk factors for the increasing number of RTIs. The causes of other injuries are not clearly understood in India. A substantial number of deaths (nearly 30%–40%) occur at the injury site and before the injured persons get definitive care. Comprehensive trauma care in India (including emergency, acute care and rehabilitation services) is in total disarray amid disparities of high technology and sophistication in urban areas and non-availability of care elsewhere. Deficient emergency care, non-availability of physical and medical resources and lack of skilled staff lead to sub-standard care and unnecessary referrals resulting in an increase in secondary injuries. As nearly 60% of care is provided by the private sector, affordability of care is a matter of concern for the poor and middle-income groups.

Road traffic injuries

The WHO report on road traffic injury prevention has outlined four sets of risk factors contributing to RTIs (WHO 2004a). These are (i) factors related to exposure (economic and demographic factors; land-use planning practices; mix of motorized and non-motorized traffic; and lack of focus on integrating road functions with speed, design and layout), (ii) factors influencing crash involvement (excessive speed; use of alcohol and drugs; young male; being vulnerable road users (VRUs); poor visibility; vehicle factors and poor eyesight of the road user), (iii) factors influencing severity of the crash (human tolerance; high speed; non-usage of seat belts; non-usage of helmets; presence of objects on the road; consumption of alcohol; and insufficient vehicle protection against crash), and (iv) factors influencing the severity of post-crash injuries (inadequate prehospital and emergency care; deficient trauma care in care facilities and delays in care).

A review of the road safety scenario in India and other developing countries undertaken by Mohan and Bawa (1985), Mohan (1992, 2002, 2004) and Tiwari *et al.* (1998) at Transportation Research and Injury Prevention Programme (TRIPP), Delhi has identified various issues and factors for the increase in road deaths and injuries in India. Some reviews by the road safety cell of the Ministry of Transport have also raised areas of critical concern (Sarin *et al.* 2000). Studies undertaken by NIMHANS during the past decade have identified non-usage of helmets, drinking and driving, speeding, two-wheeler safety, pedestrian safety and trauma care as the key issues (Gururaj *et al.* 1993; Channabasavanna and Gururaj 1994; 2000a; 2004b and 2004c.

Some important issues concerning increase in RTI deaths in India can be summarized as follows:

- States with rapid motorization rates have experienced greater deaths and injuries indicating that higher exposure combined with the absence of safety norms are a major factor.
- Even though Indian highways comprise only 2% of the total road network, they account for more than 25% of fatal injuries, indicating specific causative factors in national highways.
- Significant differences exist in RTI patterns between cities and rural areas (only 11% occur in cities), highway and non-highway injuries, arterial and non-arterial roads, and different environments.
- VRUs in India are pedestrians, riders and pillion riders of motorized two-wheelers and bicyclists. Nearly 75% of deaths and injuries occur among them.
- Thirty to forty per cent of total deaths and injuries occur among motorized two-wheeler riders and pillion riders due to absence and poor enforcement of laws related to helmet use.
- Nearly one-third of deaths and disabling injuries in India occur among pedestrians due to lack of safe walking spaces, crossing facilities and visibility factors.
- High speeds along with the absence of traffic coordination and calming facilities are major factors responsible for the increase in RTI deaths.
- Alcohol consumption by road users is a major risk factor and causes nearly 30%–40% of night-time road crashes.
- More RTIs occur during night and early morning hours due to poor visibility of vehicles and roads. Poor, inappropriate design and maintenance of roads is a significant factor.

- Deteriorating traffic law enforcement due to the absence of enforcing teams, skills, facilities and resources is a contributory factor.
- Emphasis on road user education is not accompanied by changes in road engineering, enforcement, trauma care and systems improvement. Thus, there has been no decline in the number of deaths and injuries.
- 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 are major factors for the increase in deaths and disabilities.
- Scientific crash investigation, analysis, dissemination of information are absent in India.

