Growing burden and impact of road crashes in India: need for a safe systems approach

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Abstract: As per estimates, nearly 175,000 (136,900 as per official reports) persons died due to road crashes in India in 2011 along with hospitalisations and disabilities among survivors. More than 70–80% of these deaths and injuries occurred among young people, men and among pedestrians, two wheeler riders and pillions, and cyclists. The economic loss due to road crashes is an estimated $550 billion (INR 55,000 crores) or 3% of GDP (at 2004 prices) every year. Road safety in India requires a scientific approach for making road users safer in all traffic environments considering the limitations of human behaviour. There is need for strong road safety policies and programmes, a lead agency to coordinate activities, capacity strengthening, human resources, dedicated funding, strong advocacy, implementing scientific interventions, along with monitoring and evaluation. The 4'E's of Engineering, Enforcement, Education and Emergency Care need to be addressed through an intersectoral approach. In India, road deaths and other injuries are publicly glaring, while road safety is professionally lacking and politically missing and needs to be corrected for making road environments safer through multipronged approaches.

Keywords: road traffic injuries; mortality; morbidity; disability; prevention; trauma care; rehabilitation; vehicle safety; safe systems.

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1 Introduction

As per the global burden of disease analysis for 2010, Road Traffic Injuries (RTIs) are a leading cause of death contributing to 2.5% of all deaths globally as well as in the South-Asian region. The estimated number of deaths due to RTIs is 1.33 million globally and

0.3 million in South-Asia for the year 2010. Thus, South-Asia contributes to 23.3% of all Road Injury (RI) deaths globally. Over the last two decades, the proportionate contribution of RI deaths has increased from 1.4% to 2.5% in South-Asia (Global Burden of Disease Study, 2010).

Indian society is changing at a rapid pace due to socio-demographic and epidemiological transition. Globalisation, industrialisation, urbanisation, migration with increasing motorisation has contributed for several benefits, but has also resulted in the emergence of several new problems in the Indian society. This transition is witnessing the presence of the triple epidemic of communicable and non-communicable diseases and injuries. Road crashes and deaths are becoming a matter of serious concern and a major public health problem in the last two decades with increasing number of deaths, hospitalisations and disabilities especially among the productive young population. The problem is likely to increase and situation will worsen if road safety is not given urgent priority.

2 Transportation and motorisation patterns

The population of India has increased by more than 181 million during the decade 2001–2011 to 1.21 billion in 2011 (Office of the Registrar General and Census Commissioner, 2011). Nearly half of India's population is in the age group of 15–59 years, with children and elderly constituting 42% and 7%, respectively. Only 30% of India's population lives in urban areas and is expected to reach 473 million by 2021 and 820 million by 2051 (Central Bureau of Health Intelligence, 2011). Increasing population and accompanying societal changes has brought a greater need for travel in the Indian society. As people have to commute for work, education and other leisure time activities, the reliability on transport has grown significantly in the last few years. The rapid motorisation is due to a combination of several factors like increasing necessity for personal mobility, easy availability of vehicles, poor public transportation systems, increasing purchasing power, easy availability of finances through banking institutions, aggressive promotion by vehicle industry and media and several other factors.

The total number of vehicles increased by threefold from 37 million in 1997 to 114 million by 2010 with two wheelers alone accounting for 73% of total registered vehicles (MORTH, 2012). The data from Ministry of Road Transport and Highways (MORTH) indicates that nearly 74% of Indian registered vehicles and those plying on roads are motorised two wheelers. Currently, the two wheeler density in India is around 45 per 1000 population as compared to cars which is about 8 per 1000 population (MORTH, 2013a). In addition, the non-motorised modes of transport like walking and cycling constitute a greater share of transport in both urban and rural areas. This salient observation with greater number of two wheelers, pedestrians and pedal cyclists makes India as one of the countries with high vulnerable population in the absence of safe transport policies and systems.