Work-related injuries

The causes of work-related injuries are not clearly known in India. Various machines and equipment (old and unsafe/new and unknown), factors linked to workers (age, sex, co-morbidity, use of protective devices, alcohol, lack of experience), complex and unsafe work environment (exposure to extremes of heat, chemicals, fumes, ill-ventilated places, etc.) combined with a lack of safety systems (lack of inspection, safety audits) contribute to injuries and deaths. Common causes are falls, being struck or hit by objects, impact of hot fumes and chemicals, inhalation of toxic fumes, etc. Absence of emergency and trauma care, inadequate care provided by local practitioners combined with various dangerous home remedies aggravate injuries and complications, especially in rural areas and districts.

Burn injuries

Burns are caused by a number of agent factors such as chemicals, hot liquids, fumes and electrical items. Leakage of kerosene stoves, the practice of low-level cooking, use of synthetic, loose-fitting garments have been cited as major causes of burns at home by a number of authors (Ghuliani 1988; Subramanyam 1996; Singh *et al.* 1998; Kumar *et al.* 2000; Ahuja and Bhattacharya 2002; Gupta *et al.* 1996; Bhalla *et al.* 2000). Unsafe crackers used during festivals result in death, blindness, disfigurement among a number of children, though no official figures are available (Mohan and Varghese 1990).

Suicides

The causes of suicide have their roots in the social, economic, cultural, psychological and health status of an individual. In many cases the causes of suicide are multifactorial, cumulative and progressive (Gururaj and Isaac 2001b). The causes of completed and attempted suicide are different, though some commonalities are observed. As per the NCRB report (2001b), family problems (21%) and presence of illness (21%) were the two major causes. Unknown and other causes accounted for nearly 50% of suicides indicating that suicides are not investigated in totality. The 'other' causes comprised disappointment in love affairs (3%), poverty (2.4%), economic bankruptcy (2.5%), unemployment (2.4%) and dowry dispute (2.3%). No clear conclusions can be drawn from such findings for developing specific and targeted interventions.

Among the various social factors, disturbed interpersonal relationships with family members, maladjustment with the spouse and in-laws, and broken relationships have emerged as major causes in nearly 10%–50% of suicide across independent studies. Marriage has been found to have both a protective and stressful role in the aetiology of suicide. Several economic factors such as unemployment, sudden economic bankruptcy and chronic economic deprivation are responsible factors in nearly 15%–25% of suicides, especially among men. Dowry disputes are responsible for more than 50% of suicides among young married women (NCRB 2001). Among major mental health problems, depression (14%–67%), schizophrenia (2%–12%), alcoholism in the self or spouse (7%–35%), affective disorders (10%–22%), drug dependence (3%–6%), adjustment disorders (13%–38%), obsessive–compulsive disorders (4%), and mood and personality disorders (11%–38%) have been identified among those with completed and attempted suicide (Tousignant *et al.* 1998; Venkoba Rao and Madhavan 1983; Patel and Gaw 1996; Vijay Kumar and Rajkumar 1999; Vahia *et al.* 2000; Krishnamurthy *et al.* 2000; Chandrashekaran *et al.* 2003; Gururaj and Isaac 2001a). In recent years, it has become known that genetic predisposition and vulnerability combined with neurotransmitter imbalance (often precipitated by social and economic factors) are the causes of suicide (Du *et al.* 2001; Diego De Leo 2002). A lower concentration of serotonin or 5-hydroxy indole acetic acid (HIAA) has been observed by Indian researchers. However, not much work has been carried out in India in this regard.