The need for travel and transport has been growing rapidly in India. Nearly 80% of passenger and 65% of freight transport demand is arising from land based modes of transport. With a road network of 3.34 million kilometres, India has the second largest road systems in the world. Traffic on roads is growing at a rate of 7–10% per annum

while the vehicle population growth is of the order of 10.16% per annum. The total length of national highways in the country at present is 79,243 km comprising only 1.7% of the total road network, but carries over 40% of the total road traffic (MORTH, 2013b). The national highways passing through millions of villages account for only 2% of total road network while transporting 40% of goods and contribute for 40% of road deaths (MORTH, 2011).

Several factors like social, economic, cultural attitudes and practices of people apart from age, gender, socioeconomic status, education, occupation, travel needs, transportation mode and others (apart from his/her knowledge, attitudes, beliefs and practices) have an influence on road use patterns and road user behaviour. It is further influenced by the prevailing systems, safety regulations and norms along with importance given for safety and thereby to people's lives. In some cities in India, usage of personal modes of transport is up to 80% as compared to public transport which has been <1% of total traffic at peak hours (Mohan, 2004). In India, as mentioned earlier, pedestrians, two wheelers and public transport vehicles are in large numbers on both urban and rural Indian roads; and a high proportion of travel is by walking, cycling or on two wheelers, as majority still cannot afford cars (Mohan, 2004; World Bank, 2005; Gururaj, 2006). The high dependency on motor vehicles has also contributed for many other health problems like respiratory diseases due to increasing air pollution and more number of auditory problems due to noise pollution apart from the increased stress of driving leading to increasing occurrence of stress related disorders like hypertension, diabetes, anxiety, depression, alcohol abuse and other health conditions.

2.1 Road safety information systems

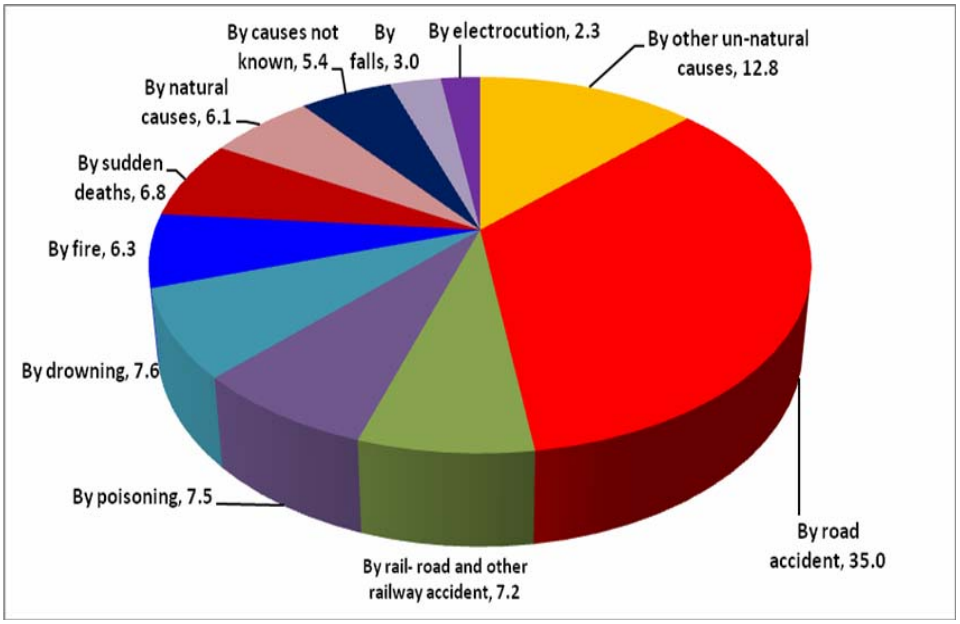
In a recent review by Barffour et al. (2012) it has been observed that the publicly available road safety data in India is yet to be improved as there is no data on safety performance indicators in the National Crime Records Bureau (NCRB) database. From the Ministry of Road Transport and Highways (MORTH) database, data availability on safety performance indicators was 60% at both national and state levels. Data availability on costs and process indicators was found to be below 20% at the national and state levels (Barffour et al., 2012).