In a case–control study of 100 suicides (Vijay Kumar and Rajkumar 1999) in Chennai, it was observed that the presence of Axis I mental disorder in the individual (odds ratio [OR] = 19.5), family history of psychopathology (OR = 12.75), presence of negative life-events in the previous months (OR = 28.5), widow/separated/divorced status (OR = 12), personality disorder (OR = 9.5), previous suicidal attempts (OR = 5.2) and presence of medical illness (OR = 4.5) were the major risk factors. A recent case–control study at NIMHANS revealed that a combination of risk factors and absence of positive protective factors were responsible for suicide (Gururaj *et al.* 2005b). Unresolved family conflicts (OR = 22.7), presence of negative life-events (OR = 15.1), unemployment (OR = 6.2), sudden economic bankruptcy (OR = 7.1), domestic violence (OR = 6.9), alcohol consumption by self (OR = 23.4) and spouse (OR = 6.1), previous history of suicidal attempts (OR = 42.6), and presence of a mental illness (OR = 11.1) were major risk factors for suicide. Accompanying these factors were

absence of a positive outlook (OR = 269.1), problem-solving skills (OR = 56.1), coping abilities (OR = 46.1), help in crisis situation (OR = 10.1), and communication abilities (OR = 10.1). Srivastava *et al.* (2004) examined 137 cases of attempted suicide with matched controls in a hospital setting in Pondicherry and identified unemployment (OR = 15.82), lack of formal education (OR = 3.1), stressful life-events (OR = 3.95), physical disorders (OR = 3.12), and presence of idiopathic pain (OR = 6.78) as important risk factors. A recent study, using qualitative methods of psychological autopsy, revealed that causative factors are multiple and operate in an interactive, progressive and cumulative manner in the majority of suicides (Gururaj *et al.* 2005b).

Violence

The causes of violence could be broadly classified under individual, family (relationship), community and societal factors (WHO 2002b). Each of these are interlinked in a complex manner and precise distinctions are difficult. No systematic and carefully evaluated population-based data are available to quantify and qualify causes of violence in Indian studies. The causes vary among the sexes, age groups, location, and type and severity of violence based on the individual researcher's initiative and interest. National-level data are highly underreported as many do not seek help or register a case with the police due to fear, stigma and legal complications.

Among various social factors, age, gender, education, socioeconomic status and place of residence have been associated with violence (Vijayendra 1997). Violence is often found to be inflicted by the husband (54%), mother-in-law (37%) and other family members (10%) as reported by some of the studies. The occurrence is high among women, especially those belonging to lower socioeconomic groups and younger age groups (Rathod 2002; Jejeebhoy 1998). The role and status of women, lack of education and employment opportunities, and patriarchial nature of families have a major influence on violence against women (Datta and Misra 2000; Martin *et al.* 2002). Social status, dependence, responsibility and issues with regard to family and extramarital relations have also been found to be influencing factors (Unisa 1999). Property disputes are a major cause of violence among men. Male dominance, role and rights of women, sexual abuse of women, and their position within the family are also found to be associated with violence (Malhotra and Sood 2000; Vijayendra 1997; Segal 1999). Alcohol usage and dependency, personality and mood disorders, aggressive behaviours, stressful states and poor coping abilities have been incriminated in the aetiology of violence (Heise *et al.* 1994; Helen 1999).

Information from India on causative factors and mechanisms of poisoning, drowning and other injuries are not known.

Injury prevention and control

With the realization that injuries are caused by a complex interaction among agent (vehicle, product), human and environmental factors operating in complex sociopolitical and economic systems, injury prevention and control depending on evidence-based research is gaining momentum all over the world. High-income countries have made significant progress in the past 2–3 decades by developing comprehensive, integrated and intersectoral approaches based on scientific understanding. This has resulted in a decline in death and disability due to injuries. The lessons learnt so far reveal the following:

- Injury prevention and control is an intersectoral activity requiring inputs from different sectors such as the police, road transport, road engineering, health, education, the media and others.
- It is an integrated activity as multiple interventions need to be combined to obtain the best results and greater success.
- It is best developed by a systems approach by integrating several components for each intervention.
- It is in need of active inputs in terms of resources, support and cooperation of policy-makers, professionals, public and the press (media); political commitment is crucial in this process.
- It should be implemented according to a public health approach of identifying the problem, delineating risk factors and mechanisms, developing, prioritizing and implementing interventions, and evaluating them for cost-effectiveness, sustainability and culture specificity; ad hoc and crisis-oriented approaches do not lead to a real decline in deaths and disability.
- Injury prevention and control is possible only with the development of institutional mechanisms for research, policies and programmes.
- It is dependent on development, implementation and evaluation of programmes at local, State and national levels.
- It is based on the combined approaches of engineering, enforcement, education and emergency care (4 Es), resulting in economic benefits.
- It needs many passive countermeasures (requiring minimal or no action by the individual), as implementing active measures (requiring voluntary human efforts) is difficult and time-consuming.
- Investments made in prevention and control are beneficial to society in the long run.

To decrease the burden of death and disability from injury, a spectrum of activities ranging from surveillance and basic research to prevention programmes to trauma management is required. Large gains can be made from prevention and hence major emphasis should be placed on this approach (WHO 2004a).

Analysis of injury data is crucial for developing relevant, cost-effective, culture-specific and sustainable interventions. William Haddon Jr proposed a matrix for various strategies that have revolutionized injury prevention and control programmes all over the world (Haddon 1968). With this approach, causes can be identified before, during or after an injury at human, vehicle/product and environment levels, thus helping in developing interventions at different stages.

These strategies can be translated into action through the 4 Es of injury prevention and control, viz. Education, Engineering, Enforcement and Emergency care (Robertson 1983; Berger and Mohan 1996; Christopher and Gallanger 1999). Educational methods rely on provision of information to people with the premise that individuals will change their behaviour and take knowledge-based action on their own. Engineering approaches involve modifying injury-causing products to make them less injury prone or undertaking environmental modifications which make them safer. Enforcement strategies rely on application of various laws in society to control or regulate human behaviour for reducing risk. Emergency and trauma care aims to provide high-quality services to minimize injuries and death, in the event of an injury. A detailed discussion on the merits and demerits of these individual approaches is beyond the scope of this report; combined approaches yield better results. However, it is important to note that in India, injury prevention strategies focus mainly on educational approaches (Gururaj 1998). The recent WHO report on RTI prevention (2004a) highlights that 'when used in isolation, education, information and publicity do not generally deliver tangible and sustained reductions in deaths and serious injuries. Although such efforts can be effective in changing behaviour, there is no evidence that they have been effective in reducing rates of road traffic crashes'. The lessons learnt also reveal that passive interventions (requiring minimal action from individuals) are much more effective than active interventions. However, India has to do much more through a systems approach than merely trying to change people's behaviour by passive approaches.

Road traffic injuries

Road traffic injuries can be effectively reduced by several interventions such as reducing individual exposure by investing in and improving public transportation in all places; separation of slow- and fast-moving traffic on all possible roads; promoting traffic-calming measures by scientific methods; reducing speeds on roads, especially on highways and in all residential areas; mandatory helmet laws, seat-belt laws and their strict implementation in all States; implementing strict programmes on drinking and driving by the police; improving the visibility of vehicles (brighter, reflective colours) and roads in all places (at vehicle design and road formation levels and thereafter); applying international safety standards for all vehicles and roads; improving safety on existing roads, and incorporating road safety audits, on all newly built roads; and restrictions on motorcycle engine power. Scientific evidence exists for most of these interventions and they only need proper implementation (WHO 2004a).

Burn injuries

Burn injuries can be reduced by instituting fire safety systems and laws in all public places, and their strict implementation; developing safer stoves; products such as electrical items should come with appropriate safety criteria and standards; promoting less inflammable fabrics; educating the community on safer first-aid practices such as applying cold water soon after sustaining burns; and improving the quality, design and structure of buildings and houses.

Occupational injuries

Occupational (including agricultural) injuries can be prevented by ensuring industry-specific protective devices such as gloves, eye shields, facemasks, etc. for all workers and necessary enforcement of safety laws; strict and periodical inspection of all workplaces for safety norms and standards, and instituting remedial measures in hazardous places; all agricultural equipment should be made safer, especially fodder cutters and threshers; establishing national safety standards for all machines and tools in the manufacturing sector; and eliminating child labour and extending protection systems by all methods.