Information on the burden of RTIs in India is available from multiple sources. However, none are complete and total in nature. Data on fatal RTIs are captured by police agencies as RTIs are medico legal in nature in India. The available police data indicates broad patterns across the country with variations across the years. In addition, there is information on some socio-demographic characteristics like age, sex, place of residence, state/region, urban/rural, impacting vehicle (not the affected road user) and time of road crashes. Underreporting of road crashes, fatal and non-fatal injuries in police sources has been reported in previous studies (Gururaj et al., 2000; Dandona et al., 2008), but is still a reliable source of data. The information from Transport Research Wing of the MORTH has similar data with minor variations on different variables. Both data sources are dependent on police reporting practices. Even though all hospitals provide care for RTI victims, there is no reporting system or surveillance from hospitals or their mortuary centres. Data from other sources like judiciary, welfare and insurance sector are not available in the public domain and are also not focussed in nature. Recently,

surveillance studies (pooling data from multiple sectors of police, hospital and mortuary) in few centres are in progress and are still not operational across the entire country (Gururaj, 2011a). Research studies are only few and handful and are not nationally representative in nature. Thus, there is a great paucity of RTI data in India.

As per NCRB, in 2011, 3,90,884 persons died due to all accidental injuries and 1,36,900 persons died due to road crashes with nearly 67% of accidental deaths occurring in less than 45 years and 80% among men (NCRB, 2012). Considering underreporting, it is estimated that a million deaths occur annually due to all injuries in India (Gururaj, 2005). Among accidental deaths in 2011, RTIs contributed for 35% of total deaths (Figure 1). However, in a nationally representative mortality survey, Jagnoor et al. (2010) reported that RTIs (1,85,000 deaths; 29% of all unintentional injury deaths) were the leading causes of unintentional injury mortality.

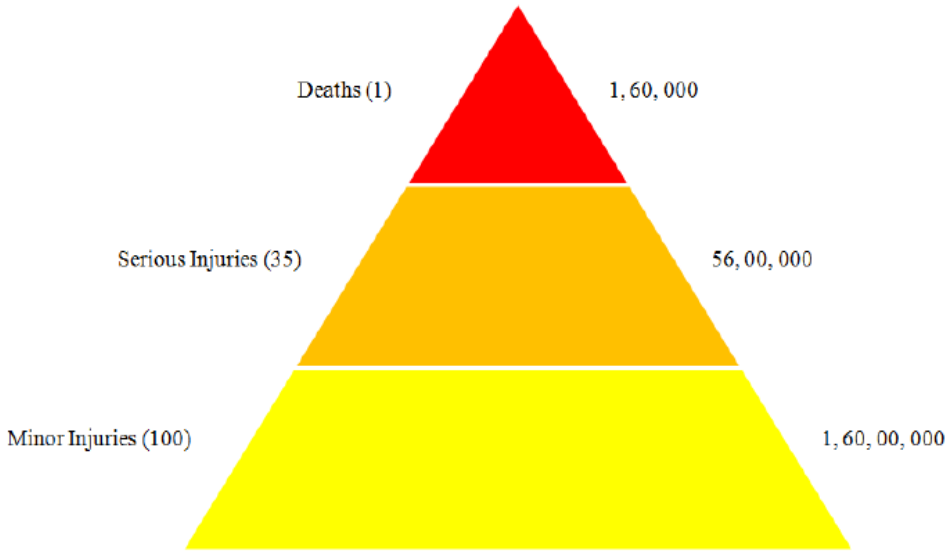
Figure 1 Distribution of injury deaths as per external causes of injuries, NCRB, 2011 (see online version for colours)



The actual number of road deaths and injuries in India could be much higher than official numbers due to underreporting as per evidence from several studies. The study in Bangalore highlighted an under reporting of 5–10% for road deaths and more than 50% for injuries (Gururaj et al., 2000). A population survey covering 20,000 households and 96,000 individuals from urban and rural Bangalore reported an annual RTI mortality rate of 240 per million population, much higher than the figures reported by police statistics (Gururaj and Suryanarayana, 2004). The recently completed verbal autopsy injury studies have also indicated the higher occurrence of injuries and RTIs (Joshi et al., 2006; Gajalakshmi and Peto, 2007). Dandona et al from Hyderabad city, also reported a three

times higher RTI related mortality rate (380 per 1,00,000) than the official figures (Dandona et al., 2008). In view of these observations, the actual number of RTI deaths is estimated to be in the range of 1,60,000–1,75,000 for the year 2011 (Figure 2).

Figure 2 India RTI pyramid, 2011 (see online version for colours)



3 Public health burden of RTIs

3.1 Mortality

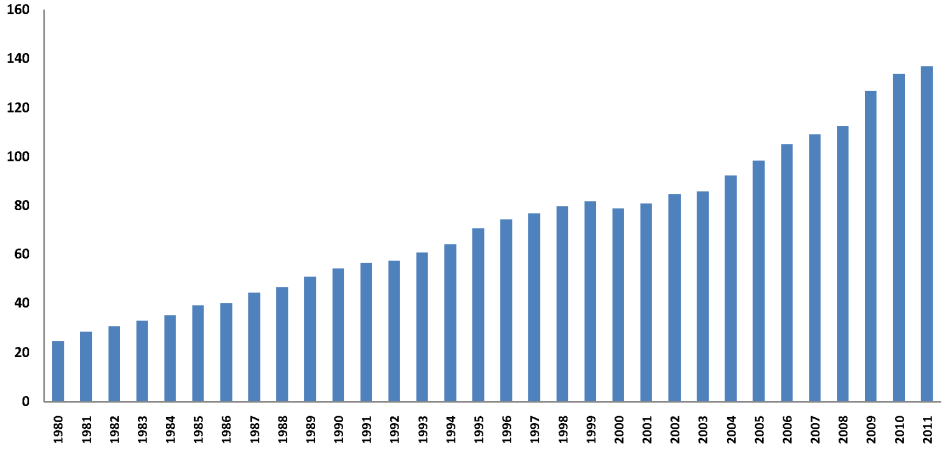
Globally, RTIs contribute over 1.2 million deaths and more than 50 million hospitalisations (WHO, 2004). In India, 136,900 persons died and 468,000 were injured in road accidents during 2011 as per official reports (NCRB, 2012). As per transport data RTIs increased by 61% during the decade and by 2.2% as compared to 2010 (MORTH, 2012). The trend of RTIs reveals that RTIs increased from 43,005 in 1980 to 136,900 by 2011 (Figure 3). Between 1970 and 2010, the number of crashes increased by 4 times, with more than sevenfold increase in injuries, eightfold increase in fatalities against the backdrop of about 64-fold increase in vehicles and threefold increase in road length (MORTH, 2012; NCRB, 2012). The RTI mortality rate in India for 2011 was 110 per million population and 1200 per million vehicles (MORTH, 2012).