Poisoning

The measures that can reduce poisoning-related deaths are making available essential antidotes for treatment of poisoning at all levels of health system; promoting child-proof containers for all medicines, pesticides, kerosene, etc.; establishing guidelines and norms for the manufacture, distribution, promotion and sale of pesticides across the country (limiting easy availability of these should gain priority); establishing regulatory mechanisms for limiting the easy availability of drugs and organophosphorus compounds to prevent misuse by vulnerable people.

Suicide

Some strategies likely to reduce suicides in India are: limiting/regulating the easy availability of organophosphorus compounds and drugs; enhancing the skills of primary care and family physicians for the recognition and treatment of mental health problems and those experiencing violence; early recognition and treatment of those with depression, alcoholism and other mood and personality problems; increasing social support systems (especially for people in distress situations); educating media professionals to be more responsible in reporting suicide; and enhancing counselling facilities in all hospitals,

educational institutions and workplaces. Strengthening and supporting programmes to destigmatize suicide, facilitating mechanisms to decriminalize suicide by modifying existing laws, and promoting community awareness programmes on suicide prevention can also reduce the number of suicides. Broader mechanisms of social and economic security for distressed populations can be of considerable help.

Violence

Implementing health screening for violence in all health care institutions; early recognition of victims of violence; enhancing health and social support systems; promoting counselling mechanisms in hospitals, schools, colleges and workplaces; limiting access of weapons and alcohol to young people; and imposing meaningful restrictions on depiction of violence (and sex) in the media can reduce violence. Promoting violence reduction programmes in the community by greater awareness, facilitating conflict-resolution techniques at the family and interpersonal levels, enhancing educational and employment opportunities for women and children (especially in rural areas), and reducing gender inequalities across society will go a long way in reducing violence in India.

Trauma care system

A trauma care system encompassing prehospital (emergency), hospital (acute care) and post-hospital (rehabilitation services) care is an essential component of preventive and control strategies. With the organization and delivery of health care being a State subject, wide disparities in health care delivery are noticed in different parts of the country. Among the plethora of intervention strategies, selected ones need to be prioritized based on technological availability, cost-effectiveness and sustainability, along with professional support and people's participation. Political support for injury prevention is important in India. Injury prevention and control requires active participation of and inputs from professionals from the transport, police and road engineering departments; sectors such as health (public health specialists, physicians, surgeons, trauma care professionals, psychologists, paediatricians, etc.), law, education, social welfare, biomechanics, the media, agriculture, industry; vehicle and product manufacturers; industry and larger civil society.

In India, more than half the health care is provided by the private sector. Teaching, non-teaching and corporate hospitals are the major providers of secondary and tertiary health care in cities. So far, no attempt has been made to include these resources in the trauma care system, where appropriate. The private sector also includes family physicians, clinics and nursing homes, missionary hospitals and unqualified traditional healers, who provide varied care depending on the available facilities and paying power of people. Trauma care is in early stages of development, the budget for primary and secondary trauma care is grossly inadequate; health functionaries are unskilled; disparities exist within States. A strategy for integrated, coordinated trauma care and injury prevention activities needs to be developed in India.

Prehospital and emergency medical care

An injured patient needs (i) treatment for life threatening injuries to maximize the likelihood of survival, (ii) treatment for potentially disabling injuries to minimize disabilities and promote return to optimal functioning, and (iii) reduction in pain and suffering (Mock *et al.* 2004). Deficiencies in trauma care are due to lack of skilled human resources, physical resources in terms of infrastructure, equipment and supplies, and the process of organization and delivery. Often, there is a lack of evaluation and quality assurance mechanisms to monitor systems. Recent studies and an extensive review of the literature point to the fact that there has been nearly 15%–30% reduction in deaths in different parts of the world due to better organization of overall trauma care at different levels (WHO 2004a; Mock *et al.* 2004).