3.2 Hospitalisations

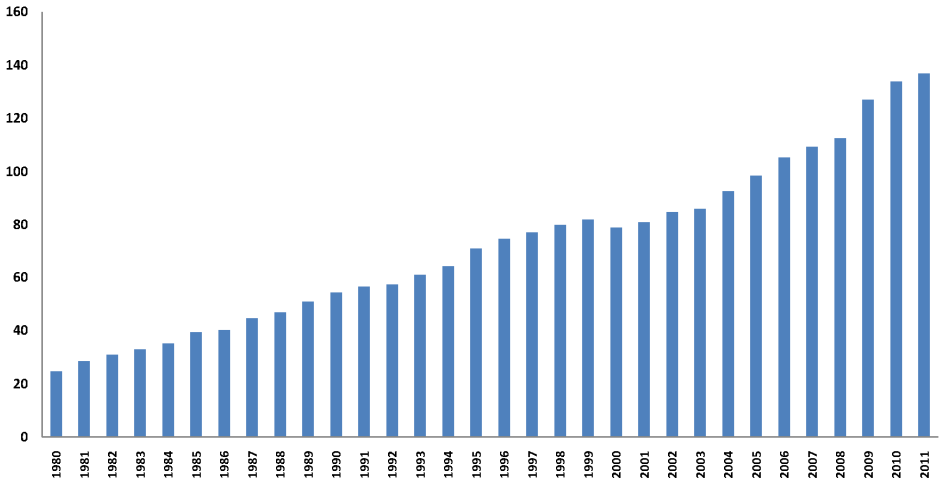
Deaths are only a tip of the iceberg in road crashes. The Bangalore Road Safety and Injury Prevention Programme (BRSIPP) showed that while 5667 non-fatal injuries were reported to the police, 26,862 persons were registered in just 25 hospitals of the city in

2009; for every death, 35 persons were hospitalised and 100 persons sought emergency care for minor injuries; RTIs contributed for 9% of casualty registrations, 3.5% of hospital admissions and 7.5% of deaths (Gururaj, 2010). Several other Indian studies have revealed that RTIs alone accounts for nearly one fourth of emergency room registrations. The incidence of non-fatal RTIs in Hyderabad was estimated to be 207 per 1000 per year (Dandona et al., 2008). Varghese and Mohan (2003) reported the ratio between critical, serious and minor injuries to be 1 : 29 : 69. Nationwide hospital based studies are essential to accurately estimate the number of persons hospitalised in India due to injuries which could vary between 8–10 million (minor injuries among 16–20 million).

Figure 3 Trend of road traffic fatalities (a) and injuries (b) in India, 1980–2012 (in thousands) (see online version for colours)



(a)



(b)

3.3 Disabilities

RTIs not only have the direct impact of death or injury, but also leave behind suffering in the form of disabilities along with psychosocial and economic loss. Nearly one third of the disabilities in India are due to injuries with one fourth of these being due to RTIs (Gururaj, 2006). In Hyderabad, Dandona et al. (2008) estimated the disability rate due to RTIs to be 35 per 1,00,000. The Bangalore traumatic brain injury study showed that 18% of hospital discharged brain injured persons at the end of two years had disabilities affecting speech, memory and activities of daily living (Gururaj, 2005).

3.4 Impact of RTIs

The impact of RTIs is huge and phenomenal and there is minimal understanding of the nature and extent of impact. There is limited data from around the world, especially from Low and Middle Income Countries (LMICs). At the global level, the economic losses are estimated to be $518 billion per annum with LMICs contributing for $65 billion as per the world report on RTI Prevention (WHO, 2004). In India, as per estimates from MORTH, RTIs account for 3% of GDP losses per year (MORTH, 2011). An independent review by Transportation Research and Injury Prevention Programme, Delhi estimated the annual economic losses due to RTI to be approximately $550 billion (Mohan, 2004). A few of the hospital based studies indicate that nearly two third of the injured patients spent on an average, an amount ranging from Rs. 25,000 to Rs. 1,00,000 as out of pocket expenditure with a median expenditure of Rs. 40,000 (Pallavi, 2010). A Study from urban Hyderabad also outlined the high burden of out-of-pocket medical and total expenditure associated with RTIs in India (Kumar et al., 2012).