According to Trunkey (1983), 50% of deaths occur within the first hour, 30% between 1 hour and 1 week, and 20% occur after the first week. The 'golden hour' and 'platinum hour' highlight the importance of early trauma care. Important factors responsible for increasing secondary injuries and complications are non-availability of first aid, delay in transfer of patients from the injury site to a hospital, lack of definitive treatment in first-contact hospitals (such as first aid, recognition of internal body organ injury), absence of triage (matching patients to hospitals according to the severity of injury), and external medicolegal problems (waiting for the police to arrive and move the patient; legal problems; lack of provision of care by hospitals). In a recent study in Bangalore (Gururaj *et al.* 2005a), those who were provided first aid at or near the injury site, transported early to a definitive hospital for management, reached a definitive hospital directly on their own or after the first medical contact had better survival and outcome (lesser grades of disability measured on Glasgow Outcome Scale).

An emergency medical services (EMS) system is an integral part of a comprehensive health system, which provides for the organization of personnel, facilities, logistics and equipment for effective and coordinated delivery of health care services covering all geographic areas of the country under emergency health conditions (WHO 1983). First aid is defined as 'measures taken by lay people in cases of injury to prevent deterioration in condition and to maintain vital functions until definitive help becomes available' (Berger and Mohan 1996). Considerable good may be accomplished by ensuring that victims receive life-sustaining care within a few minutes of injury (Mock 2003). Even in countries with limited resources, many lives may

Role of the health sector

Health professionals have been responsible for providing curative and partial rehabilitative services to trauma patients. With the realization that 'injuries are no more accidents', the health sector and health professionals have a major role to play in the prevention, management, rehabilitation and development of injury prevention and control programmes. Injuries have been neglected events in India for a long time due to lack of initiatives in the area of prevention. The health sector can play an effective role in injury prevention and control by:

- Providing appropriate emergency and prehospital care programmes, especially in district, taluka and rural hospitals
- Introducing trauma audits at all levels by establishing minimal care guidelines
- Adequate provision of physical, technical and human resources at all levels of the health care delivery system
- Developing cost-effective, culture-specific and sustainable rehabilitation programmes, especially in rural areas.
- Promoting implementation of evidence-based interventions in societies and evaluating them for effectiveness
- Actively supporting and evaluating interventions such as helmet-use promotion, reducing alcohol drinking and driving, health screening for suicidal and violent persons, enhancing after-care services, etc.
- Strengthening capacity building and manpower development by improving the curricula of medical, nursing and allied education programmes
- Enhancing the skills of health professionals in trauma care to avoid time delays and inappropriate referrals
- Systematically collecting data on the injury problem, pattern, severity and outcome at all levels of the health care delivery system by injury surveillance and trauma registries
- Strengthening research on understanding injury/risk factors and mechanism
- Including injury prevention and control in all developmental programmes by integrating them with ongoing programmes
- Advocating for the scientific development of injury prevention programme at national and State levels
- Networking with related sectors of police, transport, social welfare, women and child development, NGOs, education, the media and others to develop an intersectoral approach by taking a leadership role
- Educating all sections of society, especially patients and families, on the use of safety approaches in day-to-day life.

be saved and many disabilities prevented by teaching motivated people what to do at the scene of accident. The foundation of an effective prehospital trauma care system may be laid by recruiting carefully selected volunteers and non-medical professionals to receive special training, and providing them with basic supplies and equipment needed for effective prehospital trauma care (Joshipura *et al.* 2004).

In 2004, WHO in association with the International Association for the Surgery of Trauma and Surgical Intensive Care and the International Society of Surgery published *Guidelines for essential trauma care* (Mock *et al.* 2004) (Available from URL: www.who.int/violence_injury_prevention/publications/services/en/). This publication outlines a list of essential trauma care services along with human and physical resources that are required to deliver such services. A series of resource tables are available in the document, which detail the vital interventions along with knowledge, skills and resources required at different levels of the health care delivery system. In addition, various resources required for the management of head injuries, neck injuries, spinal injuries, chest injuries, abdominal injuries, extremity injuries, burns and wounds, pain, and rehabilitation are outlined in the report. Further, several requirements of training, performance improvement, integration of systems and coordination are discussed in detail (Mock *et al.* 2004). Developing a trauma care system in India needs inputs from all concerned stakeholders and a systematic approach to evolve a consensus for the formulation of national guidelines.