It is essential to recognise that most RTIs victims in India belong to low and middle income households. A population based survey in Bangalore revealed that the mortality in poor income households was 13.1 and 48.1 per 100,000 population in urban and rural areas respectively as compared to 7.8 and 26.1 per 100,000 population in their affluent non-poor counterparts (Thomas et al., 2004). The high costs of RTIs are also due to greater number of RTIs in poor income households and also their limited access to quality trauma care at a time when trauma care costs are increasing significantly across the country.

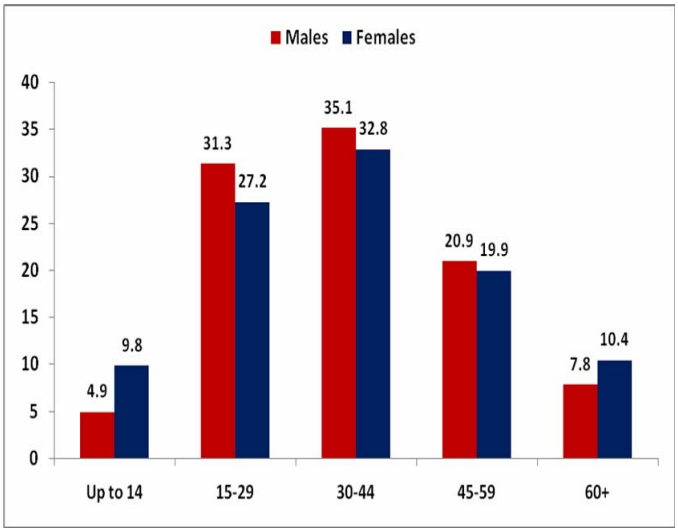
Apart from the economic impact, the social and psycho-social impact of RTIs is also phenomenal in India. RTIs result in loss of employment, education, leisure time activities and also impose huge economic costs as a significant proportion of the affected have to make emergency arrangements by selling their assets. Data from a brain injury registry indicate that nearly 14% of children and 18% of employed could not attend schools and jobs, respectively, for more than six months. One-third of rural and 20% of urban unemployed persons could not return to their jobs after the tragic event of a brain injury (Gururaj et al., 2005). The population based survey revealed that nearly half of the families had made heavy loans, sold assets or pawn on their belongings to meet the emergency situations (Thomas et al., 2004).

3.5 Age and gender

As per Global Burden of Disease report, there is a strong male preponderance with 79% of all road injury deaths in South-Asia and 75% of all deaths globally being males in

2010. Further, majority of these deaths take place in the 5–59 year age group. Nearly 15% of all deaths among males in 15–19, 20–24 and 25–29 years age groups are due to road injuries (Global Burden of Disease Study, 2010). In India, RTIs are commonly observed among young productive population, while infectious diseases predominantly target children and chronic degenerative diseases affect the elderly. The NCRB data (Figure 4) indicate that RTIs among children less than 14 years and those in 15–44 years accounted for 5.3% and 65%, respectively (NCRB, 2012). Data from the four years of Bangalore Road Safety and Injury Prevention Programme undertaken in both urban and rural areas indicate that more than 70% of the killed and injured were in 15–44 years and predominantly males (Gururaj, 2011a). Even though four out of five individuals are men, the occurrence of RTI among females is increasing in recent years due to the greater participation of women in education, employment and other activities.

Figure 4 Distribution of RTI deaths in India as per age and gender (%), 2011 (see online version for colours)



4 RTIs and Indian highways

The infrastructure expansion in India is increasing at a significant pace in recent years. Several reports indicate the greater occurrence of road crashes on both national and state highways and several anecdotal media reports confirm these observations. Nearly one third of the crashes and deaths occurred on national highways and 26–28% of deaths occurred on state highways in 2009 (MORTH, 2011). Data from the four years of Bangalore Road Safety Programme indicate that among cases brought to urban health care institutions, one third of them were due to crashes that had occurred on interconnected neighbouring highways. In addition, data from the rural component of the programme indicate that nearly half of the deaths had occurred on the three highways passing through the district (Gururaj, 2010). Even though precise data on the characteristics of highway crashes are not known clearly, it is presumed that the nature of

vehicles, highway design, road conditions, road user behaviour, traffic generators, visibility issues, speed differentials (recently built highways promote mobility along with greater speeds with less emphasis on safety) and greater presence of alcohol might be some of the contributing factors.