Acute care in hospitals

In a study of trauma outcomes in three different settings, Mock *et al.* noticed that the mortality rate in a low-income setting was 63% compared with 55% in a middle-income setting and 35% in a high-income setting (Mock *et al.* 1998). Apart from high-cost technology, the decline in death rate has been due to improvements in the organization and delivery of trauma care. In a recent nationally representative survey of trauma care facilities in India (Joshipura *et al.* 2003), it was observed that several barriers exist in the delivery of appropriate trauma care services. While cities with hi-tech hospitals and advanced trauma centres are beyond the reach of many in India, injured persons in rural areas have limited or no access to good quality care.

Accident and trauma care services have been identified as an important area for growth and development during the Tenth Plan period (Planning Commission 2003). The report acknowledges that 'there are no organized comprehensive trauma care services either at the Centre or State level.' It specifies that 'services developed in the past have not been linked to an effective multidisciplinary trauma care system'. The report further highlights that during the Tenth Plan period emphasis will be laid on adequate training of medical and paramedical personnel, provision of facilities for transport of patients, suitable strengthening of existing emergency and casualty services, and improving referral linkages.

Both research and experience have proved that with existing resources, many activities can be performed at peripheral levels with adequate knowledge and skills. This implies that staff (medical/non-medical) require training to perform these tasks with basic and refresher programmes. Availability of equipment means that these facilities are not only available but also functional, and can be put to use throughout a 24-hour period. Organizational support must be provided for skills enhancement, equipment

functioning and drug availability. Guidelines, standards and protocols for the management of injuries at different levels of the health care system need to be developed to deliver appropriate trauma care.

Rehabilitation services

Rehabilitation forms an integral part of overall trauma care. Restoring an individual to his optimum level of functioning, reducing impairments and handicaps, and improving the quality of life are the essential goals of this programme. Rehabilitation services have not developed uniformly in India. They are mostly concentrated in urban areas making it difficult for nearly 70% of the population living in rural areas to access any such care. Interventions for rehabilitation include assessment, developing an individual programme based on residual deficits and instituting combined rehabilitation measures. Minor support services—wound management, relieving contractures—should be available at *taluka* hospitals and above. Low-cost, useful walking-aid equipment such as crutches, wheelchairs and walkers should be readily available for use in community centres and above. While medical specialists would be able to provide advanced care, simple and regular physiotherapy exercises, reassurance and psychological support should be available at all levels of care. The required skills and training should be promoted for personnel at all levels from a PHC and above. Facilities for physiotherapy, minor reconstructive surgery for contractures, prevention and management of pressure sores, etc. should be available in district hospitals. Several drugs such as analgesics, antibiotics, dressing materials, plaster casts and anaesthetics should be easily available for regular use. Appropriate use of these techniques along with social support systems for employment, education and home care would be of help to many disabled persons and improve their quality of life.

Policies and programmes: A systems approach

Systems-related issues

Injuries are a reflection of absent or poor safety systems or policies and programmes. As injuries are not considered a major public health problem, a systems approach has been lacking to understand their causation and develop interventions with regard to broader systems-related factors. India does not have:

- A national policy on injury prevention and control (including trauma care)
- A nodal agency within any ministry to coordinate the range of activities
- A specified budget for injury prevention
- National guidelines/protocols on emergency care, injury prevention and trauma care
- Injury surveillance to track the growing epidemic (to identify crucial and targeted areas for intervention)
- A definitive policy on curriculum for undergraduate, postgraduate medical education and allied medical subjects
- A prioritized plan for human resource development and capacity-building programmes
- A mechanism for co-coordinated activities (as several agencies are involved in prevention and control of injuries)
- A prioritized, targeted, time-bound activity schedule for injury prevention and control
- A policy on safety and standards of products, and mechanisms to check safety of products.