5 Geographical distribution

In recent years, urbanisation and motorisation have become the hallmarks of Indian economic growth. As mentioned earlier, the number of vehicles on Indian roads has been increasing at a significant pace with variations across different states and cities of India. Consequently, Indian states and cities that are motorising rapidly due to reasonably good economic growth are also registering increasing number of road crashes, deaths and injuries. In 2011, the five rapidly growing cities contributed for nearly 35% of road deaths among the 32 mega cities of the country. However, it is interesting to note that the urban share of road crashes is only 15% of the total road crashes in the country. Five southern states of India account for nearly half of total road deaths and injuries in the country (MORTH, 2012). An additional contributing feature for this scenario is the absence of national and regional safety policies and programmes that address different types of road users.

6 Vulnerable road users

The heterogeneous traffic environment in India and other LMICs places number of vulnerable road users at high risk of sustaining road crashes. Data from several hospital based and population based studies on RTIs in India indicate that nearly 80% of those killed and injured on Indian roads are primarily pedestrians, two wheeler riders and pillions and pedal cyclists, a group commonly referred to as vulnerable road users. However, as national data from NCRB register only the impacting vehicle, the number of vulnerable road users is relatively low in national databases. The greater involvement of these groups in road crashes is due to their larger numbers accompanied with a greater degree of exposure in heterogeneous traffic environments. Data from the four years of Bangalore Road Safety Programme confirmed these observations with nearly 75–85% of injured and killed in both urban and rural areas belong to this category of vulnerable road users (Gururaj, 2011b). The specific involvement of these groups varies across urban and rural areas, highways and non-highways and residential to non-residential areas.

7 Understanding road crashes

Road crashes are complex events involving interactions between vehicles, road users and the road environment and are primarily related to generation and transfer of energy to the susceptible individuals. The complexity of this interaction varies from environment to environment. The increased probability of road crash is directly linked to presence of risk factors or absence of protective factors. Road crash investigation and analysis is not in existence in India due to limited emphasis placed on multisectoral research. Thus, many

of the official agencies and many independent studies have concluded that driver fault is the single most important factor that contributes for more than 90% of the crashes (MORTH, 2011; Mondal et al., 2011).

The world report on RTI prevention outlines causes of road crashes at four different levels linked to exposure to risk, crash environment, severity of injury and factors influencing post crash care (WHO, 2004). Though there are no comprehensive studies that have examined the causation of road crashes in India, a summary of the observations reveal the following factors to be contributory in nature (Mohan, 2004; Gururaj, 2006; Pruthi et al., 2010; Gururaj, 2011a; Das et al., 2012).