A public health approach to the problem of injury emphasizes identifying the burden, understanding the determinants, implementing interventions and evaluating them to see whether and how they work (WHO 2002d). To understand problems and determinants, good quality and representative information is needed. Injury surveillance is a comprehensive tool available to track changing trends and patterns, identify causes, and evaluate interventions by systematic data collection, analysis and interpretation (WHO 2002c). Implementation of interventions needs developing, promoting, strengthening of existing mechanisms, which can show measurable changes at the community level. India has a number of laws but there is poor implementation, as is evident by the increase in the number of deaths and injuries. With multisectoral involvement in implementation of directly or indirectly related activities for injury prevention, there is no systematic, coordinated effort with one individual agency or Ministry. There has been an absence of collective effort in this area compared with many other national health problems such as HIV/AIDS, malaria, tuberculosis, etc. Injury prevention and control also requires informed decision-making by the Government, industry, NGOs and society. For a demonstrable reduction in deaths, injuries and disabilities, major initiatives are required in terms of formulation and implementation of policies and programmes on a cost-effective and sustainable basis. There is an immediate need

- To establish a lead agency (independent of any ministry) to effectively develop, implement, evaluate, coordinate, monitor and guide activities with sufficient resources, staffing and independent powers.
- To develop a national policy and strategies for injury prevention and control with a major thrust on reduction of RTIs, suicides, burn injuries, work-related injuries (including agricultural injuries) and violence. The strategy should aim at developing a plan of action (with measurable targets), which would be integrated, coordinated, cost-effective and sustainable.
- To formulate individual programmes with clearly defined goals, objectives, approaches and mechanisms based on consensus to implement a National Road Safety Programme (at the time of completion of this report, the Ministry of

Road Transport and Highways had formulated a draft proposal on National Road Safety Policy [URL: www.morth.nic.in]), National Suicide and Violence Prevention Programme, National Work Safety Programme (including the unorganized labour sector), National Burns Prevention Programme, National Poisoning Prevention Programme and others.

- To allocate adequate financial and human resources for injury prevention and control and safety promotion at all levels of national and State systems to promote programmes.
- To prioritize and implement all known and proven counter-measures for prevention and control of RTIs, suicides, burn injury, occupational injuries, etc. by greater political commitment, and involvement of professionals and policy-makers.
- To focus on developing institutional mechanisms by establishing advanced centres, which could work independently to find solutions by providing adequate human and financial resources.
- To develop a comprehensive national policy on building an effective trauma care system including emergency care, acute hospital care and rehabilitative care along with strengthening the skills of the existing manpower, allocation of resources and promoting rational use of technology.
- To institute mechanisms to systematically collect, analyse, disseminate injury-related data from health and related sectors by establishing surveillance mechanisms and trauma registries to develop evidence-based understanding of problems and solutions with a focus on developing cost-effective and sustainable intervention policies and programmes.
- To facilitate urgent mechanisms for capacity building, strengthening the knowledge base and promoting research across all sectors (road engineering, vehicle manufacture, health, the police, legal professionals and others) connected with injury prevention and control. Within the health sector, strengthening the knowledge and skills of medical and allied students, and upgrading the skills of doctors at various levels of health care are essential.

The benefits of successful implementation of the above policies and programmes include: (i) a reduction in deaths caused by injuries; (ii) a reduction in the number and severity of disabilities caused by them; (iii) an increase in the number of productive working years through reduction of death and disability; (iv) a decrease in the costs associated with initial treatment and continued rehabilitation of trauma victims; (v) a reduced burden on local communities as well as the State and Central Governments in support of disabled trauma victims; and (vi) a decrease in the impact of the disease on 'second trauma' victims—their families.

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