- Road designs and standards contribute in a significant way for the occurrence of road crashes. The recent infrastructure development has primarily tried to address rapid mobility by relegating safety to the periphery.
- Speed is a major contributor in all fatal and serious road crashes in India. Studies from New Delhi and Bangalore indicate that excessive speed on intercity and inner city roads and presence of vehicles that can be driven at inappropriate and excessive speeds are one of the major contributing factors.
- The relatively low use of safety devices like helmets, seat belts and child restraints has been recognised as a major contributory factor. Even in situations where corresponding legislations are present, the enforcement has been found to be poor with limited knowledge of the safety benefits among road users as shown in a study by National Institute of Mental Health and Neuro Sciences (NIMHANS); mortality rate was 2.2 times higher in drivers without helmet as compared to drivers with helmet.
- Driving under the influence of alcohol is extremely common in India and alcohol increases deaths and injuries on roads. Nearly one third of crashes occur during night time and a third of these are linked to alcohol. Studies done by NIMHANS over time have revealed that 20–30% of injured patients brought to hospitals between 7 p.m. and 7 a.m. were found positive for alcohol. A review by Das et al. (2012) also highlighted that 2–33% of injured and 6–48% of killed RTI victims had consumed alcohol or drugs.
- Poor visibility on Indian roads has been recognised as an important contributing factor as nearly one third of road deaths take place during night times.
- Risk taking behaviour by pedestrians accompanied with lack of safety on roads leads to greater involvement of pedestrians in road crashes. Collision of pedestrians with high speeding heavy vehicles results in greater number of deaths due to higher energy transfer.
- The deficient trauma care services in terms of both pre-hospital and in-hospital care is one of the major factors for higher number of deaths and severely disabling injuries in both urban and rural areas accompanied with increasing of costs of trauma care. Several factors like delayed time interval, absence of first aid and triage, poor transportation facilities, lack of preparedness of the hospitals, deficient manpower and other resources are all found to contribute for negative outcomes in road crashes.

8 Towards safe system approach

As road crashes are complex events that occur due to varied interactions in different road environments, it is crucial to identify the determinants of the crashes to evolve safety programmes. As there could be several factors that contribute in different gradations it is important to separate these factors as those that can be modified and those that cannot be modified. The focus in road safety should be on ensuring that crashes do not occur; if it occurs, individuals are provided care at the earliest possible time and further on to see that individuals are rehabilitated to the best possible extent. Beginning with the classical epidemiological approach of agent, host and environment, the field of road safety has grown significantly over time with revision of concepts and approaches. The Haddon's matrix of 1970s revolutionised the understanding of road crashes and provided a framework for understanding the role and involvement of several factors that contribute before, during and after the crash in relation to the person, vehicle and the environment (Haddon, 1968). The public health approach enabled in delineating the problem, identifying the risk factors, development of appropriate interventions and ensuring whether interventions delivered the expected results (Mohan et al., 2006).

As road traffic injures are multifactorial in nature, the solutions need to be intersectoral and multiple in nature. Further, solutions should be sustainable and cost effective in nature. The safe systems approach recognises that road users are likely to make errors for a variety of reasons, knowingly or unknowingly, as risk taking is a component of human behaviour. Hence, the emphasis has shifted from addressing individual components to implementing safe systems that accommodates human vulnerability and fallibility. By understanding the human tolerance there is a need to develop road safety systems to see that crashes do not occur and even if it occurs results in no or minimal damage. This approach considers the multiple interactions and identifies the factors to be addressed in reducing road crashes with a primary focus on making the traffic environment less hazardous by focusing on safe roads, safe vehicles and safe people. The combined effects of all this will result in safe travel for different road users (WHO, 2010). The safe system approach needs to be significantly promoted in India and many other countries.

9 Decade of road safety

Recognising the need to reduce the road deaths and injuries, the United Nations recently declared the decade for road safety 2011–2020 by developing the global plan for the Decade of Action. The goal of the decade is to stabilise and reduce the number of lives lost. The overall goal is to reverse the increasing trend of RTIs around the world by augmenting activities at the national level to strengthen road safety management at different level through a multisectoral approach. The five recognised pillars of activities are – building road safety management capacity, improving road infrastructure and transport network, improving safety of vehicles, enhancing the safe behaviour of road users and strengthening post crash care. A combined approach on all these five pillars would definitely result in a reduction of road deaths and injuries in India and other low and middle income countries (WHO, 2013).

10 Summary

Road deaths and injuries will continue to increase in India, if systematic mechanisms are not put in place. This need not happen at a time when sufficient knowledge exists for prevention and control of road crashes. The Decade of Action for Road Safety is a historic opportunity for India to develop a framework for action which could ultimately save significant number of lives across the ten year period. The goal of the decade is to stabilise and then reduce the number of lives lost. It is time to set in place strong mechanisms for saving lives on Indian roads.

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